



UNIVERSIDADE FEDERAL DA PARAÍBA
CENTRO DE TECNOLOGIA
PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIA E TECNOLOGIA DE
ALIMENTOS

LARY SOUZA OLEGARIO

AVALIAÇÃO DA PERCEPÇÃO TEMPORAL DINÂMICA DE PRODUTOS
ALIMENTARES MAIS SAUDÁVEIS E EMOÇÕES EVOCADAS POR
CONSUMIDORES DO BRASIL E DA ESPANHA

JOÃO PESSOA – PB

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Tese apresentada ao programa de Pós-Graduação em Ciência e Tecnologia de Alimentos da UFPB em cumprimento aos requisitos para obtenção do título de Doutor em Ciência e Tecnologia de Alimentos.

Orientadora: Prof^a Dr^a Marta Suely Madruga
Co-orientadora: Prof^a Dr^a Sonia Ventanas Canillas

JOÃO PESSOA – PB

2021

Catálogo na publicação
Seção de Catalogação e Classificação

045a Olegario, Lary Souza.

Avaliação da percepção temporal dinâmica de produtos alimentares mais saudáveis e emoções evocadas por consumidores do Brasil e da Espanha / Lary Souza Olegario. - João Pessoa, 2021.
213 f. : il.

Orientação: Marta Suely Madruga.

Coorientação: Sonia Ventanas Canillas.

Tese (Doutorado) - UFPB/CT.

1. Alimentação. 2. Alimento saudável. 3. Cultura alimentar. 4. Léxico emocional. 5. TDS. 6. Avaliação sensorial. I. Madruga, Marta Suely. II. Canillas, Sonia Ventanas. III. Título.

UFPB/BC

CDU 612.3(043)

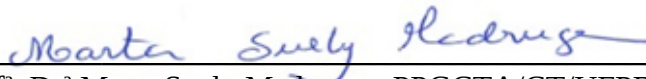
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Alimentos.

Tese aprovada em 01 / 07 / 2021

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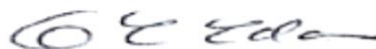
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A Deus, família e mestres

Dedico

AGRADECIMENTOS

Agradeço a Deus em Sua santíssima Trindade por me conceder sabedoria para concretizar sonhos. À virgem Maria por me abençoar e a São Miguel Arcanjo por me proteger.

A FAPESQ pela bolsa concedida para realização deste doutorado (88887.142386/2017-00) e ao CNPQ pelo suporte financeiro para realização do Doutorado Sanduíche no Exterior (208398/2017-1).

A Universidade Federal da Paraíba e a Universidad de Extremadura por disponibilizar toda infraestrutura necessária para o desenvolvimento do meu projeto de tese e possibilitar meu crescimento científico.

À minha orientadora Prof.^a Dr.^a Marta Suely Madruga por me acolher tão generosamente na UFPB, me oportunizar crescimento profissional e pessoal e transferir tanto conhecimento. A sra é incrível. Obrigada por torcer por mim em cada desafio, isso me fortalecer. Que um dia eu possa retribuir tanta dedicação e amor.

À minha coorientadora Prof.^a Dr.^a Sonia Ventanas por me receber na Espanha com tanto carinho, me ensinar novas técnicas sensoriais, confiar no meu trabalho e tornar possível esta tese. Foram experiências únicas que pude viver no IPROCAR mas também com você e sua família. A senhora junto ao Prof. Dr. Mario Estévez, são exemplos de pesquisadores, e de pais de Elena e Lucia. Obrigada por me acolherem também como amiga e por todos os momentos compartilhados. Jamais esquecerei.

Aos membros da banca examinadora Prof.^a Dr.^a Maria Aparecida, Prof.^a Dr.^a Elza Iouko Ida, Prof.^a Dr.^a Taliana Bezerra e Prof. Dr. Mario Estévez, pelas valiosas contribuições que enriqueceram a versão final desta tese. Vocês me inspiram.

A todos os membros do PPGTA, em especial ao ex Coordenador Prof. Dr. Flávio Honorato e a atual Coordenadora Prof.^a Dr.^a Taliana Bezerra e os secretários Lindalva Nóbrega, Fernanda Feitosa e Neto, pela competência, amizade e por não medirem esforços para ajudar sempre. À querida Prof.^a Dr.^a Rita Queiroga (*in memorian*) pelos primeiros incentivos no doutorado e por toda dedicação e amor ao ensino e pesquisa que exalava em sua vida.

Aos participantes das sessões sensoriais por contribuírem voluntariamente na construção desta pesquisa.

Aos meus pais, Maria Olívia e Lindoelson Olegario, por tanto amor, por me apoiarem em cada decisão, me fortalecerem em cada desafio, acreditarem em mim e dar asas. A meu irmão Laion Olegario que também é meu amigo, que me inspira, me encoraja e apoia. Amo vocês incondicionalmente. A toda minha família materna e paterna que me trazem muita alegria e paz.

A toda família “Padrão Madruga” por todos os momentos vividos dentro e fora do laboratório. Em especial a Thayse Cavalcante, pela vida compartilhada e a Ana Rita Ribeiro, Mércia Galvão, Leila Moreira, Narciza Arcanjo, Lorena Lucena, Samara Macêdo, Juliana Lopes, Mariana Oliveira, Simone Franca, Álida Soares. Cada uma de vocês deixou um pedacinho em mim.

Aos profissionais da Universidad de Extremadura Professores Dr. Juan Jose Cordoba, David Morcuende, Trinidad Pérez-Palacios, Teresa Antequera, Jorge Ruiz-Carrascal, Antonio Jiménez, Montaña Rufo. Aos pesquisadores Irene Martín, Eva Cébian, Mariela Álvarez, Patricia Padilla, Juan Carlo, Alberto Alía e muitos outros que me acolheram, compartilharam momentos de muita alegria. A Luciana Ruschel, Mauricio Brun e Chiara Brun por me acolher como família e me fazer sentir em casa, minha eterna gratidão.

Às minhas amigas Bianca dos Santos, Graciete da Silva, Danieli Shabo por todas as aventuras e tantos momentos felizes que compartilhamos em João Pessoa. Por muitos anos vocês também foram minha família. Aos meus amigos Silvia Gassi, Lucia Regidor, Marta Aunió, Jesus Porto, Jesus Barbero, Bruno Daniel, Eduardo Ferreira, Caroline Van Dessel, Luciana Kallenbach, Beatriz Martinez, Ana Caroline, Monica Sánchez, Leticia Carrero, Sydney Ellis, Nolan Dickson, que compartilharam a vida, passeios e viagens, tornando minha estadia em Cáceres tudo mais leve. Amo vocês.

A Alberto González-Mohino por todo companheirismo, cumplicidade, amizade e paciência. Com certeza, mesmo de longe, compartilhar a vida pessoal e profissional com você é incrível.

A todos que, de forma direta ou indireta, tenham contribuído para a realização deste trabalho.

“O que se faz por amor não é pequeno”

(Santa Faustina)

RESUMO

A associação do consumo de alimentos e a promoção da saúde muitas vezes vai em contrapartida às expectativas sensoriais dos consumidores quanto a produtos considerados mais saudáveis. A percepção de saudabilidade depende de hábitos culturais e alimentares do consumidor. Compreender de forma mais realista a percepção sensorial dos consumidores a partir de avaliações dinâmicas temporais, bem como as emoções geradas pelo estímulo de diferentes categorias de alimentos por diferentes culturas, podem trazer informações valiosas para o setor industrial. Neste contexto, foram realizados dois experimentos: o primeiro objetivou avaliar a aceitabilidade e percepção temporal dinâmica de quatro categorias de alimentos comerciais e suas versões mais saudáveis; o segundo objetivou devolver o léxico emocional evocado por três categorias de alimentos com consumidores de diferentes culturas (Brasil e Espanha) e avaliar as respostas emocionais evocadas pelos estímulos de versões mais saudáveis e diante de um contexto adequado de consumo para cada cultura. No primeiro estudo foi realizado uma familiarização de 23 participantes para estabelecimento de um protocolo de avaliação da Dominância Temporal de Sensações (TDS) com abordagem *multiple intake* para as categorias de café, chocolate, batata frita e iogurte. Estes produtos foram avaliados em versões tradicionais e mais saudáveis (redução total ou parcial de açúcar, cafeína, lactose ou gordura) seguido de avaliação de aceitabilidade. Os parâmetros de tempo e duração de cada atributo e a aceitabilidade foram avaliados por ANOVA e Tukey ($p < 0,05$) e os dados das curvas TDS e curvas de diferença TDS. Para a categoria de chocolate, o aumento do cacau e a redução do teor de lactose influenciaram principalmente na dominância dos atributos doçura, leite, cacau, crocante e amargo. A ausência de cafeína ou adição de açúcar no café com leite modificaram a percepção temporal de doçura, amargor, sabor do café e textura corpo. A redução da gordura na batata frita influenciou o perfil dinâmico temporal, destacando a dominância dos atributos secura, crocante, sabor de batata e salgado, e apresentando maiores valores de dominância para os atributos de textura (resíduo, secura e crocante) quando comparadas às amostras clássicas. O iogurte sem lactose resultou em características sensoriais semelhantes ao iogurte clássico, exceto quando considerado as ingestões. Tanto para chocolate quanto para café, houve impacto positivo na aceitabilidade dos produtos reformulados, enquanto para batata frita e iogurte não houve influência. No segundo experimento foram coletados termos emocionais associados em estudos anteriores às categorias de produtos chocolate, batata frita e iogurte. No total, 437 brasileiros e 397 espanhóis participaram da pesquisa online com estímulos visuais dos alimentos e foram solicitados a indicar, utilizando o método CATA (*Check-All-That-Apply*) contendo o léxico emocional, validado para cada cultura, as emoções evocadas, e as ocasiões mais frequentes de consumo em quatro dimensões (tempo de consumo, localização, ambiente social e estado de fome). Dados sociodemográficos, aceitabilidade e frequência de consumo, e nível de consciência de saúde também foram coletados, e avaliados estatisticamente. O léxico emocional evocado foi diferente para cada estímulo alimentar e claramente influenciado pelo fator cultural. Os brasileiros associaram mais termos emocionais com mais frequência para todos os estímulos do que os espanhóis. No entanto, existem mais semelhanças entre as culturas ao avaliar a mesma categoria de produto. Os contextos evocados foram avaliados como apropriados e influenciaram na frequência de citação de alguns termos emocionais, inclusive os positivos. Ambas as culturas apresentaram consciência de saúde próxima a “concordo levemente”, maior nível de consumo, aceitabilidade e intenção de compra, e maior frequência de termos emocionais positivos para os estímulos de produtos convencionais e menor para suas versões mais saudáveis.

Palavras-chave: Avaliação sensorial. Alimento mais saudável. Cultura. Léxico emocional. TDS.

ABSTRACT

The association of food consumption and health promotion often goes against the sensory expectations of consumers regarding products considered healthier. The perception of health depends on the consumer's cultural and eating habits. More realistically understanding the sensory perception of consumers from dynamic temporal evaluations, as well as the emotions generated by the stimulus of different food categories by different cultures, can provide valuable information to the industrial sector. In this context, two experiments were carried out: the first aimed to evaluate the acceptability and dynamic temporal perception of four categories of commercial foods and their healthier versions; the second aimed to return the emotional lexicon evoked by three food categories with consumers from different cultures (Brazil and Spain) and evaluate the emotional responses evoked by the stimuli of healthier versions and in view of an adequate consumption context for each culture. In the first study, 23 participants were familiarized with the establishment of a protocol for the assessment of Temporal Dominance of Sensations (TDS) with a multiple intake approach for the categories of coffee, chocolate, potato chips and yogurt. These products were evaluated in traditional and healthier versions (total or partial reduction of sugar, caffeine, lactose or fat) followed by an acceptability assessment. The parameters of time and duration of each attribute and acceptability were evaluated by ANOVA and Tukey ($p < 0.05$) and data from the TDS curves and TDS difference curves. For the chocolate category, the increase in cocoa and the reduction in the lactose content mainly influenced the dominance of the sweetness, milk, cocoa, crunchy and bitter attributes. The absence of caffeine or added sugar in coffee with milk modified the temporal perception of sweetness, bitterness, coffee flavor and silk texture. The reduction of fat in potato chips influenced the temporal dynamic profile, highlighting the dominance of the attributes dryness, crispness, potato flavor and saltiness, and presenting higher dominance values for the texture attributes (residue, dryness and crispness) when compared to the samples classics. Lactose-free yogurt resulted in sensory characteristics similar to classic yogurt, except when considering intakes. For both chocolate and coffee, there was a positive impact on the acceptability of reformulated products, while for potato chips and yogurt there was no influence. In the second study, emotional terms associated in previous studies were collected in the categories of chocolate, potato chips and yogurt products. In total, 437 Brazilians and 397 Spaniards participated in the online survey with visual food stimuli and were asked to indicate, using the CATA (Check-All-That-Apply) method containing the emotional lexicon validity for each culture, the emotions evoked, and the most frequent consumption occasions in four dimensions (time of consumption, location, social environment and state of hunger). Sociodemographic data, liking and frequency of consumption, and level of health consciousness were also collected and statistically evaluated. The evoked emotional lexicon was different for each food stimulus and clearly influenced by the cultural factor. Brazilians associated more emotional terms more often to all stimuli than Spaniards. However, there are more similarities between cultures when evaluating the same product category. The evoked contexts were assessed as appropriate and influenced the frequency of citation of some emotional terms, including positive ones. Both cultures showed health consciousness close to "lightly agree", a higher level of consumption, acceptability and purchase intention, and a higher frequency of positive emotional terms for the stimuli of conventional products and lower for their healthier versions.

Keywords: Culture. Emotional lexicon. Healthier food. Sensory assessment. TDS.

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LISTA DE ABREVIATURAS E SIGLAS

ADQ	Análise Descritiva Quantitativa
ANOVA	Análise de Variância
CATA	<i>Check-All-That-Apply</i>
GEOS	<i>Geneva Emotions and Odour Scale</i>
HCQ	Questionário de consciência de saúde
IPROCAR	<i>Instituto Universitario de Investigación de Carne y Productos Cárnicos</i>
ISO	<i>International Organization for Standardization</i>
OMS	Organização Mundial de Saúde
PCoA	Análise das Coordenadas Principais
PPGCTA	Programa de Pós-graduação em Ciência e Tecnologia de Alimentos
TDE	<i>Temporal Dominance of Emotions</i>
TDS	Dominância Temporal das Sensações
UFPB	Universidade Federal da Paraíba

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1 INTRODUÇÃO

Uma dieta saudável ao longo da vida auxilia a prevenir a desnutrição em todos seus aspectos, bem como diferentes doenças e distúrbios não transmissíveis. No entanto, o aumento da produção de alimentos processados, a rápida urbanização e a mudança no estilo de vida levaram os consumidores a uma mudança nos hábitos alimentares. Atualmente, as pessoas optam por consumir mais alimentos hipercalóricos, gorduras, açúcares livres e sal/sódio e menos Frutas, verduras e grãos integrais, que são fontes de fibras, vitaminas e minerais (WHO, 2019a).

A Organização Mundial de Saúde propõe para 2025 a redução do sal como principal alvo dietético para reduzir a mortalidade consequente de hipertensão, e faz recomendações sobre a ingestão de açúcares para reduzir risco de sobrepeso e cáries em adultos e crianças, além de outras doenças não transmissíveis (WHO, 2016, 2017).

No contexto de escolhas alimentares mais saudáveis, a reformulação de alimentos é considerada uma das principais opções para alcançar metas nutricionais da população. Neste sentido, a indústria de alimentos pode desempenhar um papel importante, reformulando produtos com o intuito de promover dietas mais saudáveis (WHO, 2017) Esta reformulação dos alimentos consiste em alterar a composição de alimentos existentes para remover (por exemplo, ácidos graxos *trans*) ou reduzir (por exemplo, açúcares, gorduras saturadas, sal) alguns componentes alimentares, mantendo características tais como sabor, textura e *shelflife*.

Descrever as características sensoriais de um produto é uma prática comum na indústria de alimentos e bebidas, para a tomada de decisões de negócios, guiando o desenvolvimento de produtos que satisfaçam os anseios do consumidor; para verificar o efeito de determinados ingredientes e processos, para fins de controle de qualidade; para monitorar as alterações de produtos ao longo do tempo, desenvolver perfil de aroma e sabor e para correlacionar com as medições instrumentais (VARELA; ARES, 2014; YU; YIN; ZHOU, 2018). Devido a essas características, a aplicação de métodos sensoriais ao desenvolvimento de alimentos mais saudáveis vem ocorrendo naturalmente.

As reações físicas e químicas que ocorrem nos alimentos e bebidas durante a mastigação, a salivação por exemplo, proporciona influência em percepções sensoriais como, de aroma, sabor e textura. Devido a isto, métodos sensoriais dinâmicos vêm sendo

desenvolvidos e aperfeiçoados, como a técnica de Dominância Temporal das Sensações (TDS). Nesta técnica é possível medir a percepção temporal dinâmica dos atributos dominantes ao longo do tempo. Diante da abordagem de múltiplas ingestões (*multiple intake*) é possível gerar uma série de avaliações concatenadas de TDS (SCHLICH et al., 2013), simulando em uma abordagem mais real uma condição de consumo. A técnica TDS apresenta vantagem sobre os métodos sensoriais estáticos convencionais, por registrar as sensações dominantes percebidas pelo consumidor ao longo da degustação e assim coletar dados significativos para a descrição do produto. O TDS certamente alavancou a pesquisa na avaliação sensorial temporal em benefício das indústrias de alimentos e bebidas, que atualmente estão usando extensivamente (GALMARINI; VISALLI; SCHLICH, 2017).

Uma tendência recente na pesquisa sensorial e de consumo tem sido medir emoções e determinar até que ponto os sentimentos estão ligados à aceitação dos consumidores de alimentos e outros produtos de consumo (PRESCOTT, 2017). Esta tendência está sendo desencadeada diante da necessidade científica de conceituar melhor a experiência dos consumidores com os alimentos, levando assim a um maior interesse em integrar as emoções na pesquisa sensorial e de consumo.

Tendo em vista que a indústria está em constante busca de produtos que correspondam às necessidades dos consumidores, é importante uma melhor compreensão dos fatores que afetam a variação individual na percepção. Por isso, é essencial entender o fenômeno cultural observando a forma como se manifesta em um grupo cultural específico. (JAEGER et al., 2017; LEE; LOPETCHARAT, 2017). Pesquisas vêm sendo desenvolvidas neste sentido, com destaque para as conduzidas em países desenvolvidos ocidentais, e por isso, existe uma forte necessidade de considerar o comportamento do consumidor como uma questão global e a percepção dos consumidores em diferentes culturas no desenvolvimento de modelos e teorias, e particularmente, quando relacionados com países em desenvolvimento ou de baixa renda, que ainda está sub-representada na literatura (ARES, 2018; HOUGH; SOSA, 2015).

2 OBJETIVOS

- Avaliar a percepção temporal dinâmica de atributos de textura e sabor de quatro categorias de produtos alimentícios (café, chocolate, batata chips e iogurte) a partir da técnica sensorial de Dominância Temporal de Sensações com abordagem de múltiplas ingestões (*multiple intake*).
- Estudar as similaridades e diferenças no perfil dinâmico das versões clássicas e mais saudáveis destas quatro categorias de produtos correlacionadas com os níveis de aceitabilidade.
- Desenvolver uma lista de termos emocionais validados para três categorias de produtos comuns para as culturas do Brasil e Espanha (chocolate, batata chips e iogurte), e os contextos mais adequados de consumo.
- Avaliar o perfil hedônico dos consumidores do Brasil e Espanha e a influência do contexto de consumo na resposta emocional a estímulos das versões clássicas destes três produtos.
- Medir o nível de consciência de saúde dos consumidores do Brasil e Espanha e o impacto no perfil emocional evocado pelas versões clássica e mais saudável de cada produto diante um adequado contexto de consumo.

3 REFERENCIAL TEÓRICO

3.1 ALIMENTO SAUDÁVEL

A conceituação de “alimentação saudável” é onipresente no discurso médico, político e midiático, bem como nos discursos da população leiga (BERNAT; NEVOT, 2019; GASPAR et al., 2018). Embora exista um consenso científico sobre as características positivas/negativas de certos alimentos (AFSHIN et al., 2019), associações entre alimentos e saúde não se baseia apenas em conhecimento nutricional objetivo (SCARBOROUGH et al., 2007; THURECHT; PELLY; COOPER, 2018).

A classificação “saudável” e “não saudável” de um alimento é complexa. Geralmente, existe um consenso de que legumes, frutas e carnes brancas, especialmente peixes, são mais saudáveis, enquanto alimentos com alto teor de gordura ou açúcar e alimentos industriais não são saudáveis (GASPAR; GARCIA; LARREA-KILLINGER, 2020). No entanto, a categoria de “saudável” é assim determinada de acordo com construções científicas e socioculturais (DE AZEVEDO, 2008; DÍAZ-MÉNDEZ; GÓMEZ-BENITO, 2010).

Existe um amplo conhecimento científico e orientações disponíveis que conduzem para uma alimentação saudável, porém, há um desafio quanto a resistência da população a mudar o consumo excessivo de açúcares, gorduras e sódio (TUORILA, 2015). Esse desafio se deve em grande parte aos alimentos de conveniência e *fast food* que tornaram-se uma característica permanente na dieta das crianças nos países ocidentais e cada vez mais no mundo (OLSEN et al., 2012). O alimento de conveniência geralmente contém uma quantidade maior de sal, gorduras e açúcar e, portanto, é considerado insalubre (DUNN et al., 2011).

A alimentação não saudável é um importante fator de risco para doenças crônicas, excesso de peso e obesidade, bem como as respectivas doenças não transmissíveis relacionadas. Essas doenças são em grande parte evitáveis e por isso são necessárias iniciativas urgentes de grande alcance com maior custo-benefício, tendo em vista que muitas estratégias atuais para promover uma alimentação saudável não são sustentáveis a longo prazo (MCCARROLL; EYLES; NI MHURCHU, 2017).

Segundo a Organização Mundial de Saúde (WHO, 2017), ambientes e comunidades de apoio são fundamentais para influenciar as escolhas das pessoas, tornando a opção por

alimentos mais saudáveis e atividades físicas regulares a escolha mais fácil (a escolha é a mais acessível, disponível e de baixo custo) e, portanto, prevenir o excesso de peso e a obesidade. Neste cenário, a WHO (2017) sinaliza que a indústria de alimentos pode desempenhar um papel importante na promoção de dietas saudáveis através da:

- Redução do teor de gordura, açúcar e sal dos alimentos processados;
- Garantia que escolhas saudáveis e nutritivas estejam disponíveis e acessíveis para todos os consumidores;
- Restrição a comercialização de alimentos ricos em açúcares, sal e gorduras, especialmente os alimentos destinados a crianças e adolescentes; e
- Garantia da disponibilidade de escolhas alimentares saudáveis e apoiando práticas regulares de atividade física no local de trabalho.

Os consumidores fazem melhores escolhas quando o produto tem informações claras sobre valores limites de atributos, em relação aos produtos que não as possuem. De acordo com essa descoberta, informações de referência relacionadas ao valor nutricional podem ajudar as pessoas a escolher produtos alimentares saudáveis (VISSCHERS & BRUNNER, 2011). A tendência de consumo por indulgência representa ainda um grande mercado, porém, tem requerido adequação devido à crescente preocupação dos consumidores com questões relacionadas à saúde e à sustentabilidade. Por isso, verifica-se o aumento das inovações na categoria “indulgência sem culpa”, isto é, produtos em porções reduzidas, com controle de calorias (100cal, 90cal), que incorporam novos atributos para diminuir a rejeição dos consumidores, ou ainda em versões zero, *light*, *sugar free*, etc. (REGO, 2010), ou alimentos com redução ou eliminação do conteúdo de cafeína (RODDA et al., 2020) e lactose (DEKKER; KOENDERS; BRUINS, 2019). Estratégias nacionais aplicadas por países como o Brasil para redução de sódio, açúcar e gordura trans em alimentos processados e ultraprocessados têm guiado à indústria a adequar as formulações de alimentos destinados a consumo direto (Brasil, 2021).

3.1.1 Importância da redução do sal em alimentos

A maioria dos países apresenta uma ingestão diária de sal tradicionalmente elevada, acima do recomendado pela Organização Mundial de Saúde (OMS) (WHO, 2016) que é de 5 g por dia. Este consumo elevado é um importante fator de risco para a hipertensão, doença que aumentou expressivamente nas últimas décadas e está associado a eventos cardiovasculares. Assim, reduzir efetivamente o consumo de sal ao nível da população, é crucial para prevenir a hipertensão induzida pela alta ingestão de sal, gerando um grande impacto na saúde pública (COBB et al., 2014; LI et al., 2017).

A OMS propôs a redução do sal como principal alvo dietético para 2025 para reduzir a mortalidade consequente de hipertensão, uma das principais doenças não transmissíveis (WHO, 2016). Os Estados membros da OMS concordaram em reduzir a ingestão de sal da população global em cerca de 30% até 2025, encorajando explicitamente parcerias colaborativas entre o governo, a sociedade civil e o setor privado para alcançar esse objetivo (WHO, 2016; LINDBERG; NICHOLS; YAM, 2017).

As medidas adotadas no Brasil para atender essas exigências, foi diante de um acordo entre o Ministério da Saúde e a Associação Brasileira das Indústrias Alimentares (ABIA), sensibilizando os fabricantes de alimentos processados a reduzirem o teor de sódio em seus produtos. Com isso, a indústria de alimentos reduziu cerca de 7,652 toneladas de sódio em muitos produtos entre 2011 e 2015, com estimativa de reduzir 28.562 toneladas até 2020. Além disto, objetiva-se com este acordo, reduzir o consumo médio de sódio, registrado em 12 gramas por dia em 2010, para cinco gramas diárias até 2022 (BRASIL, 2015).

Na Europa, as medidas para a redução no consumo de sódio também estão implementadas. A Espanha, por exemplo, promoveu iniciativas nacionais “*A Strategy for Nutrition, Physical Activity and Prevention of Obesity*” de 2005 recomendando que a ingestão de sal de todas as fontes seja reduzida para menos de 5 g/dia. O plano focado para reduzir o consumo de sal está em desenvolvimento desde 2009, sendo que o mais atual conseguiu reduzir o teor de sal nos produtos alimentícios em 20% ao longo de um período de quatro anos (2010-2014) (WHO-EUROPE, 2013).

Estima-se que pelo menos 75% da ingestão de sódio através da dieta provêm de alimentos processados e de restaurantes (DÖTSCH et al., 2009). Por isso a redução do sal em

produtos processados é uma proposta considerada como uma intervenção de alto impacto para reduzir a ingestão de sódio da população. Uma grande limitação para esta abordagem é o seu potencial impacto negativo nas características sensoriais dos produtos (ANTÚNEZ et al., 2017). Isto porque a preferência por alimentos salgados é a resposta hedônica ao salgado fortemente influenciada por suas propriedades sensoriais (LI et al. 2017).

3.1.2 Importância da redução de açúcar em alimentos

A doçura tem sido referida como um gosto inato ou naturalmente preferido, mesmo em crianças muito pequenas, enquanto os gostos salgados, azedos e amargos são adquiridos, que precisam de alguma perseverança, muitas vezes se estendendo até a infância antes de serem apreciados (RICHARDSON; SALIBA, 2011).

O papel da ingestão excessiva de açúcar tornou-se um problema de saúde pública cada vez mais ativo nos últimos anos, e é atualmente uma área ativa do debate científico e político (AZAÏS-BRAESCO et al., 2017; NEWENS; WALTON, 2016). Devido a isso, a Organização Mundial de Saúde (WHO, 2017) por meio do guia “*Sugars intake for adults and children*” fornece recomendações sobre a ingestão de açúcares para reduzir o risco de doenças não transmissíveis em adultos e crianças, com foco especial na prevenção e controle de ganho de peso e cáries. Muitos países estão seguindo estas recomendações que podem ser usadas pelos formuladores de políticas e pelos gerentes de programas para avaliar os níveis atuais de açúcares livres em seus países em relação a um *benchmark*. Podem ainda ser usados para desenvolver medidas para reduzir a ingestão de açúcares, quando necessário, através de uma série de intervenções de saúde pública, como estratégia para reformular produtos alimentares, em particular, alimentos processados que são elevados em açúcares livres, entre outros (WHO, 2017).

Além da preocupação com o favorecimento do sobrepeso e cáries, existe ainda preocupações com o risco cárdio-metabólicos (MORENGA et al., 2014; YANG et al., 2014) diabetes tipo 2 (IMAMURA et al., 2015) e alguns tipos de câncer (GIOVANNUCCI, 2001) e depressão (REIS et al., 2020). Existem ainda incerteza sobre se a ingestão de açúcar está diretamente relacionada a esses riscos de saúde ou se eles são acarretados devido a uma ingestão

excessiva de calorias (BRAY; POPKIN, 2014; KAHN; SIEVENPIPER, 2014). De qualquer forma, a diminuição do consumo de açúcar é uma boa estratégia para reduzir o consumo excessivo de calorias, o que é relevante para a atual epidemia de obesidade (AZAÏS-BRAESCO et al., 2017).

O açúcar tem sido o principal adoçante na dieta humana há décadas, representando uma alta porcentagem da ingestão diária de energia com pouco valor nutricional adicional (CABALLERO; ALLEN; PRENTICE, 2013). O termo "açúcar adicionado" geralmente é entendido como açúcar adicionado aos alimentos durante o processamento. Em muitos países, a maioria do açúcar adicionado aos alimentos é sob a forma de sacarose refinada, mas pode incluir outros monossacarídeos e dissacarídeos contendo ingredientes como glicose e frutose (e seus xaropes) (LOUIE et al., 2014; NG; SLINING; POPKIN, 2012).

As bebidas não alcoólicas fornecem mais açúcares do que sucos de frutas na maioria dos países da Europa e a maioria das faixas etárias, especialmente na Holanda, Bélgica e Espanha, enquanto que na Itália e na França. No geral, a contribuição dos produtos lácteos para a ingestão total de açúcar é a mais baixa da Itália e a mais alta na Espanha e França. O leite e as bebidas lácteas foram os principais contribuintes dos produtos lácteos, especialmente nas crianças (AZAÏS-BRAESCO et al., 2017).

A reformulação de produtos contendo açúcares adicionados pode ser vista como uma das rotas mais diretas para atingir a redução do consumo de açúcar. Tendo como alternativa a substituição total ou parcial do açúcar por adoçantes alternativos de baixas calorias (EDWARDS et al., 2016). No entanto, esta medida deve ser concebida e dirigida aos alimentos e grupos de alimentos para os quais uma diminuição do teor de açúcar diminuirá eficientemente o suprimento de açúcar na população-alvo (AZAÏS-BRAESCO et al., 2017). Os consumidores já desenvolveram uma preferência pelo sabor doce e, embora uma redução gradual de consumo possa ser benéfica, os consumidores tendem a resistir às mudanças na intensidade da doçura e outras características sensoriais (EDWARDS et al 2016).

3.1.3 Importância da redução de gordura em alimentos

A Organização Mundial da Saúde (WHO, 2019a) determina que o consumo de gorduras não deve exceder 30% da ingestão calórica total do indivíduo, a fim de evitar riscos à saúde geralmente atribuíveis a doenças cardiovasculares. Dentre as gorduras, as saturadas não devem representar mais de 10% da ingestão calórica (WHO, 2019a) embora outras associações reduzam esse número para 6% (AHA, 2019).

A redução de gordura é um dos fatores mais importantes para uma dieta saudável (WHO, 2019a), a fim de prevenir casos de sobrepeso e obesidade (HOOPER et al., 2015; WHO, 2019b), aos quais estão associadas às doenças de caráter cardiovascular (CALABRESE; RICCARDI, 2019). Existem muitas aplicações para reduzir o teor de gordura e, particularmente, a gordura saturada na dieta. Alguns exemplos de mudanças na dieta são a substituição de gordura saturada por gordura insaturada e/ou carboidratos ricos em fibras (CALABRESE; RICCARDI, 2019); o uso de óleos mais saudáveis (azeitona e girassol) em produtos tradicionais (MANICKAVASAGAN; AL-SABAHI, 2014) ou o uso de géis de chia e óleos de linhaça em hambúrgueres (HECK et al., 2019); suplementação alimentar através da soja (WANG et al., 2011); o consumo de nozes, como o pistache, relacionado à melhora de doenças cardiovasculares (TERZO et al., 2019); ou, por exemplo, o uso de filmes comestíveis em produtos fritos (ANANEY-OBIRI et al., 2018).

É notável que existe uma ação ativa do consumidor para reduzir a quantidade de gordura ingerida na dieta, bem como consumir gordura com uma qualidade nutricional mais alta que não ocasione problemas de saúde a curto e a longo prazo. É necessário destacar que um dos pontos mais importantes em qualquer modificação da composição de um produto é que ele seja sensorialmente aceito pelo consumidor, como pode ser observado em vários estudos, geralmente naqueles relacionados a mudanças na formulação (COX; LEE; LEE, 2019; CUI et al., 2019; MORIANO et al., 2019; MOUSAVI; NUR FARHANA; WAN ROSLI, 2019). Uma vez que a gordura é um dos componentes que mais impactam na aceitabilidade e intenção de compra pelo consumidor (ROMAGNY; GINON; SALLES, 2017), pois apresenta diversas funcionalidades em termos nutricionais (saciedade), tecnológicos (transferência de calor, ponto de fusão, solubilidade) e sensoriais (aparência, sabor, textura) (VAN DEN BREMT et al., 2012).

3.1.4 Importância da ausência ou redução do teor cafeína e lactose em alimentos

A cafeína e lactose são compostos presentes em produtos alimentícios amplamente consumidos em todo o mundo. A cafeína (1,3,7-trimetilxantina) é um componente farmacologicamente ativo de muitos alimentos, bebidas, suplementos dietéticos e medicamentos (WIKOFF et al., 2017). Considerada um dos ingredientes dietéticos mais consumidos em todo o mundo, é encontrada naturalmente em alguns alimentos derivados de plantas, como grãos de café, grãos de cacau, noz-decola, frutos de guaraná e folhas de chá, incluindo erva-mate (HECKMAN; WEIL; DE MEJIA, 2010). Inúmeros estudos fornecem indícios de que o consumo de cafeína tem efeitos negativos e positivos para a saúde. Como efeitos nocivos, ficou provado que a cafeína aumenta a pressão arterial (HARTLEY; LOVALLO; WHITSETT, 2004) e pode até provocar ataques cardíacos (BAYLIN et al., 2006).

Atualmente é desafiador medir o consumo de cafeína, devido à grande variedade de produtos e as diversas formas de preparação, como exemplificado na Tabela 1. A ingestão de café, por exemplo, é determinada pelo tamanho da xícara de café e pela intensidade da bebida, bem como pela frequência de consumo (BAE et al., 2013). Tanto que a Autoridade Europeia para a Segurança dos Alimentos (EFSA), por exemplo, limita seu consumo a 200 mg de cafeína por dia em um adulto (EFSA, 2015) que corresponde a menos de duas xícaras de café expresso (USDA, 2019). No entanto, deve-se considerar que não há registros de doenças crônicas durante o consumo a longo prazo (LOPEZ-GARCIA et al., 2014).

Tabela 1. Conteúdo de cafeína em bebidas.

Bebidas	Tamanho servido	Conteúdo de cafeína (mg)
Café		
McDonald's café	454 g (grande)	160
Starbucks café (<i>drip coffee</i>)	454 g (grande)	330
Starbucks Cappuccino	454 g (grande)	150
Soda		
Coca-Cola	Lata de 340 g	35
Pepsi MAX	Lata de 340 g	69
Bebidas energéticas		
5-Hour Energy	54 g	208
Monster Energy	454 g	160
Bebida Energética Jolt	666 g	280
Red Bull	238 g	80

Fonte: Kole; Barnhill (2013) adaptado.

Em relação aos efeitos positivos atribuíveis à cafeína, observou-se que o risco de diferentes doenças (como diabetes tipo 2), bem como diferentes tipos de câncer (como colorretal), e um efeito favorável nas funções hepáticas (DE MEJIA; RAMIREZ-MARES, 2014). Por isto, o consumo de cafeína é cercado por uma grande controvérsia, criando a necessidade de limitar seu consumo em certos grupos de consumidores.

A abordagem dos efeitos da lactose é diferente do da cafeína. A lactose é um dissacarídeo naturalmente presente no leite e consequentemente presente nos derivados (iogurte, bebida láctea, bebida láctea fermentada, queijo, etc.) e alimentos e bebidas que os utilizam como parte dos ingredientes. O impacto deste açúcar no nível de glicose no sangue é consistentemente menor em relação a outros açúcares como frutose e glicose (MONTONEN et al., 2007). Exceto para indivíduos que apresentam intolerância (ausência da produção natural da lactase no organismo), nenhum efeito prejudicial à saúde humana foi determinado pelo seu consumo, embora os casos de intolerância tenham aumentado (QI; TESTER, 2020). Ainda assim, existe uma ampla faixa demográfica que mesmo sendo tolerantes, aumentaram o consumo de produtos sem lactose, associando a um produto saudável (DEKKER; KOENDERS; BRUINS, 2019).

Atualmente, a dieta livre de lactose é o único tratamento para pessoas que sofrem de intolerância à lactose, com impacto social e econômico nos consumidores desses produtos (SURI et al., 2018). Como alternativa, é possível optar pelo uso de produtos lácteos tratados com lactase ou suplementos de lactase oral (SURI et al., 2018). Não há consenso global sobre os requisitos regulamentares para alegações ‘sem lactose’, no entanto, a exigência atual em alguns países é uma redução para $<0,01\%$ para ser considerado sem lactose (DEKKER; KOENDERS; BRUINS, 2019). Além disso, o uso extratos vegetais tem sido amplamente estudado como uma alternativa (PAUL et al., 2019). Como exemplos, bebida de soja e amêndoa, que mostrou bons resultados nutricionais e sensoriais (ALOZIE; YETUNDE, 2015), o uso de bebida de arroz e/ou leite de coco para preparar iogurte (BELEWU, 2016); ou o consumo de bebida de aveia (COOPER; RIVERO-MENDOZA; DAHL, 2020).

A redução ou ausência de cafeína e lactose nos produtos derivados de café e leite respectivamente, não é uma simples iniciativa da indústria de alimentos ou um apelo de marketing. Como foi exposto, existe uma necessidade real de grandes grupos populacionais em controlar a ingestão desses compostos nos alimentos. Reformular produtos mantendo suas propriedades sensoriais para atender às expectativas dos consumidores, podem trazer vantagens econômicas e mercadológica para a indústria alimentícia. Assim, estudos sensoriais devem ser

realizados de forma linear a todo o processo de reformulação de produtos, permitindo medir as respostas do consumidor e suas expectativas hedônicas.

3.2 ANÁLISE SENSORIAL

A análise sensorial é a ciência que engloba todos os métodos para evocar, medir, analisar e interpretar as respostas humanas às propriedades dos alimentos e materiais, percebidos pelos cinco sentidos: paladar, olfato, tato, visão e audição, minimizando possíveis divergências causadas por potenciais fontes de confusão, que incluem a marca e outras informações que podem afetar a percepção do consumidor (CIVILLE; OFTEDAL, 2012; MUKHOPADHYAY et al., 2013). Ao avaliar os atributos sensoriais dos produtos, as pessoas, sejam consumidores ou painéis sensoriais, respondem com base em suas percepções (CHUMNGOEN; TAN, 2015).

Compreende ainda em um conjunto de métodos com diretrizes e técnicas estabelecidas para a apresentação do produto, pesquisa de resposta bem definidas, análises estatísticas e interpretação dos resultados (LAWLESS; HEYMANN, 2010). As técnicas são muito úteis e aplicadas por muitas indústrias devido a seu desempenho crítico, que auxiliam no desenvolvimento, produção e manutenção de qualidade de produtos alimentares, produtos de higiene pessoal, bens domésticos, têxteis, produtos farmacêuticos e até mesmo experiência em móveis e automobilismo (CIVILLE; OFTEDAL, 2012).

As técnicas que medem a compreensão do produto ou sensação fornecida por ele, são consideradas metodologias objetivas e são discriminativas ou descritivas. Testes de discriminação respondem à pergunta "São dois ou mais produtos sensivelmente semelhantes ou diferentes?". Na indústria, são comumente usados para testar substituições de ingredientes quando o objetivo é manter a similaridade do produto. Por exemplo, se o objetivo é reduzir o sódio e manter propriedades sensoriais, a discriminação é um bom método. Os tipos mais comuns de testes de discriminação são testes triangulares, duo-trio ou alternativa de escolha forçada (CIVILLE; OFTEDAL, 2012; MEILGAARD; CIVILLE, 2007).

Métodos descritivos são frequentemente usados quando o objetivo é determinar como as amostras diferem, com uma descrição do perfil sensorial do produto (LAWLESS; HEYMANN, 2010). São métodos que avaliam objetivamente os aspectos sensoriais qualitativos e quantitativos de um produto, requer painel treinado e as análises diferem entre si principalmente no uso da escala. Os aspectos qualitativos dos produtos incluem características específicas de aparência, aroma, sabor ou textura, chamados atributos. O aspecto quantitativo é a intensidade de cada um dos atributos (CIVILLE; OFTEDAL, 2012; MEILGAARD; CIVILLE, 2007). Atualmente, existem muitos métodos descritivos que podem ser aplicados, como os descritos na Tabela 2.

Tabela 2. Descrição e objetivo dos principais métodos descritivos estudados para análise sensorial de alimentos.

Método	Objetivo	Descrição	Referência
Perfil de Sabor	Obter pontuações das propriedades de sabor	Os participantes indicam, por meio de escalas, o grau de diferença entre as amostras com base nas propriedades do sabor	(CAIRNCROSS, S. E.; SJÖSTRÖM, 1997)
Perfil de Textura	Obter pontuações das propriedades de textura	Os avaliadores mostram com escalas, o grau de diferenças entre as amostras com base nas propriedades texturais	(BRANDT; SKINNER; COLEMAN, 1963)
Análise Descritiva Quantitativa (ADQ)	Perfil sensorial considerando atributos de aparência, textura, odor e sabor	Os participantes pontuam em uma escala não estruturada as propriedades sensoriais dos produtos	(STONE et al., 1974)
Spectrum	Obter análises descritivas sensoriais reproduzíveis e repetíveis em diferentes produtos	Os painelistas pontuam em uma escala universal (linear 15 cm) as propriedades sensoriais dos produtos	(MEILGAARD, M., CIVILLE, G. V. AND CARR, 1991)
Perfil Livre	Versão variante do ADQ	Os participantes pontuam em uma escala não estruturada as propriedades sensoriais selecionadas por seus próprios critérios	(LANGRON, 1983; THOMPSON; MACFIE, 1983)
Métodos descritivos rápidos			
Análise Descritiva por Ordenação (ADO)	Classificar as amostras de acordo com os critérios estabelecidos	Os avaliadores classificam as amostras de acordo com um critério (intensidade, presença ou ausência de atributos, etc.)	(RICHTER et al., 2010; RODRIGUE et al., 2000)
Perfil Descritivo Otimizado (PDO)	Versão variante do ADQ	Os painelistas pontuam em uma escala não estruturada as propriedades sensoriais dos produtos, com os materiais de referência no momento da avaliação.	(DA SILVA et al., 2012)

(continuando)

Método	Objetivo	Descrição	Referência
Flash Profile	Classificar as amostras definidas com os descritores gerados	Os participantes geram seus próprios descritores e classificaram o conjunto de amostras, com foco nas diferenças das amostras	(DAIROU; SIEFFERMAN N, 2002; DELARUE; SIEFFERMAN N, 2004)
Napping	Distribuição rápida de amostra descritiva em um mapa físico	Os avaliadores posicionam as amostras incluídas em uma folha de papel, considerando suas semelhanças e diferenças	(PAGÈS, 2005)
Free Sorting Task	Classificação rápida e geral de conjuntos de produtos	Os participantes recebem simultaneamente todas as amostras e classificam-nas em grupos homogêneos	(CARTIER et al., 2006)
Check-all-that-apply	Método descritivo rápido em formato de questionário com múltiplas respostas	Os participantes avaliam o produto e são solicitados a verificar na lista as características (atributos, palavras ou frases) que melhor descrevem o produto	(ADAMS, J.; WILLIAMS, A.; LANCASTER, B.; FOLEY, 2007)
Pivot Profile	Método descritivo de frequência baseado em descrição livre	A amostra de referência (Pivô) é escolhida, depois disso as amostras são comparadas com o produto pivô pelos participantes	(THUILLIER et al., 2015)
Ultra-Flash	Versão modificada do <i>Flash Profile</i>	Procedimento de <i>Flash Profile</i> no qual o número de termos é reduzido agrupando sinônimos e termos com significados comparáveis	(PERRIN et al., 2008)
Testes descritivos temporais			
Tempo-intensidade (TI)	Técnica dinâmica baseada na avaliação temporal da intensidade	O avaliador indica sua percepção de intensidade em uma escala não estruturada ao longo do tempo	(LEE, W. E. & PANGBORN, 1986)
Dominância Temporal das Sensações (TDS)	A avaliação dinâmica enfoca o domínio das propriedades sensoriais ao longo do tempo	Os participantes escolhem diferentes atributos durante a sessão, sendo esses termos dominantes no momento de sua escolha	(PINEAU; CORDELLE; SCHLICH, 2003)

(conclusão)

A análise descritiva quantitativa (ADQ) é usada para descrever a natureza e a intensidade das propriedades sensoriais a partir da avaliação única de um produto, enquanto o domínio temporal da sensação (TDS) é usado principalmente para identificar propriedades sensoriais dominantes ao longo do tempo (NG; SLINING; POPKIN, 2012).

Existe ainda os testes afetivos, aplicados quando a finalidade é avaliar preferência e/ou aceitação de produtos. Esses testes coletam diretamente a opinião do consumidor de um produto, potencial ou já estabelecida, sobre características específicas ou ideias sobre o produto, por isso são também chamados de testes com consumidor (FERREIRA et al., 2000). Os dois métodos clássicos para medir diretamente a preferência e a aceitação são o teste de comparação pareada e a escala hedônica de nove pontos, respectivamente. Outros métodos são descritos na

literatura, mas muitos deles são modificações desses dois métodos ou são tipos de escalas de qualidade (STONE; SIDEL, 2004). As emoções evocadas por alimentos, por exemplo, fornecem informações que vão além da informação das classificações hedônicas tradicionais (GUTJAR et al., 2015a).

A necessidade científica de conceituar melhor a experiência dos consumidores com os alimentos levou a um maior interesse em integrar as emoções em pesquisas sensoriais de consumo (GUTJAR et al., 2015b; KING; MEISELMAN; CARR, 2013; MEISELMAN, 2015; MOJET et al., 2015; WALSH et al., 2017). As emoções podem ser definidas como “respostas afetivas a curto prazo para avaliações de estímulos particulares, situações ou eventos com potencial de reforço” (MATHEWS; DEARY; WHITEMAN, 2003; ROLLS, 1999). Gibson (2006) indica de modo geral que os fatores sensoriais, fisiológicos e psicológicos são os que determinam o papel que as emoções desempenham na escolha dos alimentos.

Os resultados obtidos a partir de estudos sensoriais de alimentos fornecem informações importantes sobre a qualidade e as características dos produtos alimentares que podem ser utilizados em vários aspectos, como desenvolvimento de novos produtos, compreensão do consumidor, perfis de aroma e sabor e controle de qualidade (YU; YIN; ZHOU, 2018). Devido a essas repostas, a aplicação de métodos sensoriais ao desenvolvimento de alimentos saudáveis vem ocorrendo naturalmente.

Portanto, devido às reações físicas e químicas que ocorrem nos alimentos e bebidas durante a mastigação, a salivação por exemplo, há uma influência em percepções sensoriais como de aroma, sabor, textura. Assim, os métodos sensoriais estáticos convencionais, que exigem que os julgadores avaliem suas sensações durante julgamento e dê apenas uma única resposta, ocasionam na perda de alguns dados importantes, que seriam significativos para o produto. Devido a isto, métodos sensoriais dinâmicos vêm sendo desenvolvidos e aperfeiçoados, como a técnica de dominância temporal das sensações (TDS).

3.2.1 Análise de dominância temporal das sensações (TDS)

A Dominância Temporal das Sensações, “*Temporal Dominance Sensation*” (TDS), é uma metodologia relativamente nova no campo sensorial, pois foi desenvolvida no *Centre*

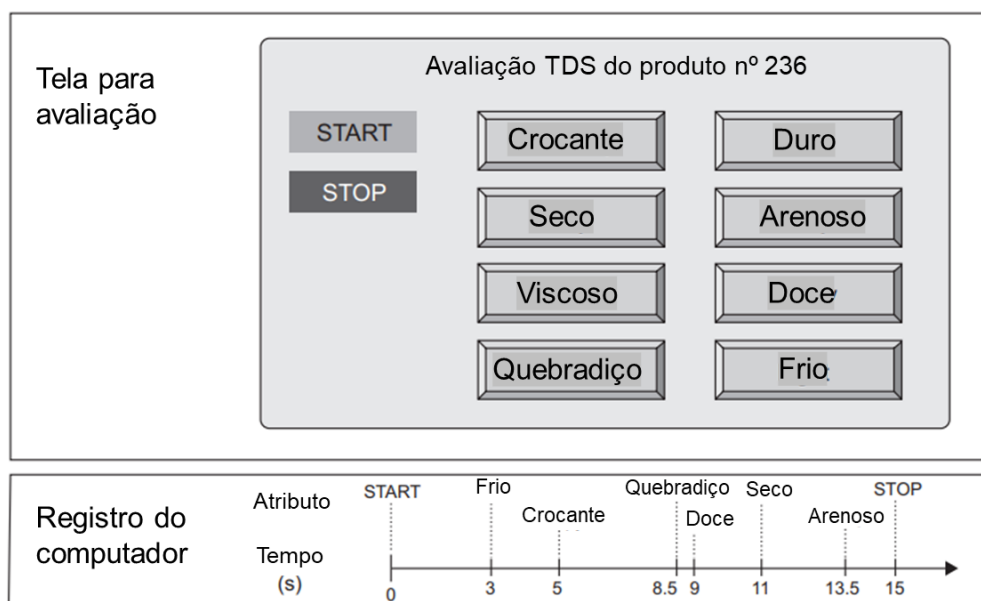
Européen des Sciences du Goût, no laboratório LIRIS em 1999 e apresentada pela primeira vez no *Pangborn Symposium* por Pineau, Cordelle, Schlich (2003), que fornece a possibilidade de descrever a evolução das percepções sensoriais dominantes durante o tempo que o julgador prova um produto alimentício (PINEAU et al., 2009). Essa técnica permite a discriminação do impacto que cada aspecto da percepção tem sobre o consumidor ao longo do tempo de consumo e ainda, que os resultados sejam associados a aceitação (ALBERT et al., 2012).

TDS descreve a evolução dos atributos sensoriais dominantes durante o consumo. A dominância possui diferentes definições (PINEAU et al., 2009; RODRIGUES et al., 2016; BRUZZONE; ARES; GIMÉNEZ, 2013; LENFANT et al., 2009; LABBE et al., 2009; ALBERT et al., 2012). Segundo Varela et al. (2018) pode ser avaliada como a sensação que capta a atenção, a mais marcante, ou a nova sensação que aparece, mas não necessariamente a mais intensa. Esta ampla definição implica que os avaliadores individuais dentro de um painel podem avaliar o domínio diferentemente, e ainda o mesmo avaliador poderia estar usando estratégias diferentes para determinar o atributo dominante na mesma avaliação do produto (VARELA et al., 2018). No entanto, o padrão da *International Organization for Standardization* (ISO) para o estabelecimento de um perfil sensorial (ISO, 2016) recomenda que a sensação de dominância no TDS seja “definida para os avaliadores como a sensação que recebe a atenção em um determinado momento, o que não significa que essa sensação deve ser muito ou mais intensa no produto”.

O TDS traz uma dimensão de tempo que pode ser útil para descobrir diferenças dinâmicas/temporais entre produtos que não podem ser identificados pela Análise Descritiva, por exemplo. Diferencia ainda, por fornecer uma visão temporal geral das características do produto mais marcantes ao longo da degustação considerando o produto como um todo. Enquanto a análise descritiva fornece uma quantificação da intensidade de cada dimensão/atributo sensorial de uma maneira “cirúrgica”. Podendo considerar que essa diferença fundamental torna a metodologia TDS mais próxima da experiência real do consumidor do que a Análise Descritiva (PINEAU; SCHILCH, 2015; SUDRE et al., 2012; THOMAS et al., 2015).

O método TDS consiste basicamente em apresentar ao julgador uma lista completa de atributos na tela do computador, solicitando que avalie qual dos atributos é percebido como dominante ou marcante naquele momento e dar uma pontuação para essa sensação. A Figura 1 exemplifica como são expostos os atributos para a avaliação. Ao longo da avaliação, quando o julgador considera que o atributo dominante mudou, o novo atributo dominante deve ser marcado, e assim por diante, até a percepção terminar (PINEAU et al., 2009).

Figura 1. Exemplo de tela de computador para avaliação TDS com botões



Fonte: Pineau; Schilch (2015) adaptado.

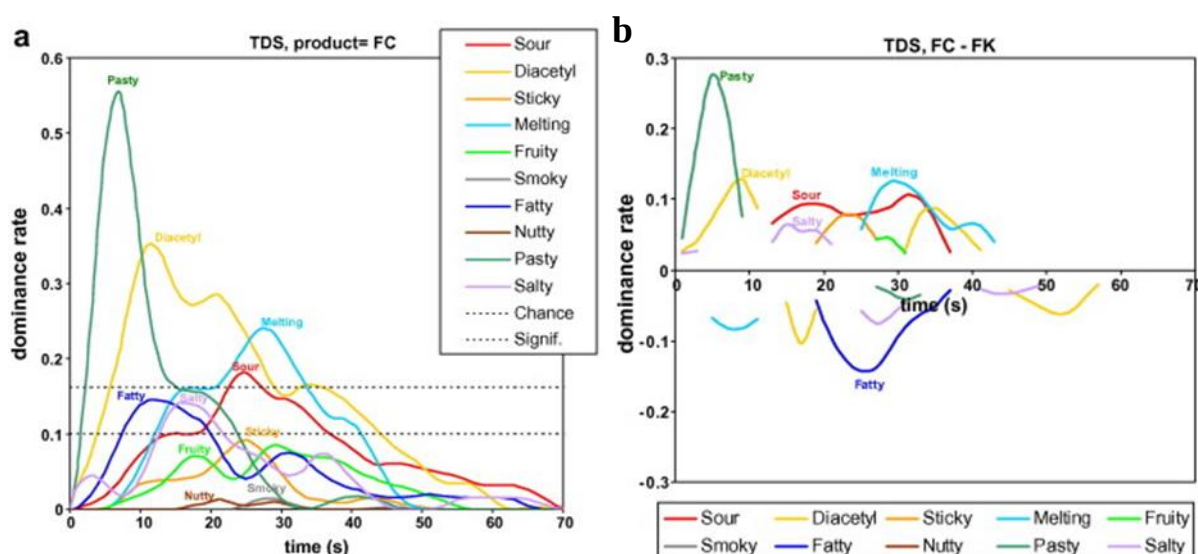
A lista de atributos é um fator importante a ser considerado nesta metodologia. Em diferentes estudos realizados por Pineau et al. (2012) em termos de número e tipos de produtos, número e tipos de atributos e tamanho do painel contribuíram para entender o desempenho do julgador durante os experimentos de TDS. Indicando que:

- Geralmente, as avaliações dos produtos são relativamente curtas (20 a 40 s).
- A ordem dos atributos deve ser equilibrada, para evitar que os atributos na parte superior da lista sejam tendenciosamente selecionados antes em relação aos atributos na parte inferior da lista, influenciando na descrição do produto.
- O uso de diferentes tipos de atributos (por exemplo, textura e sabor) na lista leva a resultados coerentes em comparação com estudos com apenas um único tipo, porém é recomendado avaliar apenas um atributo por vez e comparativamente, pode-se executar uma sessão com vários tipos de atributos para obter informações complementares.
- Os julgadores são capazes de gerenciar uma lista de atributos relativamente pequena de no máximo 10 atributos.
- É necessário a obtenção de no mínimo 30 avaliações de cada produto, obtidas por 2 ou mais repetições.

No entanto, a influência exata de listar diferentes propriedades sensoriais na mesma lista ainda é desconhecida (DI MONACO et al., 2014) e não há estudos comparando os resultados

obtidos a partir da avaliação simultânea e separada de diferentes atributos. Assim, é necessário investigar precisamente as implicações do uso de diferentes tipos de atributos em uma mesma sessão de TDS a fim de entender as vantagens e limitações desta abordagem (PINEAU et al., 2012). A representação mais comum para resumir os dados TDS de uma amostra e obter uma imagem descritiva de cada produto, é a curva TDS (Figura 2a). O procedimento considera cada atributo separadamente. Para cada ponto de cada vez, é calculada a proporção de avaliações (sujeito x repetições) para as quais o atributo fornecido foi avaliado como dominante. Essas proporções são suavizadas ao longo do tempo e exibidas como curvas da evolução da taxa de dominância para cada atributo. Para comparar duas amostras geralmente é obtida a curva de diferenças TDS (Figura 2b). Essas curvas de diferenças são traçadas subtraindo as taxas de dominância de duas amostras para cada atributo em cada ponto do tempo. A diferença na taxa de dominância só é representada graficamente quando é considerada significativamente diferente de 0.

Figura 2. Exemplos da representação gráfica TDS para um produto (a) e para a diferença entre dois produtos (b).



Fonte: Pineau et al. (2009) adaptado.

A análise TDS foi demonstrada útil para a avaliação de produtos com pequenas diferenças sensoriais (MEILLON et al., 2010). Além disso foi utilizada para fornecer uma melhor compreensão da textura e sabor dos produtos, em comparativamente a outros testes de perfil estáticos e dinâmicos (DINNELLA et al., 2013; DÉLÉRIS et al., 2011; LENFANT et al., 2009; SAINT-EVE et al., 2011) para o desenvolvimento de produtos com reduzido teor de

sódio (DE SOUZA et al., 2013; RODRIGUES et al., 2014, 2016b; SILVA et al., 2014; LORIDO et al., 2016) e reduzido teor de açúcar (ZORN et al., 2014).

No TDS clássico, a avaliação é realizada durante o primeiro gole/mordida, que é um procedimento padrão na pesquisa sensorial e do consumidor. No entanto, na vida real, os produtos são consumidos em ingestões rápidas e repetidas, o que pode causar alterações na percepção dos produtos devido à adaptação sensorial (KÖSTER et al., 2003). Por esse motivo, o primeiro gole/mordida pode não ser suficiente para perceber completamente todas as características sensoriais dos produtos, principalmente ao lidar com produtos complexos. Estudos anteriores relataram que pequenas diferenças nos perfis sensoriais dos produtos só se tornam visíveis após repetidas ingestões (STEIN et al., 2003; ZANDSTRA et al., 2004). Assim, para obter uma simulação mais realista da experiência sensorial dos produtos, foi proposta uma extensão do TDS, denominada TDS de *multiple intake*, que consiste em uma série de avaliações concatenadas de TDS (SCHLICH et al., 2013).

Alguns estudos já foram realizados com a aplicação desta técnica, por exemplo, para avaliar se a substituição de sacarose por adoçantes de baixa caloria afetaria o perfil sensorial dinâmico do suco de laranja (ZORN et al., 2014) e para avaliar a influência do queijo na percepção do vinho (GALMARINI et al., 2017). Simioni et al., (2018) aplicaram essa metodologia em conjunto com um teste repetido de aceitação de consumo para a análise de cervejas especiais, e descobriram que esse conjunto de informações obtidas também pode ajudar os pesquisadores no desenvolvimento de produtos para ajustar as formulações dos produtos e garantir a aceitabilidade.

3.2.2 Análise de resposta emocional

As emoções podem ser definidas como fenômenos complexos que se constituem de várias dimensões, pois além de possuírem um substrato biológico, são constituídas por processo psicológicos e estão inseridas em contextos históricos, culturais e sociais interativos e dinâmicos. Elas fazem parte do conhecimento cognitivo, subjetivos dos seres humanos e se interagem, de forma dialógica, ao espaço social e objetivo (GOMES; PAES; MELO, 2011).

O processo de emoção é desencadeado pelo encontro de uma pessoa com algum evento ou estímulo. Se o evento for avaliado como significativo de alguma forma, uma resposta emocional irá resultar. Essa resposta pode ser caracterizada por um conjunto coordenado e correlacionado de mudanças nas tendências (neuro) fisiológicas, expressivas (expressão facial/expressão corporal, tendências de ação) e experiência (experiência subjetiva) (ROUBY; FOURNEL; BENSAFI, 2016).

A qualidade emocional dos produtos está se tornando cada vez mais importante para a vantagem diferencial no mercado, porque outros fatores como qualidade e preço dos produtos atuais são frequentemente similares. Assim, medir as emoções evocadas pelos alimentos pode melhorar a compreensão da escolha de alimentos, consumo, comportamento do consumidor. As emoções evocadas pelos produtos aumentam o prazer de comprá-las, possuí-las e usá-las, por isso a compreensão das respostas emocionais pode oferecer uma vantagem diferencial além das medidas hedônicas tradicionais (HIRSCHMAN; HOLBROOK, 2015; JAGER et al., 2014; NG; CHAYA; HORT, 2013a; SCHIFFERSTEIN et al., 2013).

A necessidade científica de conceituar melhor a experiência dos consumidores com os alimentos levou a um maior interesse em integrar as emoções na pesquisa sensorial e de consumo (GUTJAR et al., 2015b; KING; MEISELMAN; CARR, 2013; MEISELMAN, 2015; MOJET et al., 2015). Diante disto, as pesquisas de *marketing* vêm buscando desenvolver um vocabulário que represente uma grande amplitude de emoções que os consumidores mais frequentemente associam às experiências de consumo (THOMSON; CROCKER, 2013). A avaliação de emoção comercial geralmente inicia com perguntando aos clientes como eles se sentem ao consumir produtos ou como eles esperam sentir. Alguns desses termos gerados pelo consumidor são então usados em questionários de emoção (MEISELMAN, 2017), concentrando esforços para desenvolver um questionário padronizado para mensurar emoções em um contexto de desenvolvimento de produto.

Exemplos dessas metodologias são GEOS (*Geneva Emotions and Odour Scale*) que foi desenvolvida especificamente para emoções associadas com odores (CHREA et al., 2009; PORCHEROT et al., 2010) e recentemente foi aplicada em produtos industrializados (PORCHEROT et al., 2013), o *EsSence Profile®*, desenvolvido por King e Meiselman (2010), o Perfil Conceitual, que inclui uma associação de emoções e contextualização abstratas com conotações emotivas, e mais recentemente a técnica de Dominância Temporal das Emoções, “*Temporal Dominance of Emotions*” (TDE) proposta como um TDS baseado em atributos emocionais e não sensoriais (JAGER et al., 2014).

O *EsSence Profile*®, tem sido aplicado para marcas e alimentos, e consiste no emprego de uma lista de 39 emoções e humores apresentados como adjetivos (Tabela 3). Este método apresenta como vantagens: a facilidade de realização e aplicação; menor tempo gasto na execução; a natureza quantitativa dos dados; a praticidade; e menor gasto de recursos com a sua execução. As limitações desta metodologia consiste em: um menor poder discriminativo devido a sua natureza geral; a perda de emoções importantes na caracterização do produto; e relevância dada a termos positivos (CARDELLO et al., 2012; KING; MEISELMAN, 2010; NG; CHAYA; HORT, 2013a, 2013b). Para eliminar estas desvantagens, o estudo das emoções evocadas pelos alimentos, requer uma pré-triagem dos léxicos emocionais. Um léxico de emoção é uma lista de palavras que podem ser usadas para identificar cada emoção (MOHAMMAD; TURNEY, 2010). Sugere-se que os léxicos emocionais sejam selecionados da literatura da língua nativa, a fim de evitar interpretações errôneas causadas por diferenças culturais (JIANG; KING; PRINYAWIWATKUL, 2014; VAN ZYL; MEISELMAN, 2016). No entanto, é adequado que grupos de nativos bilinguis ajustem a tradução de termos em inglês ou outros idiomas disponíveis na literatura científica, para termos no idioma do grupo de participantes objeto de estudo (HU; LEE, 2019).

Tabela 3. Lista de termos descritores de emoções do *EsSence Profile*®.

<i>EsSence Profile</i> ®		
Active	Glad	Pleasant
Adventurous	Good	Polite
Affectionate	Good-natured	Quiet
Aggressive	Guilty	Satisfied
Bored	Happy	Secure
Calm	Interested	Steady
Daring	Joyful	Tame
Disgusted	Loving	Tender
Eager	Merry	Understanding
Energetic	Mild	Warm
Enthusiastic	Nostalgic	Whole
Free	Peaceful	Wild
Friendly	Pleased	Worried

Fonte: King; Meiselman (2010).

A aplicação de questionários emocionais podem ser efetuadas recorrendo a escalas de intensidade ou CATA (*Check-All-That-Apply*). O questionário CATA é constituído por questões de resposta múltipla, consistindo numa lista de atributos (palavras ou frases), em que

os avaliadores escolhem aqueles que melhor caracterizam cada produto (VALENTIN; CHOLLET; LELIE, 2012). Nas perguntas CATA os termos propostos não contem escalas, sendo, portanto, uma tarefa mais fácil para o consumidor (JAEGER et al., 2020).

Uma tendência recente na pesquisa sensorial e de consumo tem sido medir emoções e determinar até que ponto os sentimentos estão ligados à aceitação dos consumidores de alimentos e outros produtos de consumo (PRESCOTT, 2017). Segundo Piqueras-Fiszman; Jaeger (2014), outro fator que pode influenciar nas emoções, é o contexto de consumo, pois este pode direcionar o humor e mentalidade, e pode dar origem a uma série de emoções (positivas, negativas ou neutras) que provavelmente modularão a percepção do alimento e o gosto e desfrute da experiência alimentar e de consumo. A avaliação da qualidade e aceitabilidade dos produtos alimentícios pelos consumidores é uma experiência multidimensional que é explicada pela percepção sensorial, memória, cultura e emoções (CORREDOR et al., 2010; TORRICO et al., 2019). Por tanto, entender a relação entre a percepção sensorial e as emoções eliciadas no consumo de alimentos contribui no entendimento do comportamento dos consumidores, mas fatores não sensoriais, como a cultura, podem ter um grande efeito nas escolhas e preferências alimentares destes consumidores.

3.2.3 Influência cultural na resposta sensorial

A pesquisa intercultural é cada vez mais relevante na ciência sensorial e de consumo, pois a cultura é um dos principais fatores subjacentes às nossas escolhas alimentares, influenciando as atitudes e as crenças sobre os alimentos, bem como o papel desempenhado em nossas vidas (ARES, 2018).

Para Lee e Lopetcharat (2017), existem três objetivos principais que devem ser buscados para melhor compreender as limitações e os avanços atuais dos diferentes aspectos da cultura, muitas vezes utilizados na pesquisa sensorial e de consumidores multicultural:

- 1) Entender um fenômeno cultural observando a forma como se manifesta em um grupo cultural específico;

- 2) Investigar o que é percebido de forma diferente em todas as culturas a partir de um estímulo mais universal através de efeitos culturais na percepção e preferências sensoriais;
- 3) Testar a extensão da aptidão e as diferenças nos estilos de resposta aos métodos de pesquisa em todas as culturas e desenvolver metodologias que tenham validade e confiabilidade comum aos humanos nas culturas com procedimentos de teste universalmente aplicáveis (isto é, alcançando equivalência de instrumentação/invariância de medição).

A indústria está em constante busca a elaboração de produtos que correspondam às necessidades dos consumidores, e para isso é necessário uma melhor compreensão dos fatores que afetam a variação individual na percepção (JAEGER et al., 2017). As decisões do consumidor são determinadas por dois modos de pensamento: o primeiro, caracterizado por respostas rápidas, intuitivas, sem esforço, automáticas e associativas, e o segundo, responsável por decisões seriais, esforçadas e racionais (KAHNEMAN, 2003).

Os estudos interculturais é um meio apropriado para avaliar este primeiro modo de pensamento, considerando o efeito da familiaridade dos consumidores sobre a percepção de qualidade. Estes estudos geralmente convergem para concluir que um aumento na familiaridade leva a um aumento na preferência e percepção de qualidade (SCHNETTLER; RUIZ; SEPU, 2008) e dá origem a efeitos do país de origem (isto é, o fato de que os consumidores tendem a gostar mais dos produtos de seu próprio país) (SÁENZ-NAVAJAS et al., 2014).

Estudos que avaliam as tendências supracitadas, como mencionado por Onwezen et al., (2012) que realizaram uma segmentação de consumo nacional baseada em benefícios alimentares em quatro países europeus (Grécia, Países Baixos, Polônia e Espanha) usando amostras não prováveis que representavam a população dos países em termos de idade e gênero. Da mesma forma, Markovina et al., (2015) que utilizaram amostras representativas a nível nacional de nove países europeus para avaliar a validade e a confiabilidade do Questionário de Escolha de Alimentos, utilizando cotas para idade, gênero e maior nível educacional completo.

Para Kim et al., (2016), examinar as diferenças culturais na definição de saúde é um esforço significativo teoricamente e praticamente. Para os Europeus que são mais analistas, por exemplo, a definição de saudabilidade tende a ser mais analítica e limitada à ausência de doença ou à presença de saúde física, enquanto para asiáticos do leste, que são mais holísticos, tendem

a definir a saúde em associação com fatores não anatômicos, como a satisfação no trabalho, a vida social ativa, a felicidade na família, etc.

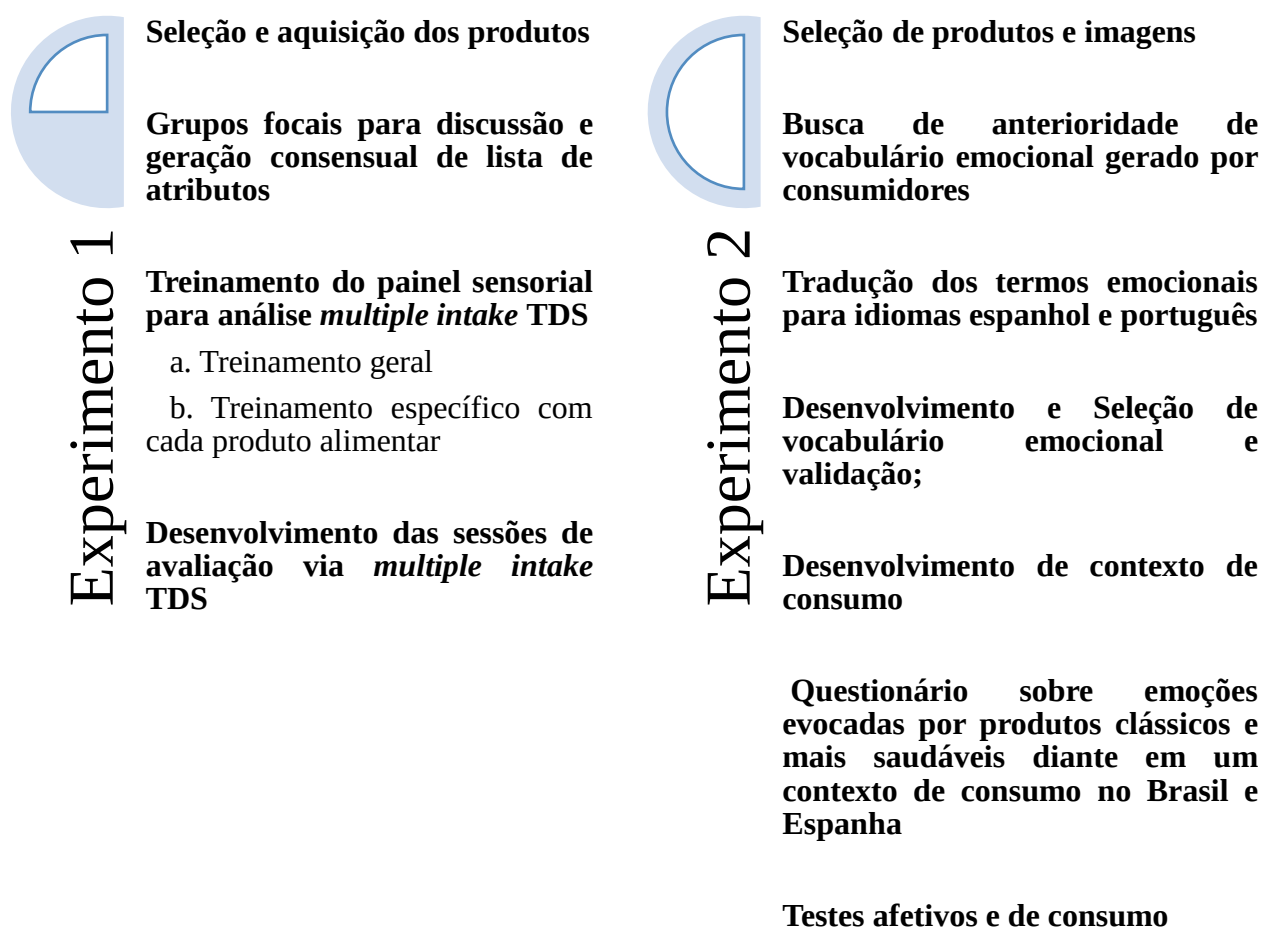
A pesquisa sensorial e de consumo intercultural envolve a psicologia do consumidor e a interação dinâmica entre consumidor, situação e alimento (LEE; LOPETCHARAT, 2017). A maioria destas pesquisas são conduzidas em países desenvolvidos ocidentais, a exemplo das construções e modelos para explicar o comportamento alimentar do consumidor são desenvolvidos nos EUA ou na Europa e são testados em outros países. Portanto, existe uma forte necessidade de considerar o comportamento do consumidor como uma questão global e considerar a percepção dos consumidores em diferentes culturas no desenvolvimento de modelos e teorias, e particularmente dos consumidores de baixa renda, que ainda está sub-representada na literatura (ARES, 2018; HOUGH; SOSA, 2015). Descrever a complexidade dos efeitos culturais na percepção sensorial e no comportamento do consumidor, requer o desenvolvimento de teorias e medidas que sejam válidas entre culturas e especificidades para os objetivos de pesquisa de estudos intercultural (LEE; LOPETCHARAT, 2017).

4 MATERIAIS E MÉTODOS

4.1 DESENHO EXPERIMENTAL

Para cumprir os objetivos propostos na presente Tese, foi considerada duas fases experimentais com base no tipo de técnica sensorial aplicada. A Figura 3 exibe o fluxograma que descreve de maneira geral as etapas seguidas, para melhor compreensão da parte experimental do trabalho.

Figura 3. Fluxograma das etapas experimentais.



Todos os procedimentos realizados neste estudo envolvendo participantes humanos foram aprovados nos padrões éticos da Delegação da Comissão de Bioética e Biossegurança da Universidade de Extremadura (Delegación de Comisión de Bioética e Bioseguridad de la Universidad de Extremadura) com o número de registro 71/2016.

4.2 EXPERIMENTO 1: ASPECTOS TEMPORAIS DA PERCEPÇÃO SENSORIAL DINÂMICA DE PRODUTOS ALIMENTÍCIOS TRADICIONAIS E SAUDÁVEIS

4.2.1 Produtos

Para realização do treinamento *multiple intake* TDS, foram selecionados produtos com características similares aos produtos que seria posteriormente utilizado para a análise TDS (Figura 3). Os produtos foram bebida láctea de cacau para o treinamento de café, chocolate branco para chocolate, batata chips sem sal para batata chips clássica, creme de baunilha para iogurte. Os estudos sensoriais TDS foram aplicados para: café com leite descafeinado, café com leite sem adição de açúcar, café com leite expresso, chocolate ao leite (30% cacau), chocolate ao leite reduzido em lactose (35% cacau), chocolate negro (55% cacau), batata frita, batata frita light (<30% gordura), batata frita sabor presunto, iogurte natural, iogurte natural sem lactose. Todos os produtos foram adquiridos no supermercado de marca registrada localizado em Cáceres (Extremadura, Espanha). Todas as amostras correspondem ao mesmo lote de produção e estavam dentro do prazo de validade.

Tabela 4. Produtos utilizados para o treinamento e análise sensorial *multiple intake* TDS.

Categorias	Treinamento <i>multiple intake</i> TDS	Análise sensorial <i>multiple intake</i> TDS
Café com leite Carrefour® Hacendado®		
	Bebida láctea de cacau	Expresso; Descafeinado; Sem açúcar
Chocolate Hacendado®		
	Chocolate branco	Ao leite; Reduzido Lactose; Negro 55% cacau
Batata chips Carrefour® Lay's ©		
	Batata crocante	Presunto; Clássico; Light (<30% gordura)
Iogurte Carrefour®		
	Creme de baunilha	Sem lactose; Clássico

4.2.1 Treinamento de painel sensorial

O treinamento foi aplicado no Laboratório de análise sensorial do IPROCAR na Universidad de Extremadura (Espanha). Em todas as etapas foi utilizada a língua castelhana, devido ao país de aplicação do teste. Foram recrutados 23 participantes (10 homens e 13 mulheres, entre 21 e 55 anos) entre alunos de graduação, pós graduação e pesquisadores que se declaram consumidores de chocolate, iogurte, café e batata chips e posteriormente avaliaram os produtos.

O treinamento para o estudo de *multiple intake* TDS foi realizado em cinco sessões devido a necessidade da melhor familiarização com a técnica *multiple intake*. Na primeira sessão de treinamento, os participantes foram introduzidos à noção de "sensação dominante" usando uma analogia a uma sinfonia e imagens com elementos em destaque (Figura 4), e a um protocolo ilustrativo de avaliação sensorial das sensações dominantes (Figura 5).

Figura 4. Exemplo de foto usada no treinamento da técnica *multiple intake* TDS.



Fonte: <http://noorafshan.com/download/CFL.pdf>

Figura 5. Exemplo do protocolo ilustrativo usado no treinamento da técnica *multiple intake* TDS.

NATILLA

AHORA TRAGA **00:30** **284**

Dulce

Vanilla

Lacteo

Cremosidad

Arenosidad

Frio

START

STOP

El protocolo es el siguiente:

- Coger el producto con una cuchara, poner el en la boca y estar listo para hacer clic en el **botón de inicio** **START** en la pantalla.
- Iniciar la evaluación de la muestra.
- Durante la evaluación de la muestra tienen que **seleccionar la sensación** que perciben como dominante y hacer clic en ella.
- Se permite elegir el mismo atributo varias veces a lo largo de la evaluación o por el contrario, no seleccionar nunca un atributo como dominante.
- Después de 00:10 es el momento en el que tienen que **tragar la muestra**.
- Tiene 00:10 para evaluar y elegir los atributos que sean dominantes.
- Sigue a prójimo consumo, con el mismo protocolo.
- En ultimo trago, seguir la evaluación después de tragar la muestra hasta que no perciban nada y entonces hacer clic en el **botón de parada** **STOP**

Fonte: Autoria própria.

Nas quatro sessões seguintes, os participantes do painel foram treinados para usar o sistema informatizado de captura de dados TDS (FIZZ v 2.40A), com produtos semelhantes aos que seriam avaliados neste estudo: bebida láctea de cacau, chocolate branco, batata chips sem sal, creme de baunilha (Tabela 4). Seguindo o protocolo descrito por Pineau et al. (2009) como o máximo de 10 atributos, que apareceram simultaneamente na tela do computador, randomizados para cada avaliador. O sistema computadorizado TDS (software FIZZ) mostrou aos avaliadores toda a lista de atributos com seus botões correspondentes na tela do computador (Figura 6).

Figura 6. Exemplo de tela do computador TDS com botões.

The screenshot shows a computer screen with a questionnaire interface. On the left side, there are five attributes listed vertically: Lácteo, Vainilla, Dulce, Cremosidad, and Frio. To the right of each attribute is a horizontal input bar. At the top right of the screen, there is a 'START' button, a timer displaying '01:10', and a counter displaying '089'. At the bottom of the screen, there are two buttons: 'Anterior' on the left and 'Siguiente' on the right.

Fonte: Autoria própria

Nas quatro sessões, os participantes do painel foram solicitados a identificar a sensação que eles dominavam durante o protocolo de degustação (Tabela 5). Eles foram informados de que não precisavam selecionar todos os atributos da lista e que podiam escolher o mesmo atributo várias vezes durante a avaliação ou também nunca o selecionar. A seleção dos atributos dominantes para cada produto treinamento foi realizado a partir de um grupo focal de 4 avaliadores, que provaram as amostras e desenvolveram uma lista consensual de até 10 atributos, além de definir o tempo necessário para que o produto permaneça na boca antes e ser deglutido.

Os atributos selecionados para a bebida láctea de cacau foram: líquido (sensação de líquido na boca); sedoso (sensação suave na boca); doce (gosto primário); cacau (sensação de sabor a chocolate e/ou cacau); laticínios (sabor associado ao leite).

Os atributos selecionados para chocolate branco foram: doce (gosto doce); chocolate (sensação de sabor de chocolate); laticínio (sensação de sabor associada ao leite); adesividade (a sensação da amostra adere à boca e aos dentes); revestimento bucal (sensação de recobrimento da boca); crocante (sensação combinada de saída acústica e força mecânica na mordida); derretimento (sensação em que a amostra se dissolve na boca); firme (sensação de resistência à mordida); cremosidade (sensação de cremosidade na boca).

Os atributos selecionados para batata chips foram: doce (gosto doce); salgado (gosto salgado); áspero (sensação de aspereza na língua); crocante (força necessária para quebrar um

produto em migalhas ou pedaços); resíduo (alimento residual na boca depois de engolir); seco (sensação de secura na boca); batata (sensação de sabor característico de batata).

Os atributos selecionados para o creme de baunilha foram: doce (gosto primário); baunilha (sabor de baunilha); lácteo (sabor associado ao leite); cremosidade (sensação de cremosidade na boca); frio (sensação ligada à temperatura percebida).

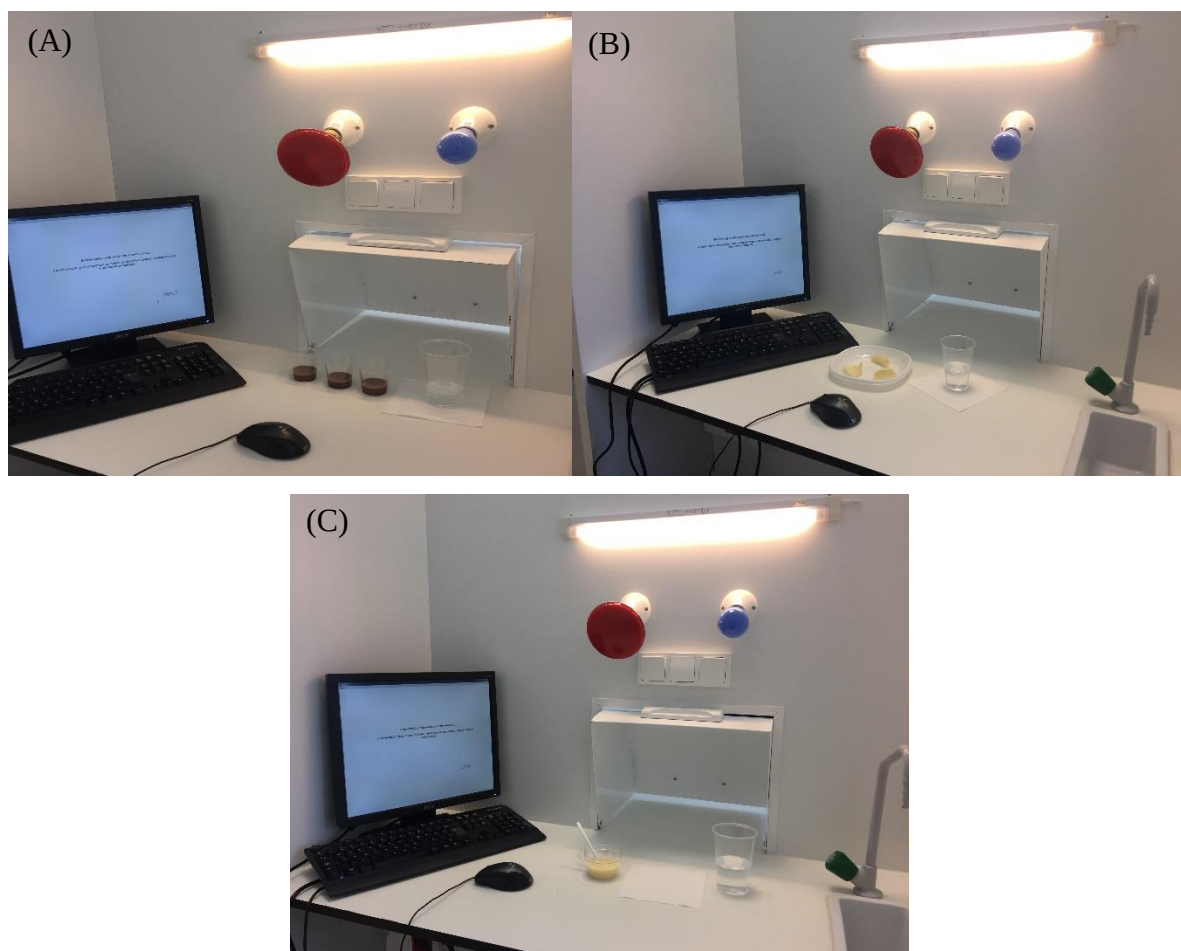
Tabela 5. Protocolo de treinamento TDS e lista de atributos.

Bebida láctea de cacau			Chocolate branco			Batata chips			Creme de baunilha		
Porção			½ quadrado			1 chip			colher (5 mL)		
Consumo			3			3			3		
Termos	Tempo (s)		Termos	Tempo (s)		Termos	Tempo (s)		Termos	Tempo (s)	
Líquido	1º	Iniciar	Doce	1º	Iniciar	Doce	1º	Iniciar	Doce	1º	Iniciar
Sedoso	Trago	8	Chocolate	Trago	15	Salgado	Trago	17	Baunilha	Trago	8
Doce	2º	14	Lácteo	2º	26	Áspero	2º	28	Lácteo	2º	14
Cacau	Trago	24	Sedoso	Trago	43	Crocante	Trago	47	Cremoso	Trago	24
Lácteo	3º	30	Revestimento bucal	3º	54	Resíduo	3º	58	Frio	3º	30
	Trago	40	Crocante	Trago	71	Seco	Trago	77		Trago	40
	Parar	70	Derretendo	Parar	100	Batata	Parar	100		Parar	70
			Firme								
			Cremosidade								

No início de cada sessão de treinamento *multiple intake* TDS, foi solicitado a cada membro do painel que colocasse a primeira porção do produto na boca e clicasse no botão “Iniciar” para iniciar a sessão avaliando as sensações dominantes. Após algum tempo, com a mensagem emitida pelo software, foi solicitado que engolisse a amostra e continuasse a avaliação. Para avaliar as sensações dominantes durante um consumo contínuo, foi solicitado, também com uma mensagem emitida pelo software, que o painelistas colocasse a segunda porção do produto na boca e depois a engolisse. A avaliação foi repetida até completar três ingestões e, em seguida, foi solicitado a cada membro do painel que continuasse a avaliação até que não sentissem mais nada e clicassem em “Parar” para terminar, ou até o programa encerrar automaticamente a sessão. Todas as sessões seguiram o mesmo protocolo, ajustando-se aos intervalos de tempo adaptados para cada tipo de produto (Tabela 5).

Os quatro produtos comerciais foram avaliados em três consumos, sendo um produto avaliado por dia, de acordo com um design equilibrado. Foram apresentadas as três porções de cada produto simulando um consumo contínuo, sem intervalo (Figura 7). O teste será realizado em cabines individuais sob luz branca com ventilação adequada. Os participantes foram instruídos a provar e avaliar cada amostra e a enxaguar a boca com água opcionalmente ao final da sessão.

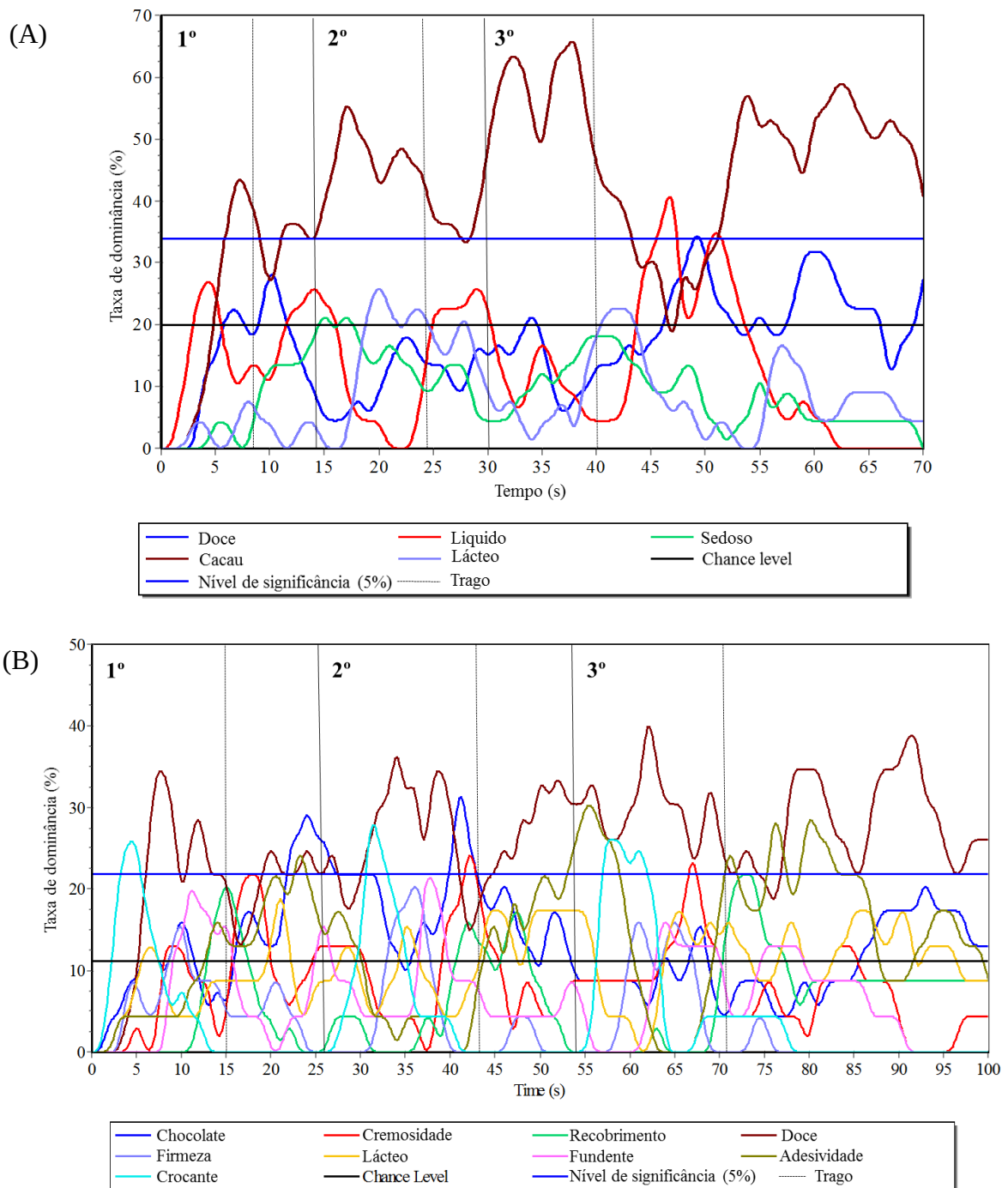
Figura 7. Apresentação das amostras de para a técnica TDS (A) bebida láctea de cacau; (B) batata frita; (C) creme de baunilha.

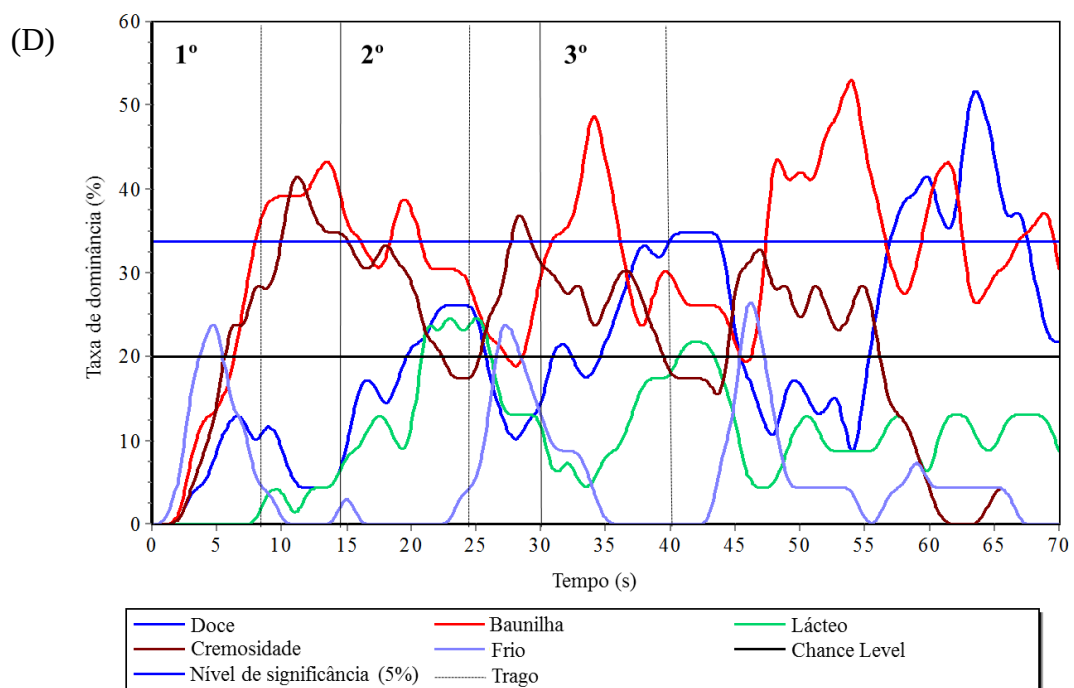
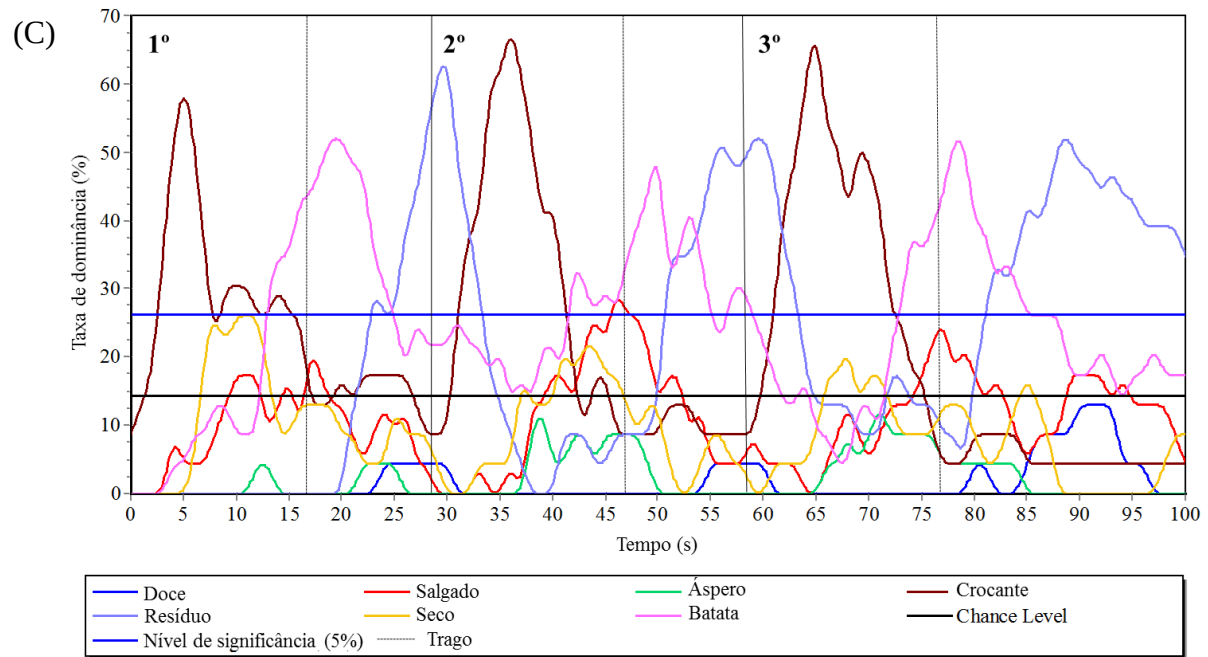


Fonte: Autoria própria.

Os dados do TDS foram coletados usando o software FIZZ (Biosystem, Couternon, França). As curvas *multiple intake* TDS geradas para o treinamento com cada produto estão expostas na Figura 8. A partir das curvas foi possível avaliar que todos os participantes selecionaram todos os termos de sensações dominantes, e apresentam um alto consenso pois a taxa de dominância muito atributos se apresentaram acima da linha do nível de significância (5%) em diferentes intervalos de tempo. Além disso, todos os atributos se apresentaram acima do *chance level* em ao menos um intervalo de tempo da avaliação, comprovando também que os participantes tiveram consenso na avaliação e foram capazes de discriminar as sensações dominantes em diferentes categorias de alimentos. Após avaliadas as curvas TDS, os participantes estavam treinados para participar das seguintes sessões TDS com as diferentes categorias de produtos.

Figura 8. Curvas *multiple intake* TDS obtidas no treinamento (A) bebida láctea de cacau; (B) chocolate branco; (C) batata frita; (D) creme de baunilha.





Fonte: Autoria própria.

4.2.2 Análise sensorial *multiple intake* TDS

Inicialmente houve uma discussão aberta com o líder do painel, e os avaliadores selecionaram uma lista consensual de atributos de sabor e textura para cada produtos a serem

avaliados usando TDS. Foram selecionados nove atributos para categoria café com leite: café (sensação de sabor semelhante ao café); caramelo (sabor doce semelhante a caramelo); amargo (gosto amargo); torrado (sensação de sabor associada ao café torrado); sedoso (sensação suave na boca); doce (gosto doce); lácteo (sensação de sabor associada ao leite); ácido (gosto ácido); adstringente (sensação de aumento da fricção dos alimentos na boca).

Foram selecionados oito atributos para a categoria chocolate: amargo (gosto amargo); cacau (sensação de sabor de cacau); cremoso (sensação de cremosidade na boca); crocante (sensação combinada de saída acústica e força mecânica na mordida); adesividade (sensação de aderência a uma superfície específica do palato e dos dentes); lácteo (sensação de sabor associada ao leite); doce (gosto doce); fundente (sensação em que a amostra se dissolve na boca).

Foram selecionados sete atributos para categoria batata frita: umami (gosto umami); salgado (gosto salgado); crocante (sensação de ruído ao morder); resíduo (alimento residual na boca depois de engolir); seco (sensação de secura na boca); batata (sensação de sabor de batata); defumado (sensação de sabor semelhante a fumaça).

Foram selecionados seis atributos para categoria iogurte: Lácteo (Sensação de sabor associada ao leite); Doce (gosto doce); Cremosidade (sensação de cremosidade na boca); frio (Sensação ligada à temperatura percebida); Ácido (Gosto ácido); Fermentado (sensação de sabor de ácido láctico).

Uma vez definidas as condições do teste com o grupo focal, os mesmos membros do painel foram recrutados para fazer a análise do TDS. Foram avaliados três tipos de café com leite, três tipos de chocolate, três tipos de batatas fritas, dois tipos de iogurte, como detalhado na Tabela 2. Cada atributo TDS foi representado por um botão na tela do computador (Figura 4). A sequência dos botões de atributo diferia entre os participantes, no entanto, a mesma sequência era mantida em cada sessão. Amostras da mesma categoria do produto foram avaliadas no mesmo dia, apresentadas monadicamente. As amostras foram balanceadas e codificadas com números de 3 dígitos gerados automaticamente pelo software. Os testes foram realizados em cabines individuais sob luz branca com ventilação adequada. A apresentação do café com leite foi igual a utilizado no treinamento como exposto na Figura 5(A), da batata chips e chocolate igual a Figura 5(B) e do iogurte igual a Figura 5(C). Os participantes foram instruídos a provar e avaliar cada amostra e a enxaguar a boca com água apenas entre as sessões, para que a análise sensorial simulasse um cenário de consumo do produto.

O mesmo protocolo de avaliação aplicado no treinamento foi utilizado para a análise do TDS, com adequação dos tempos e termos correspondentes a cada produto a ser avaliado (Tabela 6). A degustação da amostra foi iniciada pelos participantes do painel, clicando no botão “Iniciar” paralelamente à colocação da amostra na boca, realizando *multiple intake* TDS selecionando a sensação oral dominante ao longo do tempo e entre as porções. A avaliação foi interrompida automaticamente após o tempo final ou individualmente pelos juízes quando os atributos não eram mais dominantes.

Tabela 6. Protocolo para análise sensorial *multiple intake* TDS.

Café com leite			Chocolate			Batata chips			Iogurte		
Porção	copo (20 mL)			½ quadrado			1 chip			colher (5 mL)	
Consumo	3			3			3			3	
Termos	Tempo (s)		Termos	Tempo (s)		Termos	Tempo (s)		Termos	Tempo (s)	
Café	1º	Iniciar	Amargo	1º	Iniciar	Umami	1º	Iniciar	Lácteo	1º	Iniciar
Caramelo	Trago	8	Cacau	Trago	15	Salgado	Trago	17	Doce	Trago	10
Amargo	2º	14	Cremoso	2º	30	Crocante	2º	28	Cremoso	2º	20
Torrado	Trago	24	Crocantes	Trago	45	Resíduo	Trago	47	Frio	Trago	32
Sedoso	3º	30	Adesividade	3º	60	Seco	3º	58	Ácido	3º	42
Doce	Trago	40	Lácteo	Trago	75	Batata	Trago	77	Fermentado	Trago	54
Lácteo	Parar	70	Doce	Parar	100	Defumado	Parar	100		Parar	70
Ácido			Fundente								
Adstringente			Amargo								

4.2.3 Teste de aceitabilidade

Após as sessões TDS, os participantes receberam uma ficha para avaliação da aceitabilidade de cada produto (Figura 9). As amostras foram apresentadas de forma monádica, sendo avaliadas uma única categoria de produto por dia.

A apresentação das amostras seguiu o mesmo protocolo explicitado no tópico 3.2.2 para cada produto. Os participantes receberam a amostra codificada com três dígitos, e foram solicitados a provar e em seguida indicar o grau de aceitação, em uma escala não estruturada de 10 cm ancoradas nos extremos com “desgostei extremamente” e “gostei extremamente”.

Figura 9. Exemplo de ficha sensorial utilizada para avaliação da aceitabilidade dos produtos.

Nome:	Data:
Sobrenome:	
Você irá provar uma amostra de café com leite. Avalie a amostra e utilize a escala abaixo para indicar quanto você gostou e desgostou:	
Cód. Desgostei extremamente Gostei extremamente	

4.2.4 Análise dos dados

4.2.4.1 Curvas TDS

As curvas TDS foram realizadas por FIZZ v 2.40A. A suavização baseada em linha foi aplicada em cada curva. Para facilitar a interpretação das curvas TDS, duas outras linhas adicionais (*chance level* e nível de significância) são exibidas em cada curva TDS. O limite da *chance level* representa a taxa de dominância que um atributo pode obter por acaso ($P_0 = 1/\text{número de atributos}$) (PINEAU et al., 2009). O limite do nível de significância representa o menor valor da proporção, sendo significativamente ($p < 0,05$) maior que o nível do *chance level* (eq. 1)

$$P_s = P_o + 1.645 \sqrt{\frac{P_o(1 - P_o)}{n}} \quad (1)$$

Ps: valor da proporção significativa mais baixa ($p = 0,05$) em qualquer ponto no tempo para a curva TDS; n = número de julgadores x replicação.

Dois parâmetros TDS foram extraídos das curvas TDS para cada atributo: Tempo (Tempo da primeira citação) e Duração (Duração total da dominância sobre as citações).

4.2.4.2 Curvas de diferença TDS

As diferenças das curvas TDS foram usadas para comparar pares de produtos (versão clássica e saudável). Esta comparação consistiu em exibir as curvas dos atributos p das diferenças das taxas de dominância no mesmo gráfico (PINEAU et al., 2009). Essas diferenças são plotadas apenas quando significativamente diferentes de zero, destacando as diferenças entre os produtos ao longo do tempo. A diferença significativa entre cada curva é calculada para cada ponto no tempo e atributo usando o teste para comparar duas proporções binomiais (KIEMELE; SCHMIDT; BERDINE, 1995).

4.2.5 Análise estatística

Os parâmetros de tempo e duração de cada atributo foram analisados pelo teste T, comparando pares de produtos (versão clássica e saudável) em $p \leq 0,05$. Os dados gerais de aceitabilidade também foram avaliados pela análise de variância (ANOVA) e pelo teste de Tukey em $p \leq 0,05$ usando o IBM SPSS v.22 (IBM Co., Nova York, Nova York, EUA). O parâmetro de duração de cada atributo e a aceitabilidade dos produtos das categorias café, chocolate e batata frita foram exibidos na análise de componentes principais (PCA) realizada no XLSTAT 2014 (Addinsoft, Paris, França).

4.3 EXPERIMENTO 2: DESENVOLVIMENTO DE LISTA DOS TERMOS EMOCIONAIS E CONTEXTO DE CONSUMO EVOCADOS POR CONSUMIDORES DO BRASIL E ESPANHA COM ESTÍMULOS DE PRODUTOS CLÁSSICOS E MAIS SAUDÁVEIS

4.3.1 Produtos

Foram selecionados produtos comuns ao consumo da população do Brasil e da Espanha, para gerar uma lista de termos emocionais individuais e identificar as ocasiões de consumo mais frequentes. Assim, três categorias de produtos foram avaliadas, chocolate, batatas chips e iogurte e suas versões com alto conteúdo de cacau, reduzido teor de sal e ausência de gordura respectivamente (Tabela 7). Para todos os produtos o mesmo protocolo de avaliação foi aplicado. Imagens de cada item alimentar foram mostradas aos participantes em todos os questionários (Tabela 7). Existem evidências de que as respostas/associações emocionais dos consumidores com a exibição estimulante da imagem alimentar podem ser iguais ou semelhantes às estimuladas pelo consumo de alimentos (CARDELLO et al., 2012).

Tabela 7. Produtos utilizados para avaliação das emoções e imagens ilustrativas.

Categoria	Denominação do produto	Imagens
Iogurte	Iogurte Iogurte 0% gordura	
Batata Chips	Batata chips clássica Batata chips reduzido em sal	
Chocolate	Chocolate ao leite Chocolate 55% cacau	

4.3.2 Participantes para o desenvolvimento do léxico emocional

No Brasil foram recrutados alunos e funcionários brasileiros da Universidade Federal da Paraíba e na Espanha, alunos e funcionários espanhóis da Universidade de Extremadura. Os consumidores foram convidados por meio de convites por e-mail a preencher os questionários on-line usando os formulários do Google (Google L.L.C., Mountain View, Califórnia, EUA).

Para serem selecionados, os consumidores declararam ser consumidores da categoria de produto focal (iogurte, chocolate, batatas fritas) e solicitados a indicar o nível de aceitação usando escala de 7 pontos com “nada” (1) e “muito” (7) âncoras extremas. Os participantes que responderam (1) na escala foram excluídos. No total participaram 190 brasileiros e 186 espanhóis usados. As características demográficas dos participantes estão na Tabela 8.

Tabela 8. Características sociodemográficas dos participantes para geração da lista dos termos emocionais ocasiões de consumo para brasileiros e espanhóis.

Gênero	Brasil (%)	Espanha (%)
Feminino	60	55
Masculino	40	45
Idade		
18 a 30 anos	60	35
31 a 40 anos	40	30
41 a 50 anos	0	5
Mayor de 50 anos	0	30
Composição Familiar		
1	25	30
2	35	25
3	0	10
4	30	25
5	10	10
+5	0	0
Renda familiar		
Menos de um salário	0	0
Até dois salários	0	45
Entre 2 e 3 salários	20	25
Entre 3 e 5 salários	25	20
Entre 5 e 7 salários	10	0
Mais que 7 salários	45	10
Nível de estudos		
Sem estudos	0	0
Ensino primário	0	0
Ensino médio	0	5
Universitário	100	95

4.3.3 Questionários para desenvolvimento de léxico emocional

Para a geração de uma lista de termos emocionais evocados pelos diferentes produtos, foram seguidas duas etapas. Em ambas as etapas os participantes foram apresentados a uma imagem do produto e foram instruídos a selecionar em uma lista de termos tudo o que for aplicável (abordagem CATA) pela seguinte frase: “Marque todas as emoções que você se lembra ao ter consumido (chocolate ou batata frita ou iogurte)”. Eles também puderam sugerir termos adicionais com a opção “outros”. A ordem de apresentação das emoções foi aleatória entre os consumidores.

Na primeira etapa, foi usada uma lista com o léxico emocional *EsSense25* (NESTRUD et al., 2016) e um específico para cada categoria de produto geradas por estudos anteriores: chocolate (SCHOUTETEN et al., 2017; THOMSON; CROCKER; MARKETO, 2010; TORRICO et al., 2019), batata chips (CARDELLO et al., 2012) e iogurte (MOJET et al., 2015; SCHOUTETEN et al., 2017). No total, 79 termos emocionais foram listados para chocolate, 64 para batatas fritas e 65 para iogurte, conforme exposto na Tabela 9. A ordem de apresentação das emoções foi randomizada entre os consumidores, buscando mitigar os efeitos dos termos das ordens de apresentação. Todos os termos emocionais foram traduzidos do inglês para o português e espanhol foi realizado por pesquisadores e consumidores bilíngues, seguindo a metodologia aplicada por Hu e Lee (2019).

Na primeira etapa foram selecionadas as emoções citadas por >5% dos participantes, que foram selecionadas pelos brasileiros 38 emoções para chocolate, 37 para batata chips, 27 para iogurte e pelos espanhóis 42 para chocolate, 33 para batata chips, e 36 para iogurte. As emoções selecionadas foram aplicadas para a segunda etapa para validação dos termos seguindo o mesmo protocolo de avaliação. Os resultados da segunda etapa também foram filtrados de acordo com os termos mais frequentes (>5% de citação). No total os participantes brasileiros selecionaram 32 termos para chocolate, 25 para batata chips e 20 para iogurte, e os espanhóis 29 para chocolate, 18 para batata chips e 15 para iogurte. Sempre foi utilizado o produto café como amostra de “aquecimento” para evitar efeitos da primeira posição (DORADO et al., 2016). Com os resultados obtidos nesta etapa, foi possível validar os termos emocionais e gerar uma lista reduzida de emoções para ser aplicada nos testes sem contexto e com contexto.

Tabela 9. Lista de termos emocionais traduzidos do *Essence Profile* ® (*) e outros questionários, para o espanhol e português.

Chocolate			Batata chips			Iogurte		
Inglês	Espanhol	Português	Inglês	Espanhol	Português	Inglês	Espanhol	Português
Active*/Energic*	Activo/Enérgico	Ativo/Enérgico	Accompanied	Acompañado	-	Active*/Energic*	Activo/Enérgico	Ativo/Enérgico
Adventurous*	Aventurero/Atrevido	Aventureiro	Active*/Energetic*	Activo/Enérgico	Ativo/Enérgico	Adventurous*	Aventurero/ Atrevido	Aventureiro
Affectionate*	Afectuoso	Afetuooso	Adventurous*	Aventurero	Aventureiro	Affectionate*	Afectuoso	Afetuooso
Afraid/Fearful	Miedoso/Temeroso	Medroso	Affectionate*	Afectuoso	Afetuooso	Afraid/Fearful	Miedoso/Temeroso	Medroso
Aggressive*	Agresivo	Agressivo	Afraid/Fearful	Miedoso/Temeroso	Medroso	Aggressive*	Agresivo	Agressivo
Alone	Solo	Sozinho	Aggressive*	Agresivo	Agressivo	Alone	Solo	Sozinho
Angry	Enfadado	Raiva	Alone	Solo	Sozinho	Annoyed/Irritated	Irritado	Irritado
Arrogant	Arrogante	Arrogante	Annoyed/Irritated	Irritado	Irritado	Arrogant	Arrogante	Arrogante
Bad	Malo	Mal	Bad	Malo	Mal	Bad	Malo	Mal
Bewildered	Desconcertado/ Desorientado	Confuso / Desorientado	Bewildered	Desconcertado/ Desorientado	Confuso/ Desorientado	Bewildered	Desconcertado/ Desorientado	Confuso/ Desorientado
Calm*/Tame*	Calmao/Sosegado	Calmo/Inofensivo	Bored*	Aburrido	Entediado	Bored*	Aburrido	Entediado
Carefree	Despreocupado	Despreocupado	Calm*/Tame*/Peaceful*	Calmao/Sosegado	Calmo/Inofensivo	Calm*/Tame*/Peaceful*	Calmao/ Sosegado	Calmo/Inofensivo
Comfortable	A gusto/Cómodo	Confortável	Carefree	Despreocupado	Despreocupado	Carefree	Despreocupado	Despreocupado
Comforting	Reconfortado	Reconfortado	Comfortable	A gusto/Cómodo	Confortável	Comfortable	A gusto/Cómodo	Confortável
Confident	Confiado/Seguro	Confiante	Craving	Deseoso	Desejoso	Confident	Confiado/Seguro	Confiante
Craving/Desire	Deseoso	Desejoso	Critical	Crítico	Crítico	Contented/Happy*Cheerful	Feliz/Contento	Feliz/Contente
Critical	Crítico	Crítico	Daring*	Temerario/Osado	Audacioso/Ousado	Craving	Deseoso	Desejoso
Daring*	Temerario/Osado	Audacioso/Ousado	Destroyed	Destrozado	Destruído	Critical	Crítico	Crítico
Destroyed	Destrozado	Destruído	Disagreeable	Desagradable	Desagradável	Daring*	Temerario/Osado	Audacioso/Ousado
Disagreeable	Molesto	Desagradável	Discouraged	Desanimado	Desencorajado	Depressed/Discouraged	Deprimido/ Desanimado	Deprimido/ Desencorajado
Disappointed	Decepcionado	Desapontado/Frustrado	Disgusted*	Asqueado	Enojado	Destroyed	Destrozado	Destruído
Discontented/ Dissatisfied	Descontento/ Insatisfecho	Descontente/ Insatisfeito	Eager*	Ansioso	Ansioso	Disagreeable	Molesto	Desagradável
Discouraged	Desanimado	Desencorajado	Enthusiastic	Entusiasmado	Entusiasmado	Disappointed/ Frustrated	Decepcionado/ Frustrado	Desapontado/ Frustrado

(continuando)

Chocolate			Batata chips			Iogurte		
Inglês	Espanhol	Português	Inglês	Espanhol	Português	Inglês	Espanhol	Português
Disgusted*	Asqueado	Enojado	Free*	Libre	Livre	Discontented/ Dissatisfied	Insatisfecho/ Descontento	Descontente/ Insatisfeito
Eager*	Impaciente/Ansioso	Ansioso	Friendly*	Amigable	Amigável	Disgusted*	Asqueado	Enojado
Easygoing	Llevadero/De trato fácil	Tranquilo/ Despreocupado	Good*/Good-natured*	Bueno/Bondadoso	Bom/Bondoso	Eager*	Ansioso	Ansioso
Enthusiastic*	Entusiasmado	Entusiasmado	Guilty*	Culpable	Culpado	Enthusiastic	Entusiasmado	Entusiasmado
Friendly*	Amigable	Amigável	Happy*/Merry*/Blissful/ Content/Glad*	Feliz/Contento	Feliz/Contente	Friendly*	Amigable	Amigável
Fun	Divertido	Divertido	Hungry	-	Faminto/Esfomeado	Good*	Bien	Bem
Good*	Bien	Bem	Interested*	Interesado	Interessado	Good-natured*	Bueno/Bondadoso	Bom/Bondoso
Good-natured*	Bondadoso	Bom/Bondoso	Irresistible	Irresistible	Irresistível	Guilty*	Culpable	Culpado
Guilty*	Culpable	Culpado	Joyful*	Alegre	Alegre	Interested*	Interesado	Interessado
Happy*/Glad*/ Blissful/Merry*	Feliz/Contento	Feliz/Contente	Lazy	Perezoso	Preguiçoso	Irresistible	Irresistible	Irresistível
Interested*	Interesado	Interessado	Lonely	Solitario/Aislado	Solitário/Isolado	Joyful*	Alegre	Alegre
Irresistible	Irresistible	Irresistível	Lost/Sunk	Perdido/Hundido	Perdido	Kind	Amable	-
Irritated/Annoyed	Irritado	Irritado	Loving*	Amoroso	Amoroso	Lazy	Perezoso	Preguiçoso
Joyful*	Alegre	Alegre	Mean/Cruel	Mezquino/Cruel	Mesquinho/Cruel	Lost/Sunk	Perdido/Hundido	Perdido
Lazy	Perezoso	Preguiçoso	Mild*/Pleasant*	Agradable	Agradável	Loving*	Amoroso	
Lonely	Solitario/Aislado	Solitário/Isolado	Miserable	Horrible/Miserable	Péssimo/Miserável	Mean/Cruel	Mezquino/Cruel	Mesquinho/Cruel
Lost/Sunk	Perdido/Hundido	Perdido/Afundado	Naughty	Travieso/Obsceno	Malicioso	Miserable	Horrible/Miserable	Péssimo/Miserável
Loving*	Amoroso	Amoroso	Nauseated	Nauseabundo	Enjoado	Naughty	Travieso/Obsceno	Malicioso
Luxurious	Lujoso/Suntuoso	Luxuoso	Nervous/Tense	Nervioso/Tenso	Nervoso/Tenso	Nauseated	Nauseabundo	Enjoado
Mean/Cruel	Mezquino/Cruel	Mesquinho/Cruel	Nostalgic*	Nostálgico	Nostálgico	Nervous/Tense	Nervioso/Tenso	Nervoso/Tenso
Miserable	Horrible/Miserable	Péssimo/Miserável	Pleased*	Complacido	-	Nostalgic*	Nostálgico	Nostálgico
Naughty	Travieso/Obsceno	Malicioso	Polite*	Educado/Respetuoso	Educado/ Respeitoso	Open	Abierto/ Desatascado	Aberto
Nauseated	Nauseabundo	Enjoado	Quiet*	Reservado/Tranquilo	Quieto	Pleasant*/Mild*	Agradable	Agradável/Meigo
Nervous/Tense	Nervioso/Tenso	Nervoso/Tenso	Rejected	Rechazado	Rejeitado	Polite*	Educado/Respetuoso	Educado/Respeitoso

(continuando)

Chocolate			Batata chips			Iogurte		
Inglês	Espanhol	Português	Inglês	Espanhol	Português	Inglês	Espanhol	Português
Neutral	Neutro	Neutro	Relaxed	Relajado	Relaxado	Rejected	Rechazado	Rejeitado
Nostalgic*	Nostálgico	Nostálgico	Sad	Triste	Triste	Relaxed	Relajado	Relaxado
Ordinary	Corriente	Medíocre	Satisfied*	Satisfecho	Satisfeito	Reliable	Fiable	Confiável
Pleasant*/Mild*	Agradable	Agradável/Meigo	Secure*	Seguro	Seguro	Sad	Triste	Triste
Pleased*	Complacido	-	Shaky	Inestable/Débil	Trêmulo/Fraco	Satisfied*	Satisfecho	Satisfeito
Polite*	Educado/Respetuoso	Educado/Respeitoso	Shy/Timid	Tímido/Vergonzoso	Tímido/Acanhado	Shaky	Inestable/Débil	Trêmulo/Fraco
Powerful	Poderoso	Poderoso	Steady*	Estable	Estável/Sóbrio	Shy/Timid	Tímido	Tímido
Pretentious	Pretencioso	Pretensioso	Suffering	Apenado/Dolorido	Angustiado/Aflito	Solitary/Lonely	Solitario/Aislado	Solitário/Isolado
Rejected	Rechazado	Rejeitado	Surprised	Sorprendido	Surpreendido	Steady*	Firme/Estable	Estável/Sóbrio
Relaxed	Relajado	Relaxado	Tender*	Sensible/Delicado	Delicado	Stressed	Estresado	Estressado
Sad	Triste	Triste	Tormented	Atormentado/Fastidiado	Atormentado	Suffering	Apenado/Dolorido	Angustiado/Aflito
Satiating	Saciado	Saciado	Understanding*	Comprensivo	Compreensivo	Suspicious	Desconfiado	Desconfiado
Satisfied*	Satisfecho	Satisfeito	Warm*	Acogedor	Acolhedor	Tormented	Atormentado/ Fastidiado	Atormentado
Scared	Asustado	Assustado	Whole*	Completo	Inteiro	Understanding*	Comprensivo	Compreensivo
Sensual	Sensual	Sensual	Wild*	Salvaje	Selvagem	Warm*	Acogedor	Acolhedor
Serious	Serio	Sério	Worried*	Preocupado	Preocupado	Wild*	Salvaje	Selvagem
Shaky	Inestable/Débil	Trêmulo/Fraco	Young	Joven	Jovem	Worried*	Preocupado	Preocupado
Shy/Timid	Tímido/Vergonzoso	Tímido				Young	Joven	Jovem
Sociable	Sociable	Sociável				Healthy	Saludable	
Sophisticated	Sofisticado	Sofisticado						
Steady*	Firme/Estable	Estável/Sóbrio						
Suffering	Apenado/Dolorido	Angustiado/Aflito						
Surprised	Sorprendido	Surpreendido						
Tormented	Atormentado/Fastidiado	Atormentado						
Traditional	Tradicional	Tradicional						
Trustworthy	Fiable	Confiável						

(continuando)

Chocolate			Batata chips			Iogurte		
Inglês	Espanhol	Português	Inglês	Espanhol	Português	Inglês	Espanhol	Português
Uncomplicated	Sin complicaciones	Descomplicado						
Understanding*	Comprensivo	Compreensivo						
Warm*	Acogedor	Acolhedor						
Wild*	Salvaje	Selvagem						
Worried*	Preocupado	Preocupado						
Youthful/Young	Joven	Jovem						

(conclusão)

4.3.4 Participantes para contexto de consumo e respostas às versões clássicas e mais saudáveis

Os consumidores foram convidados a participar por meio de convites por e-mail e a preencher um questionário on-line usando os formulários do Google (Google L.L.C., Mountain View, Califórnia, EUA). No Brasil, os alunos e funcionários brasileiros da Universidade Federal da Paraíba e Espanha, alunos e funcionários espanhóis da Universidade de Extremadura. Foram recrutados para preencher um questionário on-line em três fases: a) indicação de ocasiões de consumo; b) avaliação do produto sem contexto; c) avaliação do produto clássico e mais saudável com contexto. Em todas as sessões foram coletados dados demográficos relacionados a gênero, idade, composição familiar, renda familiar, nível de estudos e etnia. As características demográficas dos participantes estão expostas na Tabela 10.

Para serem elegíveis à participação, os consumidores foram obrigados a declarar consumidores da categoria de produto focal (chocolate, batatas fritas, iogurte). Essa triagem também foi operacionalizada para aceitação, utilizando uma escala hedônica de 7 pontos com âncoras extremas “nada” (1) e “muito” (7). Os participantes que responderam (1) na escala foram excluídos.

Tabela 10. Características sociodemográficas dos participantes dos questionários.

	Sem contexto		Com contexto	
	Brasil (%) N=190	Espanha (%) N= 186	Brasil (%) N=187	Espanha (%) N=151
Gênero				
Feminino	66	62	38	44
Masculino	34	38	62	56
Idade				
18 a 30 anos	80	29	58	26
31 a 40 anos	20	22	38	21
41 a 50 anos	0	20	4	23
Mais de 50 anos	0	29	0	30
Composição Familiar				
1	7	22	16	8
2	27	20	37	17
3	22	18	14	15
4	24	24	23	18
5	13	13	6	42
+5	7	2	6	0
Renda familiar				
Menos de um salário	11	4	3	2
Até dois salários	29	36	7	23
Entre 2 e 3 salários	13	22	21	42
Entre 3 e 5 salários	16	22	17	17
Entre 5 e 7 salários	11	9	11	11
Mais que 7 salários	20	7	41	6
Nível de estudos				
Sem estudos	0	0	0	0
Ensino primário	0	0	0	0
Ensino médio	0	8	1	13
Universitário	100	92	99	88

4.3.5 Emoções evocadas por produtos sem contexto

Os consumidores de chocolate, batata chips e iogurte avaliaram a sua resposta emocional seguindo o mesmo protocolo para a geração dos termos emocionais (sessão 3.3.3). Após a coleta dos dados sociodemográficos dos participantes (Tabela 10), foi aplicado o questionário de consciência de saúde (HCQ) (HU, 2013) com 8 perguntas com as dimensões de “Autoconsciência da saúde” e “Responsabilidade da saúde”, sendo: 1) Sou muito crítico comigo mesmo; 2) Sou muito consciente do meu estado de saúde; 3) Estou constantemente examinando meu estado de saúde; 4) Eu me envolvo muito em tudo que tem a ver com meu estado de saúde; 5) Estou constantemente pensando no meu estado de saúde; 6) Eu assumo a responsabilidade de manter meu peso dentro de uma faixa saudável; 7) Eu deveria cuidar de

mim mesmo para prevenir doenças; 8) Minha saúde depende de como eu me cuido. Foi utilizada a escala *Likert* de 6 pontos, de 1 “discordo totalmente” a 6 “concordo totalmente”, para a coleta das respostas.

Logo após, foi aplicado o questionário específico para cada produto, quando os participantes foram apresentados à imagem do produto perguntado sobre uma frequência de consumo com uma escala categórica de 5 pontos (1 = menos de uma vez por mês, 5 = uma vez por dia ou mais). Em seguida, foram instruídos a selecionar tudo o que fosse aplicável (abordagem CATA) pela seguinte frase: “Por favor, marque todas as emoções que você lembra sentir ao consumir chocolate (ou batata chips ou iogurte)”. A ordem de apresentação das emoções foi aleatória entre os consumidores, mas, para facilitar a tarefa, a mesma ordem foi mantida para cada categoria de produto para o mesmo consumidor (KING; MEISELMAN, 2010). Foi utilizada o produto de café na primeira posição para evitar efeitos da primeira posição (DORADO et al., 2016).

Depois de selecionar as emoções evocadas por cada produto, os consumidores foram solicitados a classificar sua aceitabilidade com uma escala hedônica de 7 pontos, ancorados de 1 “não gosto nada” e 7 “gosto muito”. A lista de emoções foi apresentada antes, para evitar qualquer efeito do gostar nas repostas emocionais, que é objetivo deste estudo (KING; MEISELMAN; CARR, 2013).

4.3.6 Contexto de consumo

Após avaliar a resposta emocional sem cenário, os participantes foram expostos a imagem do produto e solicitados a responder uma série de perguntas para que indicassem as ocasiões de consumo mais usuais de cada produto. Elas diziam respeito a um horário, local, ambiente social e estado de fome, que costumam consumir cada produto (Tabela 11), com o objetivo de gerar um cenário adequado para o consumo de cada categoria de alimento. Foram selecionadas as ocasiões com maior frequência (> 50%) para compor uma narrativa do contexto de consumo para cada produto. Isso permitiu obter o cenário de consumo mais comum para cada cultura. Estes foram apresentados aos participantes em formato escrito.

Tabela 11. Dimensões de consumo utilizadas no questionário para eleição do cenário específico para cada alimento.

Dimensão	Questão	Alternativas
Momento do dia	Eu normalmente como batatas fritas... Eu normalmente como chocolate... Eu normalmente consumo iogurte...	a. Café da manhã
		b. Almoço
		c. Jantar
		d. Entre horas
Localização	Quando estou comendo batatas fritas, geralmente estou... Quando estou comendo chocolate, geralmente estou... Quando estou consumindo iogurte, geralmente estou...	a. Em casa
		b. No trabalho
		c. Centro de alimentação (bar, restaurante, etc.)
		d. Centro de lazer (cinema, teatro, etc.)
Cenário social	Quando estou comendo batatas fritas, geralmente estou... Quando estou comendo chocolate, geralmente estou... Quando estou consumindo iogurte, geralmente estou...	a. Sozinho
		b. Com amigos
		c. Com família
Estado de fome	Eu normalmente como batatas fritas quando estou... Eu normalmente como chocolate quando estou... Eu normalmente consumo iogurte quando estou...	a. Faminto
		b. Saciado

4.3.7 Resposta emocional com contexto para versões clássicas e saudáveis de produtos

Para estudar uma resposta emocional dentro de um contexto de consumo para diferentes tipos de produtos, foram coletados os dados demográficos dos participantes (Tabela 7) e aplicado o questionário HCQ seguindo a mesma estrutura aplicada para o teste sem contexto (seção 3.4.3). Para a coleta de respostas emocionais foram usados os produtos café expresso e descafeinado como aquecimento, para evitar o efeito da primeira posição (dados não mostrados) (DORADO et al., 2016).

Para avaliação da resposta emocional com contexto, foram utilizados os contextos evocados pelos consumidores do Brasil e Espanha para cada produto. Os sujeitos foram primeiramente apresentados à imagem do produto, solicitados a indicar que são consumidores do produto e questionados sobre a frequência de consumo (escala de 5 pontos). Em seguida, os participantes foram apresentados ao cenário de consumo em formato escrito, sendo solicitados a imaginar uma experiência com a seguinte frase: “Imagine que você está vivendo a seguinte situação e responda às perguntas da maneira mais realista possível”. Para avaliar a adequação

do cenário de consumo, os sujeitos foram questionados sobre a adequação do contexto com a pergunta: “Esse cenário é apropriado para o consumo deste produto?” com escalas categóricas de 7 pontos (1 = 'Não é apropriado' e 7 = 'muito apropriado').

Logo após, foram instruídos a selecionar tudo o que fosse aplicável (CATA) ao imaginar consumir cada produto em cada ocasião evocada: “Quais são as emoções que você sente ao consumir (chocolate ao leite/chocolate com 55% de cacau; batatas fritas salgadas/batata com pouco sal; iogurte natural/iogurte natural desnatado) neste contexto?”. Também pode sugerir termos adicionais com a opção “outro”. Os mesmos termos emocionais que foram utilizados para a obtenção da resposta emocional sem contexto e foi utilizada para esse teste. A ordem de apresentação das emoções foi aleatória entre os consumidores.

Evocando contextos de consumo, não se está sugerindo que as pessoas experimentem (ou até relatem) as mesmas emoções quando pensam em um contexto de consumo do que quando participam nele de verdade. No entanto, evocar cenários de consumo é uma ferramenta usada em pesquisas para ajudar os entrevistados a 'enquadrar' suas respostas (HEIN et al., 2010, 2012).

Após indicar as emoções evocadas para cada contexto e produto, os participantes foram solicitados a indicar o quanto gostavam do produto utilizando uma escala hedônica de 7 pontos (1 = não gosto, 7 = gosto muito) e a intenção de compra usando uma escala de 5 pontos (1 = definitivamente não compraria; 5 = definitivamente compraria). Como o objetivo deste estudo foi particularmente focado na resposta emocional, as escalas emocionais foram apresentadas primeiro para evitar qualquer efeito da questão de gostar (KING; MEISELMAN; CARR, 2013).

4.3.6 Análise de dados

A frequência de citações das emoções evocadas na avaliação de cada categoria de produto foi avaliada de acordo com a frequência relativa de citação (%), e os dados foram filtrados a nível de > 5% na primeira e segunda etapa (PIQUERAS-FISZMAN; JAEGER, 2014).

Para investigar o efeito dos contextos nas respostas emocionais, foram realizados testes Q de Cochran em cada uma das emoções para explorar as diferenças entre a frequência de

menção de cada emoção entre os produtos com contexto (incluindo a condição sem contexto). Comparações post-hoc em pares entre os contextos foram feitas usando o procedimento de Marascuilo (PIQUERAS-FISZMAN; JAEGER, 2014).

Foi realizado um teste não paramétrico de Wilcoxon de duas amostras emparelhadas nas classificações de adequação entre as duas versões de cada categoria de produto avaliadas com o mesmo contexto de consumo. Foram utilizados testes bicaudais e nível de significância de $p \leq 0,05$. Para como resposta sobre o nível de consumo, a aceitabilidade e a intenção de compra, foram aplicadas análises de variância (ANOVA) usando o nível de significância de 5%. Foram avaliados os efeitos dos gêneros (masculino e feminino), grupos étnicos (participantes brasileiros e espanhóis), contexto (sem e com contexto) e estímulos de itens alimentares (clássico e saudáveis).

Os resultados da Consciência em Saúde foram analisados por Wilcoxon de duas amostras emparelhadas e expressos em média e desvio padrão. A Análise das Coordenadas Principais (PCoA) foi aplicada aos coeficientes de correlação para visualizar as semelhanças entre as emoções evocadas para cada categoria de alimentos e os níveis de Consciência de Saúde.

Todas as análises estatísticas foram realizadas no XLSTAT 2014 (Addinsoft, Paris, França).

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5 RESULTADOS E DISCUSSÃO

A apresentação dos resultados obtidos nos dois estudos foram realizados em forma de artigos, de acordo com as normas estabelecidas pelo Programa de Pós Graduação em Ciência e Tecnologia de Alimento da UFPB (Norma complementar nº 03/2011).

ARTIGO I: IMPACT OF ‘FREE-FROM’ AND ‘HEALTHY CHOICE’ LABELED
VERSIONS OF CHOCOLATE AND COFFEE ON TEMPORAL PROFILE (MULTIPLE-
INTAKE TDS) AND LIKING

O artigo foi publicado no periódico *Food Research International* (Fator de impacto: 4.972)
(<https://doi.org/10.1016/j.foodres.2020.109342>).



Contents lists available at ScienceDirect

Food Research International

journal homepage: www.elsevier.com/locate/foodres

Impact of 'free-from' and 'healthy choice' labeled versions of chocolate and coffee on temporal profile (multiple-intake TDS) and liking



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ARTICLE INFO

Keywords:

Chocolate
Milk coffee
Temporal dominance of sensations
Liking
Multiple-intake
Sensory attributes

ABSTRACT

Product reformulation for obtaining "free-from" or "healthy choice" versions may confer significant changes in sensory characteristics which could not meet consumer expectations in terms of sensory perception. Therefore, this paper aims to evaluate the influence of formulations of different product categories on their dynamic sensory profile and consumer acceptability. A sensory panel of 23 semi-trained assessors evaluated two product categories, chocolate and milk coffee, using Temporal Dominance of Sensations (TDS) over three consecutive intakes/sips (multiple-intake TDS) on two replications. TDS allowed us to describe the dynamic profile of classic products over the three intakes and to identify differences in the sensory temporal profile compared to their 'healthier choice' reformulated versions. For the chocolate category, increasing the cocoa and the reduction of lactose content mainly influenced the dominance of sweetness, dairy, cocoa, crunchy and bitterness attributes. No sugar addition and absence of caffeine (decaffeinated version) in ready to drink milk coffee beverage modified temporal perception of sweetness, bitterness, coffee flavor and smoothness texture. Higher overall liking averages were associated with the dominant attributes of chocolate with a higher level of cacao and milk coffee decaffeinated. The obtained results of the present work suggest that the multiple-intake TDS technique can be applied for the evaluation of different food categories, helping to develop healthier products and predicting the liking.

1. Introduction

Consumers are continuously offered a great variety of food products labelled with "free-from" or "healthy choice" information trying to catch consumer attention and to satisfy their requirements regarding health benefits and wellness. Compared to nutritional tables, consumers do not have to invest a lot of effort and time to process the information provided by these types of label claims (Hartmann, Hieke, Taper, & Siegrist, 2018). Food products reformulation is considered one of the main options for achieving nutritional goals of the population (Santos et al., 2013; WHO, 2017). This reformulation consists of changing the composition of existing foods by reducing and/or replacing some "un-healthy/undesirable" food components (e.g. sugars, saturated fats, salt, lactose, gluten) or increasing the presence of "healthy/desirable" ones (e.g. vitamins, fiber etc.) in order to satisfy consumer expectations. Maintaining the sensory properties and mostly the acceptability of the new "healthier" version is an important challenge for the food industry

in order to guarantee the success of a product in the market.

Application of sensory evaluation techniques to food products help industries to check and guarantee the sensory quality along all stages of food product chain until consumers consumption (Civille & Oftedal, 2012). Nowadays, sensory assessment is considered a key tool for product innovation. Among the available sensory techniques, dynamic sensory methods focus on evaluating the temporal aspects related to sensory perception along food consumption are gaining popularity. These techniques allow obtaining a more realistic picture of the sensory changes undergone during food consumption.

Among dynamic sensory techniques, Temporal Dominance of Sensations (TDS) (Pineau, Cordelle, & Schlich, 2003) is applied to identify and quantify the dominance of a sensory properties over time. The concept of 'dominance' is related to the attribute that most attracts the assessor's attention and not necessarily should be also the most intense (Schlich, 2017). TDS provides a time dimension that may be useful for product description and for discovering dynamic/temporal

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<https://doi.org/10.1016/j.foodres.2020.109342>

Received 4 March 2020; Received in revised form 13 May 2020; Accepted 17 May 2020

Available online 19 May 2020

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Table 1
Attributes and descriptions of each product category.

Category (Brand)	Commercial name (code)	Attribute	Description ¹
Chocolate (Hacendado®)	Milk Chocolate (CH-M)	Bitterness ^{ta}	Primary taste associated with caffeine
	Dark Chocolate (CH-D)	Cocoa ^f	Flavor sensation of cocoa
	Milk Chocolate low lactose (CH-LL)	Creaminess ^{te}	Sensation of creaminess to the mouth
		Crunchy ^{te}	Sensation combined of acoustic output and mechanical strength in the bite
		Adhesiveness ^{te}	Sensation of the adheres to a specific surface of the palate and teeth
		Dairy ^f	Flavor sensation associated with milk
		Sweetness ^{ta}	Primary taste associated with sucrose
		Melting ^{te,m}	Sensation at which the sample dissolves in the mouth
Milk Coffee (Hacendado®)	Espresso Milk Coffee (MC-E)	f-Coffee ^f	Flavor sensation resembling coffee
	Milk Coffee no added sugar (MC-NS)	Caramel ^f	Flavor sensation resembling caramel
	Milk Coffee decaffeinated (MC-D)	Bitterness ^{ta}	Primary taste associated with caffeine
		Roasted ^f	Flavor sensation associated with roasted coffee
		Smoothness ^{te,m}	Sensation of smooth feel in the mouth
		Sweetness ^{ta}	Primary taste associated with sucrose
		Dairy ^f	Flavor sensation associated with milk
		Sourness ^{ta}	Primary taste associated with citric acid
		Astringent ^{te,m}	Sensation of increased friction of food in the mouth

^{te} = texture; ^f = flavor; ^{ta} = taste; ^m = mouth feel; ^{tr} = trigeminal. ¹Hayakawa et al. (2010), Palazzo and Bolini (2014) and Simioni et al. (2018) modified.

differences between products that cannot be identified by conventional sensory profiles (Pineau & Schlich, 2015; Sudre, Pineau, Loret, & Martin, 2012; Thomas, Visalli, Cordelle, & Schlich, 2015). The inclusion of the temporal dimension using dynamic sensory techniques is one of the most important advantages of these techniques compared to the more conventional static sensory methods such as Quantitative Descriptive Analysis (Charles, Endrizzi, Aprea, Zambanini, & Betta, 2017; de Lavergne, van Delft, van de Velde, van Boekel, & M., 2015; Paulsen, Nys, Kvarberg, & Hersleth, 2014).

TDS has been already used to study the dynamic perception of a large variety of products, including chocolate (Oberrauter, Januszewska, Schlich, & Majchrzak, 2018; Rodrigues et al., 2016), cheese (Rodrigues et al., 2018), dry-cured ham (Lorido, Hort, Estévez, & Ventanas, 2016), strawberry pulp (Gonçalves et al., 2017), wine (Frost, Blackman, Ebeler, & Heymann, 2018), yogurt (Esmerino et al., 2017), olive oil (Dinnella, Masi, Zoboli, & Monteleone, 2012), coffee (Dinnella, Masi, Naes, & Monteleone, 2013), fish sticks (Albert, Salvador, Schlich, & Fiszman, 2012), salmon-sauce combinations (Paulsen, Naes, Ueland, Rukke, & Hersleth, 2013) and nuts (Hutchings, Foster, Grigor, Bronlund, & Morgenstern, 2014). Reduced sodium or sugar content products have also been successfully analyzed by using TDS (De Souza et al., 2013; Lorido et al., 2016; Rodrigues et al., 2014; Silva et al., 2018; Zorn, Alcaire, Vidal, Giménez, & Ares, 2014). However, in order to obtain a more accurate and complementary information related to the temporal sensory changes taking place along food consumption, an extension of TDS methodology called multi-intake, multi-bite or multi-sip TDS was developed (Delarue, Lawlor, & Rogeaux, 2015). The multi-intake TDS technique consists of a serial of concatenated TDS evaluations (Schlich, Visalli, Urbano, & Pineau, 2013).

The multi-intake approach appears to be relevant mostly for the evaluation of sensory attributes (Lesme et al., 2020). Zorn et al. (2014) applied this method to evaluate the dynamic perception of orange juice containing low calorie sweeteners. Galmarini, Loiseau, Debreyer, Visalli, and Schlich (2017) evaluated the influence of cheese on wine perception. Simioni, Ribeiro, de Souza, Nunes, and Pinheiro (2018) combined this methodology together with a repeated consumption acceptance test for the analysis of special beers. This gives evidence of advances in the use of methodologies that simulate the consumption experience in a more realistic way. Thus, there is a need to investigate how the dominant sensory attributes of different food formulations in a multiple intake scenario are perceived in order to provide more solid and real information that can guarantee consumer acceptability.

Within this context, the objective of the present work was to explore the temporal sensory aspects related to the classic and the “healthy”

and/or “free-from” version of different product categories using the multiple-intake TDS approach. According to our hypothesis, this technique will provide a more realistic and accurate information related to consumers responses during the course of food consumption. The likely relationship between sensory perceptions and hedonic aspects as acceptability, will also be addressed.

2. Material and methods

2.1. Samples

Commercially available chocolate milkshake (*batido de cacao*, Carrefour®, Spain), and white chocolate (*chocolate blanco*, Carrefour®, Spain) were used for training sessions. Different varieties of commercial milk coffee beverage (*espresso milk coffee* (MC-E) -*café con leche espresso*-, *decaffeinated milk coffee* (MC-D) -*café con leche descafeinado*- and *no added sugar milk coffee* (MC-NS) -*café con leche sin azúcares añadidos*-, Mercadona®, Spain), and chocolate (*milk chocolate* (CH-M) -*chocolate extrafino con leche*-, *low lactose milk chocolate* (CH-LL) -*chocolate extrafino con leche bajo en lactosa*-, *dark chocolate* (55% of cocoa) (CH-D) -*chocolate negro*-, Hacendado®, Spain) were analyzed by using Multiple-intake TDS method. All samples correspond to the same production batch and were within the shelf-life period. MC-E and CH-M are “classic”, MC-D and CH-LL are the ones labeled as “free-from” versions, and MC-NS and CH-D as “healthy choice” versions.

2.2. Panel participants

The multiple-intake TDS was carried out by 23 semi-trained panelists (10 male and 13 females from 21 to 55 years old) recruited from the Service of Innovation in Products of Animal Origin (SIPA) and Research Institute of Meat and Meat Products (IProCar) of University of Extremadura. Participants had previous experience in dynamic sensory techniques but no particular training in this technique.

2.3. Multiple-intake TDS technique

First, a focus group session (Lawless & Heymann, 2010) was performed ($n = 3$) in which the selected products (milk chocolate, milk coffee) were tasted. In this session, the total number of intakes or sips, the total time of evaluation, the sample amount to be ingested in each intake or sip and the sensory attributes to be evaluated were selected and discussed. The selected attributes and definitions are presented in Table 1. The description of the attributes were generated in consensus

by the focus group and based on the search for anteriority (Hayakawa et al., 2010; Palazzo & Bolini, 2014; Simioni et al., 2018) and adjusted to address sensations. All sensory analysis sessions were carried out in individual booths, under white light and with adequate ventilation. Only one product was evaluated per day of analysis.

2.3.1. Training in multiple-intake TDS technique

All panelists attended to five one-hour training sessions. In the first one, the participants were introduced to the notion of “dominant sensation” in TDS by defining this term as those characteristics that catch his/her attention the most at a given time, and which does not mean that this sensation has to be very intense in the product. To illustrate this definition, we used as analogy a symphony orchestra and images with elements in highlights, and an illustrative protocol of sensory evaluation of dominant sensations as described by Lorido et al. (2016). The panelists were then trained to use the computerized TDS data capture system (FIZZ v 2.40A), by evaluating similar products to those that would be evaluated in this study (chocolate milkshake, white chocolate). The protocol described by Pineau et al. (2009) was followed, fixing a maximum of 10 attributes which simultaneously appeared on the computer screen. Each TDS attribute was represented by one button on the computer screen.

At the beginning of each TDS training sessions, each panelist was requested to place the first portion in the mouth and clicked the “start” button and started to evaluate the dominant sensations. They could then successively select the dominant attribute from the provided list. Attribute order within the list was randomized across the panel (Pineau et al., 2012). The TDS total session time for milk coffee was 70 s with a 14 s interval between intakes and a total session time of 100 s for chocolate with 28 s interval between intakes. After the third intake, they were instructed to click the “stop” button to indicate the end of TDS session. All sessions followed the same protocol, adapted to the adjusted time intervals for each product type with a “delay time” of 2 s between each intake.

2.3.2. Experimental procedure

Once test conditions were defined with the focus group and panelist were trained, the selected products were evaluated. The portions, temperature and multiple-intake time protocol are shown in Table 2. The same protocol applied in the training was used for multiple-intake TDS analysis, with times and terms corresponding to each product to be evaluated. Sample tasting started by panelist clicking the start button parallel to putting the sample in the mouth, performed TDS by selecting the dominant oral sensation over time. Assessment stopped automatically after final time or individually by the judges, when attributes were no longer dominant. Samples of the same category of product were evaluated on the same day, presented in monadic form. Panelists were requested not to clean their palates between sips so that the sensory analysis simulated a scenario of product consumption. Each of the 23 panelists performed two replications of each product (i.e. 46 trials).

Table 2
Multiple-intake TDS analysis conditions.

Product Portion	Milk Coffee cup with 20 mL	Chocolate (1/2) square
Temperature	~58 °C	25 °C
Intake	Time (s)	Time (s)
1st	Start	Start
Swallow	8	15
2nd	14	30
Swallow	24	45
3rd	30	60
Swallow	40	75
Stop	70	100

2.4. Overall liking

After multiple-intake TDS analysis, panelists were requested to evaluate product liking of using an unstructured scale of 10 cm anchored in the extremes with “dislike extremely” and “like extremely”. The three versions of each product category coded with a random three-digit number were monadically presented to the panelists. They also received a glass of water and were asked to rinse their mouths between each sample.

2.5. Data analysis

2.5.1. Multiple-intake TDS curves

TDS curves were obtained and analyzed using FIZZ software (v 2.40A). For each product, the Dominance Rate (the proportion of subjects that selected each attribute) (DR%) was computed at each time point, and TDS curves were represented over the three intakes. Line based smoothing was applied on each curve. In order to facilitate the interpretation of TDS curves, two other additional lines (chance and significance) are displayed on each TDS curve. The chance level represents the DR% that an attribute is obtained by chance ($P_0 = 1/\text{number of attributes}$) (Pineau et al., 2009). The significance level represents the smallest value of the proportion being significantly ($p < 0.05$) higher than the chance level ($P_s = P_0 + 1.645[P_0(1 - P_0)/n]^{1/2}$, n is the number of runs: judges $\times$ replicates). Two TDS parameters were extracted from TDS curves for each attribute: Time, computed in relation to the average time the attribute was selected as dominant for the first time (Lorido et al., 2016) and Dominance Duration (DD), computed at individual level by adding the time periods during which an attribute was cited as dominant (Galmarini, Visalli, & Schlich, 2017).

2.5.2. TDS difference curves

Difference of the TDS curves were used to compare product pairs (classic vs the healthier version). As described by Pineau et al. (2009), TDS difference curves display the differences between dominance rates (DR%) of attributes. These differences are plotted only when significantly different from zero, highlighting the differences between the products over time. The significance of the difference between each curve is calculated for each time point and attribute using the test to compare two binomial proportions (Kiemle, Schmidt, and Berdine, 1995).

2.5.3. Statistical analysis

Average, along the three intakes/sips and two replications per panelist, of Time and Dominance Duration TDS parameters were extracted and calculated per attribute in each product and were analyzed by T-student test, to compare product pairs (classic and ‘free-from’ and/or ‘healthy’ version) at $p \leq 0.05$. The overall liking data were also evaluated by ANOVA and Tukey’s Test at $p \leq 0.05$ using IBM SPSS software (v.22) (IBM Co., New York, New York, USA). Results from the DD parameter of each attribute and the liking (mean scores) of the products of the evaluated product categories (chocolate, and milk coffee) were subjected to principal component analysis (PCA) carried out using the XLSTAT 2014 (Addinsoft, Paris, France). Plots of scores and loadings were built from the first two principal components.

3. Results

3.1. TDS curves

The data was assessed by analyzing the chance and significance levels. Chance level marks the limit of the probability of an attribute checked at random, while the level of significance is the minimum value for the attribute to be considered as significantly dominant (Pineau et al., 2009). Figs. 1 and 4 show multiple-intake TDS curves of

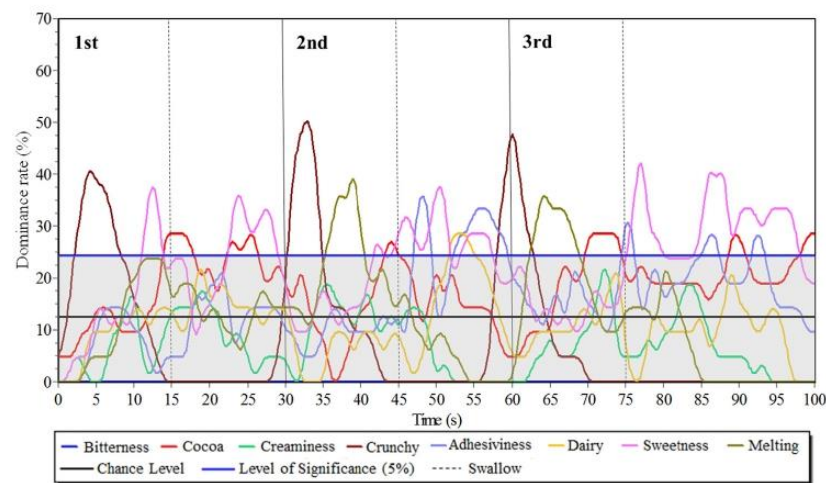


Fig. 1. TDS curve of milk chocolate (CH-M).

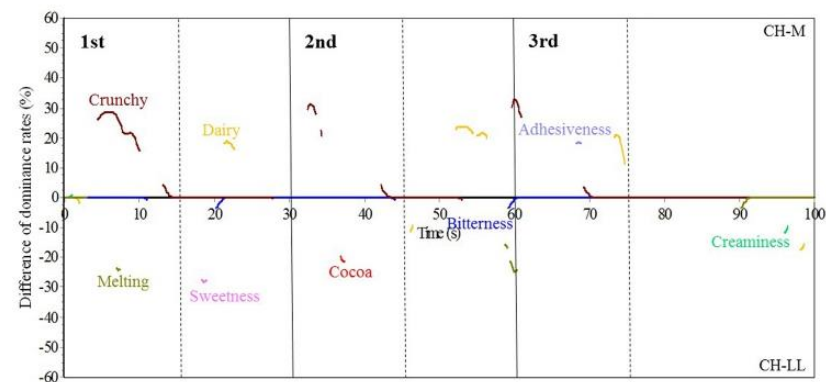


Fig. 2. Multiple-intake TDS graphical representation for the TDS difference curves between CH-M and CH-LL (filtered level of significance 5%). Footnote: CH-M = milk chocolate; CH-LL = milk chocolate low lactose.

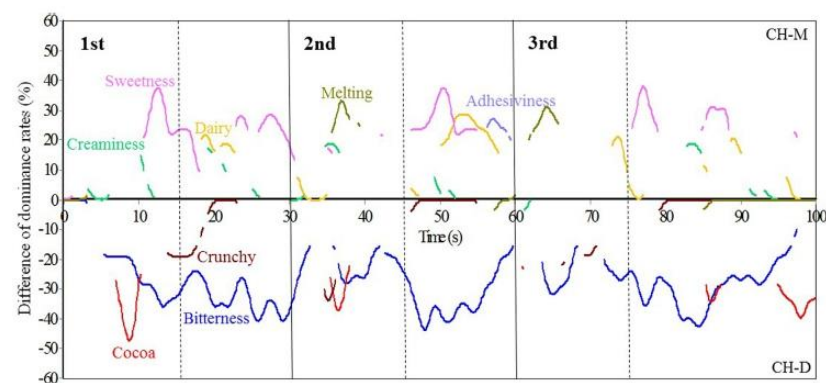


Fig. 3. Multiple-intake TDS graphical representation for the TDS difference curves between CH-M and CH-D (filtered level of significance 5%). Footnote: CH-M = milk chocolate; CH-D = dark chocolate.

the two different products categories (chocolate, milk coffee). Each curve represents the evolution of the DR% of an attribute over time (Pineau et al., 2009). Figs. 2, 3, 5 and 6 show multiple-intake TDS difference curves, to compare classic and healthier products, plotted

only when significantly different from zero, highlighting the differences between the products over time. These differences enable to highlight the specific and discriminating dominant attributes for each product (Pineau et al., 2009).

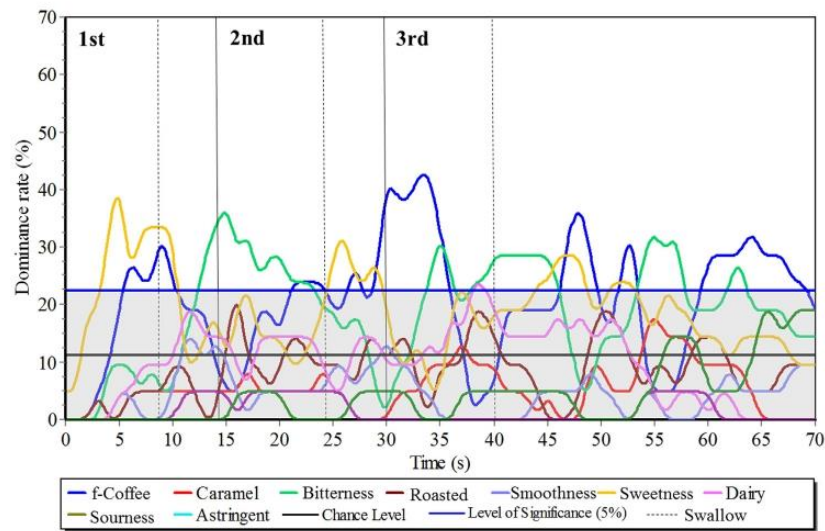


Fig. 4. TDS curve of espresso milk coffee (MC-E).

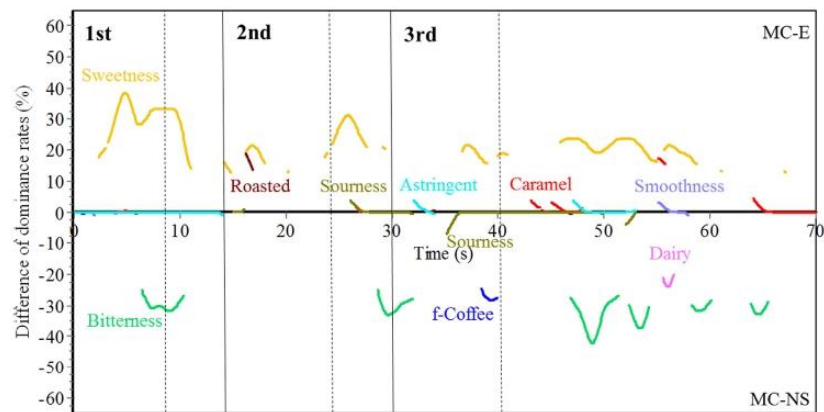


Fig. 5. Multiple-intake TDS graphical representation for the TDS difference curves between MC-E and MC-NS (filtered level of significance 5%). Footnote: MC-E = espresso milk coffee; MC-NS = milk coffee no sugar added.

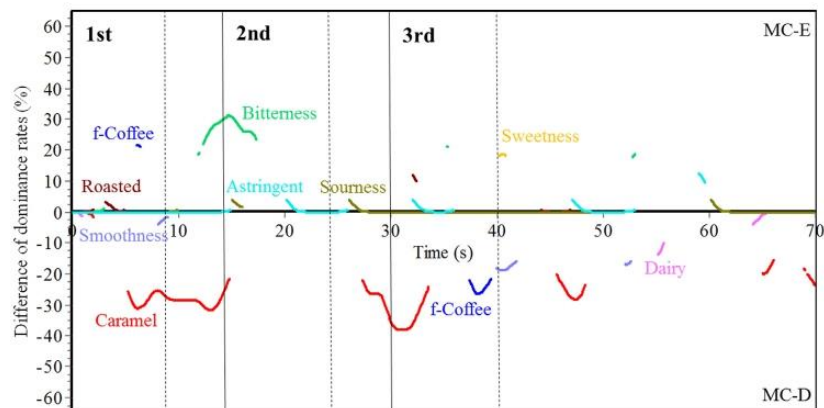


Fig. 6. Multiple-intake TDS graphical representation for the TDS difference curves between MC-E and MC-D (filtered level of significance 5%). Footnote: MC-E = espresso milk coffee; MC-D = decaffeinated milk coffee.

3.1.1. Chocolate

Fig. 1 displays the TDS curves for three intakes of CH-M, representing the evolution of the DR% of eight attributes over time. Chance (12.5%) and significance (24%) levels are represented on the curves. The first intake was characterized by the significant dominance of three attributes (crunchy, sweetness and cocoa), the second intake by six (crunchy, melting, sweetness, cocoa, adhesiveness and dairy) and the third intake by five attributes (crunchy, melting, sweetness, cocoa and adhesiveness). Crunchy was selected as the first significant dominant sensation by 41% of the panelist at 4 s of product evaluation. Crunchy was also the most dominant attribute in each intake, with a maximum of 50% of DR% in the second intake at almost 35 s. Melting and adhesiveness showed significant dominance during the second intake, with a DR% of 39% and 35% respectively. Cocoa and dairy attributes showed lower DR% (< 30%) compared to the attributes previously described but with a significant extent particularly for cocoa during the first and third intake and for dairy flavor during the second intake.

Fig. 2 displays the difference TDS curves of dominant sensations between classic milk chocolate (CH-M) vs low lactose milk chocolate (CH-LL) per intake. Higher differences in the DR% of crunchy attribute was observed in the first intake compared to the second and the third one. In CH-M chocolates significant dominance of crunchy was observed particularly at the beginning of the three intakes whereas in CH-LL samples no significant dominance of this attribute was obtained in any of the intakes. The first and second intakes of CH-M were characterized by significantly higher DR% of crunchy and dairy, and the third by crunchy, dairy and adhesiveness. Otherwise, CH-LL showed a higher but shorter significant DR% of melting and sweetness during the first intake, cocoa and dairy in the second and melting, dairy and creaminess during the third intake.

Fig. 3 displays difference in the DR% of TDS curves between CH-M and CH-D. In general, CH-M was characterized by a significantly higher DR% of sweetness, dairy, melting (only in the second intake), creaminess and adhesiveness (only in the second intake) attributes whereas CH-D was characterized by a significantly higher DR% of bitterness, cocoa and crunchy attributes. For CH-M samples, sweetness was the attribute with the higher and longer significant DR% over the three intakes. However, in CH-D chocolates bitterness was the attribute presenting the higher and longer DR% during the three intakes but not in the first one in which cocoa displayed a higher but shorter significant DR%.

Results of TDS extracted parameters related to the total dominance duration (DD) and first time of dominance citation (Time) of the evaluated attributes in chocolate samples are presented in Table 3. Regarding the most classic chocolate evaluated, CH-M, sweetness and cocoa attributes displayed the longest dominance followed by adhesiveness, dairy and melting and finally the shortest dominance corresponded to creaminess and crunchy. Bitterness was not selected as dominant attribute during the evaluation of this chocolate. No significance differences in DD TDS parameter was obtained for any of the evaluated attributes in CH-LL samples compared to CH-M ones. However, significant differences were obtained in Duration TDS parameter when CH-M was compared to CH-D samples. Dominance of cocoa flavor and crunchy were significantly longer in CH-D compared to CH-M samples whereas for creaminess, adhesiveness and sweetness duration of dominance was significantly shorter. For CH-D samples, cocoa flavor and bitterness were the attributes presenting the highest values for Duration TDS parameter but creaminess and sweetness displayed the lowest one.

The type of chocolate evaluated influenced the Time TDS parameter (Table 3) more than the DD TDS parameter previously reported. The first attribute selected as dominant in the most classic chocolate, CH-M, was crunchy followed by creaminess, sweetness, cocoa, melting, dairy, and finally adhesiveness. Significant differences were obtained for the Time TDS parameter between CH-M and CH-LL samples in all evaluated

attributes except in dairy flavor. Cocoa flavor and creaminess attributes were selected for the first time as dominant later, whereas crunchy, adhesiveness, dairy, sweetness and melting were selected earlier in low lactose chocolate (CH-LL) compared to classic ones (CH-M). Moreover, increasing the cocoa content (CH-D samples) led to a significant effect on Time TDS parameter of all evaluate attributes except for melting. Adhesiveness, and particularly creaminess and sweetness were recorder for the first time dominant later in CH-D compared to CH-M samples. However, first citation of dominance for cocoa flavor and crunchy was before in CH-D compared to CH-M with a significant extent.

Regarding acceptability significant differences were obtained between the evaluated samples. The higher cocoa content (CH-D) significantly increased the acceptability values compared to classic chocolate (6.10 ± 1.45 for CH-M vs 7.18 ± 1.30 for CH-D). Decreasing the lactose content also had an impact on overall acceptability but without a significant extent (6.49 ± 1.27 for CH-LL).

3.1.2. Milk coffee

Fig. 4 shows multiple-intake TDS curve for the three sips of espresso milk coffee samples (MC-E). All presented attributes were selected as dominant by the panelists during sample evaluation. Four of them (sweetness, f-coffee, bitterness and dairy) were significantly dominant along the 100 s of evaluation. Chance (11%) and significance (22%) levels are represented on the curves. Noticeable differences in the dominance profile were obtained between the three different sips. Sweetness attribute showed the highest DR% in the first sip, bitterness in the second, and f-coffee attribute in the third. At five seconds of the first sip of MC-E samples, sweetness dominated the temporal profile reaching the significantly highest DR% (39%) (Fig. 4). This attribute was also dominant in the second and third sip but with lower DR%, 30 and 24% respectively. Bitterness was the main dominant attribute in the second sip reaching a DR% of 36% (from 13 to 24 s, with a maximum at 16 s). Finally, the third sip was characterized by the dominance of f-coffee attribute reaching a DR% over 40% at the beginning of the third sip. Difference in the dominance rates of TDS curves between the most classic milk coffee (MC-E) and no added sugar milk coffee (MC-NS) are shown in Fig. 5. Sweetness DR% was the highest and dominated in all the three sips as well as in the after-taste period for MC-E samples. Other sensations as astringent, caramel and roasted were also dominant in these samples. However, MC-S samples showed a higher DR% of bitterness during the first sip, the third sip and the after taste.

Fig. 6 displays TDS curves of the difference in DR% between MC-E and MC-D samples. Caramel flavor dominated the temporal profile along the entire evaluation period including after-tasted in MC-D samples whereas bitterness presented a significantly higher DR% in MC-E samples particularly at the final of the first sip and at the beginning of the second one. Significantly higher DR% for f-coffee and roasted flavor, sourness, astringent and sweetness were obtained in MC-E samples. Moreover, MC-D samples presented higher DR% for smoothness in the first sip, coffee flavor in the third and dairy flavor in the after-taste period.

Results of TDS extracted parameters, DD and Time of the evaluated attributes in milk coffee samples are presented in Table 4. Regarding the most classic milk coffee, MC-E, bitterness attribute displayed the longest dominance followed by f-coffee, caramel, sweetness, sourness, dairy, roasted, astringent and finally the shortest duration was for smoothness. Significant differences in DD TDS parameter were obtained for most evaluated attributes between MC-E and MC-NS samples except for f-coffee and sourness attributes. Dominance of caramel, roasted, sweetness and dairy were significantly longer in MC-E compared to MC-NS samples whereas for bitterness, smoothness and astringency dominance duration was significantly shorter. However, significant differences were obtained in DD TDS parameter for f-coffee, roasted, smoothness, sweetness and dairy between MC-E and MC-D samples. DD TDS parameter of f-coffee, sweetness and dairy were significantly

Table 3
Multiple-Intake TDS parameters of chocolate evaluation (Mean $\pm$ SD).

Attribute Parameters (s)	Product			P CH-MvsCH-LL	P CH-MvsCH-D
	CH-M	CH-LL	CH-D		
Bitterness					
Time	–	14.00 $\pm$ 2.83	15.05 $\pm$ 4.91	–	–
DD	–	16.5 $\pm$ 4.95	26.48 $\pm$ 5.81	–	–
Cocoa					
Time	16.18 $\pm$ 7.57	21.00 $\pm$ 4.78	9.05 $\pm$ 2.50	*	***
DD	21.88 $\pm$ 4.44	20.18 $\pm$ 5.50	31.45 $\pm$ 6.60	n.s.	***
Creaminess					
Time	12.33 $\pm$ 4.12	21.59 $\pm$ 4.98	34.60 $\pm$ 8.87	***	***
DD	12.25 $\pm$ 4.39	15.35 $\pm$ 5.81	5.00 $\pm$ 0.70	n.s.	*
Crunchy					
Time	11.25 $\pm$ 4.36	3.14 $\pm$ 1.86	6.42 $\pm$ 2.79	***	***
DD	10.70 $\pm$ 3.72	9.71 $\pm$ 2.63	15.75 $\pm$ 4.60	n.s.	***
Adhesiveness					
Time	28.80 $\pm$ 6.63	20.47 $\pm$ 4.14	33.39 $\pm$ 8.70	***	n.s.
DD	16.70 $\pm$ 4.00	16.89 $\pm$ 4.12	13.17 $\pm$ 4.00	n.s.	*
Dairy					
Time	22.81 $\pm$ 5.97	19.93 $\pm$ 4.45	–	n.s.	–
DD	15.12 $\pm$ 5.52	11.71 $\pm$ 3.69	–	n.s.	–
Sweetness					
Time	14.58 $\pm$ 3.17	11.55 $\pm$ 3.05	46.25 $\pm$ 3.61	**	***
DD	22.42 $\pm$ 5.61	22.50 $\pm$ 6.86	10.12 $\pm$ 4.61	n.s.	***
Melting					
Time	16.50 $\pm$ 4.29	9.12 $\pm$ 3.77	17.42 $\pm$ 4.25	***	n.s.
DD	13.61 $\pm$ 4.04	14.68 $\pm$ 5.25	11.75 $\pm$ 2.73	n.s.	n.s.

DD = Dominance Duration TDS parameter. CH-M = milk chocolate; CH-LL = milk chocolate low lactose; CH-D = dark chocolate. n.s.: non-significant; * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$.

Table 4
Multiple-Intake TDS parameters of milk coffee evaluation (Mean $\pm$ SD).

Attribute Parameters (s)	Product			P MC-EvsMC-NS	P MC-EvsMC-D
	MC-E	MC-NS	MC-D		
f-Coffee					
Time	16.89 $\pm$ 4.02	15.24 $\pm$ 5.08	16.78 $\pm$ 6.56	n.s.	n.s.
DD	16.47 $\pm$ 4.86	17.00 $\pm$ 6.06	13.63 $\pm$ 3.23	n.s.	*
Caramel					
Time	16.00 $\pm$ 3.46	26.00 $\pm$ 3.46	7.75 $\pm$ 2.54	**	***
DD	15.60 $\pm$ 6.54	4.00 $\pm$ 1.73	19.37 $\pm$ 5.08	*	n.s.
Bitterness					
Time	14.08 $\pm$ 3.86	9.43 $\pm$ 3.88	18.50 $\pm$ 3.70	**	n.s.
DD	20.92 $\pm$ 6.65	25.57 $\pm$ 6.18	21.2 $\pm$ 1.64	*	n.s.
Roasted					
Time	21.61 $\pm$ 5.19	24.00 $\pm$ 8.73	18.50 $\pm$ 3.51	n.s.	n.s.
DD	9.77 $\pm$ 2.62	7.08 $\pm$ 2.64	13.37 $\pm$ 2.50	*	**
Smoothness					
Time	23.42 $\pm$ 4.29	10.28 $\pm$ 3.20	18.85 $\pm$ 4.28	***	*
DD	5.91 $\pm$ 2.87	11.86 $\pm$ 2.73	9.15 $\pm$ 3.21	***	*
Sweetness					
Time	7.31 $\pm$ 3.20	31.5 $\pm$ 4.95	9.00 $\pm$ 3.59	***	n.s.
DD	15.35 $\pm$ 4.74	8.00 $\pm$ 1.41	12.00 $\pm$ 3.40	*	*
Dairy					
Time	17.75 $\pm$ 6.50	14.38 $\pm$ 4.56	10.00 $\pm$ 4.47	n.s.	**
DD	12.67 $\pm$ 4.16	8.61 $\pm$ 2.50	8.00 $\pm$ 2.70	**	**
Sourness					
Time	15.50 $\pm$ 2.12	7.5 $\pm$ 0.71	–	*	–
DD	14.00 $\pm$ 4.24	10.50 $\pm$ 3.53	–	n.s.	–
Astringent					
Time	53.71 $\pm$ 5.34	31.5 $\pm$ 6.59	66.67 $\pm$ 2.89	***	**
DD	7.14 $\pm$ 2.54	13.33 $\pm$ 3.27	5.00 $\pm$ 0.00	**	n.s.

DD = Dominance Duration TDS parameter. MC-E = milk coffee express; MC-NS = milk coffee no sugar added; MC-D = milk coffee decaffeinated. n.s.: non-significant; * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$.

shorter in MC-D samples compared to MC-E whereas for roasted and smoothness significantly higher values were found. For MC-D, caramel, roasted and smoothness were the attributes presenting the highest values for DD TDS parameter but f-coffee, sweetness and dairy displayed

the lowest one.

Significant differences were obtained for the Time TDS parameter between MC-E and MC-NS samples in all evaluated attributes except in f-coffee, roasted and dairy. Caramel and sweetness attributes were selected for the first time as dominant earlier, whereas bitterness, smoothness, sourness and astringent were selected later in classic milk coffee (MC-E) compared to no sugar added (MC-NS). Significant differences for Time TDS parameter were obtained for caramel, dairy and astringent attributes between MC-E and MC-D. Caramel and dairy attributes were recorded as dominant for the first time later in MC-E compared to MC-D samples, and astringent before with a significant extent.

Regarding acceptability results for milk coffee samples, significant differences were obtained between all evaluated samples ($p < 0.05$). Removing the caffeine content (MC-D) significantly increased the acceptability values compared to MC-E (6.25 $\pm$ 1.12 for MC-D and 5.32 $\pm$ 1.45 for MC-E). No addition of sugar significantly decreased overall acceptability from very much (5.32 $\pm$ 1.45 for MC-E) to moderately disliked (2.63 $\pm$ 1.01 for MC-NS).

3.2. Principal component analysis

Exploratory analysis of the data was performed by the PCA in order to obtain the profile of each sample in relation to the dominant sensations and overall liking of samples. The similarities and differences of each category of analyzed product are shown in Figs. 4 and 8. The proximity between the vectors suggests the existence of a positive correlation between them, due to which the vectors that are very close, suggest a strong correlation.

PCA of each attribute dominance duration (DD) and liking of chocolates (CH-M, CH-LL, CH-D) is shown in Fig. 7. The first Principal Component (PC1) explained 81.86% of the total variation among the samples and, with the second (PC2), allowed to explain 100% of the variability among the different attributes. CH-LL and CH-M samples are positioned on the positive axis of PC1 but in different quadrants. CH-LL samples were particularly characterized by long dominance of melting and creaminess attributes, while CH-M were characterized by higher

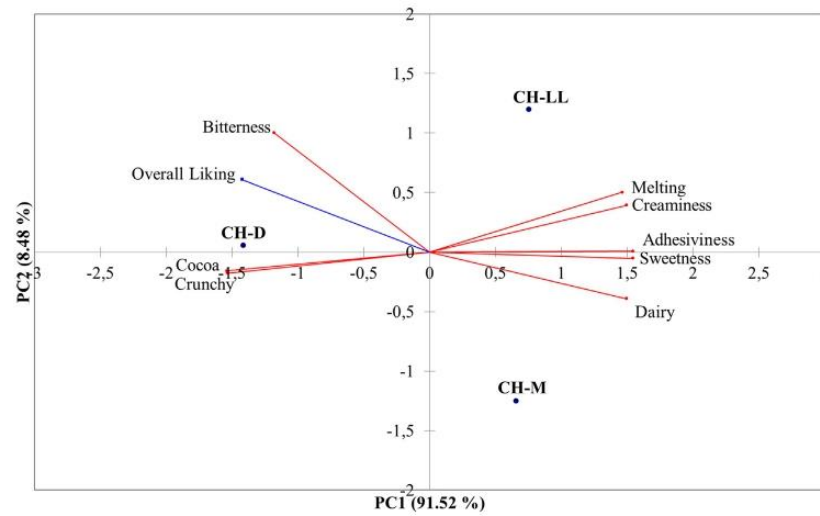


Fig. 7. Principal Component Analysis of Dominance Duration of each attribute and overall liking of chocolates. Footnote: CH-M = milk chocolate; CH-LL = milk chocolate low lactose; CH-D = dark chocolate. Overall liking was analyzed as additional variable.

values of dairy and sweetness DD TDS parameters of CH-D sample were positively correlated with overall liking and bitterness, cocoa and crunchy DD TDS parameters, as can be showed in Table 3. Fig. 8 shows the PCA of DD parameter of each attribute and overall liking of milk coffee samples, MC-E, MC-NS and MC-D. The first Principal Component (PC1) explained the 67.33% of the total variation and, with the second (PC2), explained 100% of the variability. Sourness, f-coffee, astringent, bitterness and smoothness are placed on the negative axis of PC1, being bitterness and smoothness located in the same quadrant of the MC-NS. dairy and sweetness are positively correlated with MC-E and caramel and roasted positively correlated with MC-D and the overall liking.

4. Discussion

4.1. Temporal profile of milk chocolate category

Temporal profile recorded using multiple-intake TDS technique in milk chocolate has been considered as the reference temporal profile for this product category in the present work. Graphical representations (TDS curves during three intakes) together with the results from the TDS parameters extracted from the curves, DD and Time, have been used to describe and discuss the temporal perception of this product. Most evaluated attributes significantly dominant the CH-M temporal profile through the evaluation and particularly in the second and in the third intake increasing from the second intake the number of attributes presenting DR% with a significant extent. During the first intake, only crunchy descriptor was dominant among texture attributes but from the second intake creaminess, adhesiveness and melting were also

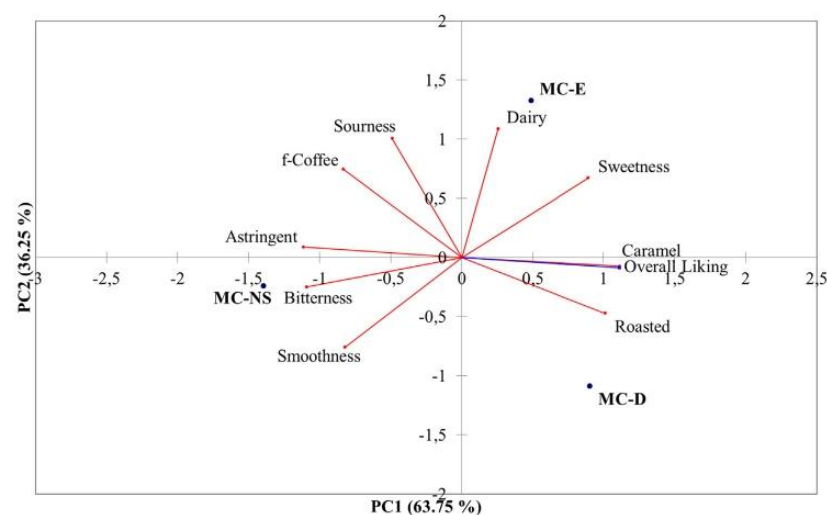


Fig. 8. Principal Component Analysis of Dominance Duration of each attribute and overall liking of milk coffee. Footnote: MC-E = espresso milk coffee; MC-D = decaffeinated milk coffee; MC-NS = milk coffee no sugar added. Overall liking was analyzed as additional variable.

dominant. Among flavor attributes, sweetness and cocoa flavor presented significant DR% during the three intakes but dairy flavor only in the second one. Crunchy, sweetness and melting attributes reaching the highest maximum DR% along the evaluation. However, in terms of DD parameter, sweetness and cocoa flavor presented the longest duration and crunchy the shortest, concluding that crunchy texture presented an important impact in terms of dominance (high dominance rates) at the beginning of each intake. However, sweetness also displayed a high DR% together with a long duration suggesting that this attribute also presented a great impact on the dynamic profile of milk chocolate. In this sense, sweetness and milk/dairy perceptions have been described as usual attributes found in chocolate (Rodrigues et al., 2016). Moreover, results from Time TDS parameters confirm that crunchy attribute was the first attribute selected as dominant and adhesiveness the last one. Crunchy is one of the attributes commonly perceived as dominant in the early chewing stage of most hard solids, such as chocolate (Fizman & Tarrega, 2018). Melting was the second texture attribute with the greatest dominance on the dynamic time profile. This attribute appears on the second and third intake just after crunchy and before swallowing. According to Tang, Larsen, Ferguson, and James (2017), chocolate is taken as reference food to define melty sensation ("degree to which sample melts during mastication"). Therefore, the application of multiple-intake TDS technique resulted very useful to better characterize the temporal dynamic profile of chocolate.

Adhesiveness showed a significant DR% after swallowing the sample particularly during the second and the third intake. During the last phase of the chewing process, whatever its initial structure or composition, foods such as chocolate are turned into a swallowable bolus. Therefore, within a few seconds, the hardness of this bolus tends to decrease rapidly and its adhesiveness should increase at the end of the swallow phase (Fizman & Tarrega, 2018).

In a previous study, authors reported that milk chocolate tasted sweetness with a little bitterness sensation, but no significant differences were found for the basic tastes (De Pelsmaeker, De Clercq, Gellynck, & Schouteten, 2019). However, in the present study bitterness was not selected as dominant at any moment of the evaluation, while sweetness presented a high DR% and duration along the entire evaluation. The noticeable presence of sugar in the formulation of the milk chocolate evaluated in the present work (54%) could have suppressed the bitterness perception in this product.

4.1.1. Effect of cocoa content and lactose reduction on chocolate temporal profile

Different strategies can be used to reformulate milk chocolate for getting healthier versions as "low lactose" or "dark chocolate" by means of incorporating or removing ingredients contributing to modify the temporal sensory perception in the new products compared to the classic ones. In the production of milk chocolate, milk powder needs to be added. In the present work, in two of the evaluated milk chocolate varieties, CH-M and CH-LL products, the cocoa and sugar content are similar and the reduction in lactose content is mainly attributed to the lower addition of milk powder, as opposed to a higher addition of milk fat. This reduction in lactose content had a noticeable impact on the temporal sensory profile when compared with the classical milk chocolate. The presence of milk fat which softens the chocolate may have contributed to the higher DR% of melting in CH-LL compared to CH-M during the first intake while in CH-M crunchy attribute was the dominant. According to De Pelsmaeker et al. (2019), the most significant differences generally found between milk chocolates are those related to texture attributes. However, in the present study, multiple-intake TDS technique also allowed to find differences in flavor and taste attributes as dairy, cocoa, and sweetness.

Due to the compositional requirements (such as the absence of dairy ingredients, lower sugar content), the sensory profile of dark chocolates is expected to differ considerably from milk chocolate (Oberrauter et al., 2018). Cocoa flavor is associated to both dark and milk chocolate

whereas milk flavor are more closely related to milk chocolate (De Pelsmaeker et al., 2019). Supporting this fact, clear differences were obtained in the DR% (difference TDS curves) of the evaluated attributes between CH-M and CH-D products (Fig. 3).

Three main ingredients used in the manufacture of milk chocolate are sugar, cocoa and milk, while for dark chocolate they are cocoa, sugar and cocoa butter. Cocoa, has a natural bitterness, caused by the presence of polyphenols and alkaloids. In milk chocolates, for example, the sugar and milk added could suppress the bitterness linked to cocoa. Due to this fact, it can be considered that the lower cocoa content and the higher sugar and milk content in CH-M, were responsible for the great differences found in the DR% of sweetness and dairy attributes along the entire evaluation. Conversely, higher cocoa content and lower sugar content in CH-D samples may have been responsible for the particular and different DR% of cocoa and bitterness attributes. Results of the current study are not as found in De Pelsmaeker et al. (2019) where cocoa flavor was associated with both milk and dark chocolate. The reason for this can be explained due to the proportions of ingredients in the studied chocolates, some dark chocolates had a higher sugar proportion in relation to the cocoa content. This highlights more strongly that the proportions of the ingredients contribute to sensory perception.

Texture mouthfeel-related attributes (creaminess, melting and adhesiveness) showed higher DR% in CH-M compared to CH-D which can be related to the higher milk fat content in CH-M that softens the chocolate. In contrast, in CH-D higher dominance for crunchy attribute was found. The DD TDS parameter follows the same trend of this profile, since CH-M presented the longest dominance for creaminess, melting and adhesiveness, while CH-D presented the longest dominance for crunchy.

Chocolate is a well-accepted product category worldwide, but when they have a high level of cocoa they are more bitterness, which generally limits the potential for consumer acceptance (Oberrauter et al., 2018). In general, the overall liking test indicated that all chocolate samples had a high level of liking scores. The results indicated a significantly higher acceptability for CH-D sample containing a higher cocoa content compared to CH-M. In this case, it can be hypothesized that the higher dominance of bitterness attribute did not negatively influence the acceptability of the product.

4.2. Temporal profile of milk coffee category

TDS profile of milk coffee across the three intakes was characterized by the significant dominance of sweetness, f-coffee, and bitterness. Sweetness was first chosen as dominance attribute during first intake, presenting the lowest value of Time TDS parameter. This fact could be related to the presence of sucrose as described by Dinnella et al. (2013) in a previous study. These authors reported that using different sweeteners in coffee, the attribute sweetness was the first significantly dominant only in coffees when sucrose was added. Bitterness also showed significant dominance during the second and the third intake and coffee flavor appeared as dominant attributed along the three intakes but reaching the maximum DR% in the third intake. The presence of caffeine, which is one of the major non-volatile compounds in coffee contributes to coffee bitterness (Farah, Monteiro, Calado, Franca, & Trugo, 2006) and can be important for coffee flavor also (Buffo & Cardelli-Freire, 2004).

The most important ingredient in MC-E is milk, but the correlated attribute for this ingredient (dairy) was only significantly dominant in the third intake, despite showing above the chance level in the first and in the second intake. These results show that even though milk is the ingredient with higher proportion, only after successive intakes the attribute linked to this ingredient can be perceived as significantly dominant, but in a short period of time.

4.2.1. Effect of no addition of sugar and absence of caffeine on temporal profile of milk coffee

The reduction in sugar content in the MC-NS sample seems to have strongly affected the TDS multiple intake profile, when compared with the classic product (MC-E). While the highest value of the DD TDS parameter was for bitterness in MC-NS, sweetness and caramel was higher for MC-E. Sugar (sucrose) is known to be an ingredient that provides the sweetness to a product and suppressing other basic tastes, particularly bitterness (Beck, Jensen, Bjoern, & Kidmose, 2014). In coffee, sugar can also suppress coffee flavor when is added, and vice versa (Keast & Breslin, 2003). Probably due to these properties conferred by the addition of sugar, the sweetness attribute presented a significantly higher DR% for MC-E compared to MC-NS, while the non-addition of sugar confers a higher DR% of bitterness and coffee attribute for MC-NS. The influence of this ingredient on the temporal profile of a milk coffee becomes clearer.

The temporal profile of the MC-D presented differences in the DR% particularly for the caramel attribute in comparison with MC-E suggesting that the absence of caffeine was mainly responsible for the higher DR% of this attribute. Moreover, higher DR% for bitterness particularly during the second intake was found in MC-E compared to the decaffeinated version. Caramel notes arise from Maillard reactions between sugars and amino acids, and caffeine and chlorogenic acids contribute to bitterness (Sunarharum, Williams, & Smyth, 2014).

Decaffeinated milk coffee samples characterized by the longest DD of caramel attribute showed the highest overall liking level compared to MC-E and MC-NS. According to Di Pizio, Shoshan-Galeczki, Hayes, and Niv (2019), bitterness and sweetness are defined as opposites, also in affective terms, regarding emotion and nutrition. The overall liking of these products was positively correlated with DD TDS parameter of dairy, sweetness, roasted and mostly caramel which better characterized MC-E and MC-D. Therefore, regarding coffee formulation, a lower sugar content and the absence of caffeine have a strong influence on the multiple-intake profile and the acceptability of this product by consumers.

5. Conclusions

In the present study, the use of multiple-intake TDS technique provided solid data to describe the temporal profile of commercial milk chocolate and milk coffee. The "multiple-intake/sip" approach allowed to demonstrate the changes in sensory perception in a more realistic consumption situation in different food matrices. Moreover, the results confirmed that multiple-intake TDS is enabled to identify noticeable differences between classic products and their 'healthier' versions. In addition, also highlighted the importance to analyze the TDS parameters of time and dominance duration to provide valuable information, complementary to data analysis focused on temporality.

Understanding the temporal changes in sensory perception caused by reformulations are highly important for the development of new products displaying expected or requested sensory characteristics linked to a high consumer's acceptability. Thus, this study provides for the first-time results that could contribute to improve the development of new versions of chocolate and milk coffee, with a valid approach for solid and liquid products.

CRedit authorship contribution statement

Lary Souza Olegario: Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization. **Alberto González-Mohino:** Validation, Formal analysis, Data curation, Writing - review & editing. **Mario Estévez:** Resources, Supervision, Writing - review & editing. **Marta Suely Madruga:** Resources, Writing - review & editing, Supervision, Project administration, Funding acquisition. **Sonia Ventanas:** Conceptualization, Resources, Writing - review & editing, Supervision,

Project administration, Funding acquisition.

Acknowledgments

National Council for Scientific Development (Conselho Nacional de Desenvolvimento Científico – CNPQ, Brazil) for the support to LSO through the PVE scholarships 208398/2017-1. This study was partly co-funded by FEDER and Junta e Extremadura (project IB16043). Authors gratefully thank all members of the sensory panel for their participation.

Compliance with ethical standards

Declaration of Competing Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Compliance with ethics requirements: All procedures performed in this study involving human participants were approved on the ethical standards of the Delegation of the Bioethics and Biosafety Commission of the University of Extremadura (Delegación de Comisión de Bioética y Bioseguridad de la Universidad de Extremadura) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards with the register number 71/2016.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.foodres.2020.109342>.

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ARTIGO II: INFLUENCE OF THE ABSENCE OF LACTOSE ON THE MULTIPLE-INTAKE TDS BEHAVIOR OF YOGURT

O artigo será submetido ao periódico *Food Science and Technology – LWT*. (Qualis Capes A1, Fator de impacto 4,006)

Influence of the absence of lactose on the multiple-intake TDS behavior of yogurt

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13 **Abstract**

14 This paper aims to evaluate the influence of the absence of lactose on their dynamic sensory
15 profile and consumer acceptability of yogurt. A total of 46 responses from the panel participants
16 evaluated yogurts in a classical (SNY) and lactose-free (SNY-L) version using multiple-sip
17 TDS technique, provided information about the sequence of attributes that were dominant for
18 each intake during consumption. The dominance of six sensory attributes was evaluated. The
19 overall liking level was measured. In the first intake SNY-L being more sourness in relation to
20 SNY, this was not the first perceived dominant sensation for most panelists in the evaluation of
21 this product. There were no differences between the profile of the second intake. In the third
22 intake, the highest difference of dominance was of the dairy attribute for the SNY and fermented
23 and creaminess for SNY-L. Finally, the results indicated that the perception of some sensory
24 attributes can be influenced by the composition and number of intakes. Similar levels of
25 acceptability that are possibly associated with the most dominant sensations throughout
26 consumption. These results suggest the application of the multiple-intake TDS technique in
27 dairy products such as yogurt, due to allowed to know the effect of the absence of lactose in
28 these products.

29 **Keywords:** Temporal Dominance of Sensations; Sensory trajectories; Dynamic perception;
30 Dairy product; Overall liking.

1. INTRODUCTION

Lactose is a disaccharide sugar composed glucose and galactose that naturally occurs in milk and various milk-products. More than half of the world population is lactose intolerant (Chey et al., 2020), and even today, lactose-free diet is the only treatment for people suffering from lactose intolerance or direct ingestion of lactase enzyme. Since most of the dairy products available in the market contain lactose naturally, the avoidance of such products would lead to a complete change in lifestyle that may not be practicable for everyone (Suri et al., 2019). Therefore, there is a high demand for lactose-free products in order to meet the consumer's nutritional and sensory needs.

Among the wide variety of fermented dairy products, yogurt is the most popular and most acceptable worldwide (Kumar, Vijayendra, & Reddy, 2015). Yogurt is traditionally consumed throughout the world among populations who are seemingly unable to digest lactose without experiencing symptoms; however, because yogurt contains lactose, this would appear to be counterintuitive (Savaiano, 2014). The lactose-free dairy market is the fastest growing segment in the dairy industry (Dekker, Koenders, & Bruins, 2019). Changing from traditional to new lactose-free products poses technological challenges for the food industry in order to maintain or improve their food characteristics and consumer preferences (Skryplonek, Gomes, Viegas, Pereira, & Henriques, 2017). The sensory properties of food products are key factors determining their acceptance by consumers.

The sensory properties of foods and beverages are commonly measured by Descriptive analysis (DA) static since it provides detailed, consistent, and reliable results (Moussaoui & Varela, 2010), such as Quantitative Descriptive Analyses (ADQ) (Stone, Sidel, Oliver, Woolsey, & Singleton, 2008), but these techniques do not consider the dynamics involved during consumption, which can greatly affect sensory perception. The removal of the temporal aspect

of the data makes the comparison with a classical sensory profiling possible, but aspects linked to the temporality of the descriptors are lost (Di Monaco, Su, Masi, & Cavella, 2014).

The act of consuming a food product is multidimensional and dynamic, so it is expected that temporal methods will be used more fully to characterize this sensory characteristic. For semisolid products such as yogurt for example, the texture perception depends on structural changes that occur during oral manipulation (Van Vliet, 2002). In addition, the viscosity of these semi-solid products has an important effect on the release and perception of flavor, with the intensity of the flavor decreasing with the increase in viscosity (Wilson & Brown, 1997). Among dynamic sensory techniques, Temporal Dominance of Sensations (TDS) allows assessors have to characterize the temporal aspects of the product, evaluating simultaneously all the sensations perceived (Pineau et al., 2009). TDS has been already used to sensory exploration of sensation in plain yoghurts and yoghurt-like products (Bouteille, Cordelle, Laval, Tournier, & Lecanu, 2013); fermented dairy products (Esmerino et al., 2017); and the temporal aspects of yoghurt texture perception (Bruzzone, Ares, & Giménez, 2013).

The standard procedure is to perform the TDS during the first spoon, but a multiple intake approach is appropriate for evaluating milk products, such as milk chocolate and milk coffee (Olegario, González-Mohino, Estévez, Madruga, & Ventanas, 2020) and fat-free yogurt (Lesme et al., 2020), as repeated intakes can influence the perception of the product due to sensory adaptation or persistence of flavor. The multi-intake approach appeared to be relevant mostly for the evaluation of taste attributes (Lesme et al., 2020). Although some studies have addressed the evaluation of yogurts, dynamic sensory studies on these products are rare. This indicates that studies are needed to understand how consumers perceive the sensory characteristics of yogurt and lactose-free yogurt from more realistic sensory techniques. In addition to knowing which sensory attributes are dominant at the time of consumption and which can stimulate consumer liking.

In this context, the aims of the present study were to (i) apply the multiple-intake TDS methodology to evaluate the dynamics of traditional yogurt and lactose-free yogurt sensory perception, (ii) study the influence of the absence of lactose on the temporal profile of yogurt sensory perception, and (iii) assess the likely relationship between sensory perceptions and hedonic aspects. Changes in yogurt perception over multiple-intakes were analyzed in terms of multiple intake TDS curve for the difference between products, Time and total Dominance Duration of sensations, and overall-liking.

2. MATERIAL AND METHODS

2.1 Samples

Custard of vanilla (*Natilla*, Carrefour®, Spain) for training session, Sugared Natural Yogurt (SNY) (*Yogur natural azucarado*, Carrefour®, Spain) and Lactose Free Sugared Yogurt (SNY-L) (*Yogur natural azucarado no lactosa*, Carrefour®, Spain) for Multiple-sip analysis and overall liking, were purchased from the trademark supermarket located in Cáceres (Extremadura, Spain). All samples correspond to the same production batch and were within the shelf-life period and served at a temperature of 5 °C.

2.2 Panel and training

A total of 23 yogurt consumers (9 males, 14 females; aged between 22 and 50 years old) interested in participating in the research, with availability and without restrictions on the consumption of such products, were recruited. The sensory panel consisted of semi-trained panelists from the University Research Institute of Meat and Meat Products (IProCar) of University of Extremadura who had experience in the Time-Intensity techniques but no particular training in this technique. In the first training session the participants were introduced to the notion of “dominance sensation” in TDS should be “defined to the panelists as the catches his/her attention at a given time, which does not mean that this sensation has to be very or very

intense in the product (Olegario et al., 2020). To illustrate this definition, we have used analogy to a symphony and images with elements in highlights, and an illustrative protocol of sensory evaluation of dominant sensations.

In the second session, panelists were then trained to use the computerized data capture system (FIZZ v 2.40A) to become familiar with the TDS methodology and the computer system, using the custard of vanilla product. Five attributes and associated definitions were defined by a focus group and based on the literature (Richardson-Harman et al., 2000; Tournier, Martin, Guichard, Issanchou, & Sulmont-Rossé, 2007) (Table 1), the total number of sips, the total time of analyze and the amount to be ingested by each sip, for this session.

Panelists were asked to evaluate the three spoons (one per sip) of custard of vanilla to identify the sensation they perceived as dominant during the tasting protocol which simultaneously attributes appeared on the computer screen, randomized to each assessor. They were informed that they did not have to select all attributes from the list and that they could choose the same attribute several times during the evaluation or also never select it.

At the beginning the TDS tasting session, each panelist was asked to place the first portion of the product in the mouth and click the “start” button to start the session evaluating the dominant sensations. After ten seconds, with a message presented by the software, he was asked to swallow the sample and continue the evaluation until another message appeared (after twenty seconds) asking to put the second portion of the product in his mouth. The evaluation was repeated until the third portion and then each panelist was asked to continue evaluating after swallowing until they did not feel anything else and clicked “stop” to finish, or until the program automatically closed the session at seventy seconds. There was a 3 second delay between the sips. Analyses were carried out in individual booths, under white light and with adequate ventilation. The replicability of the panelists was assessed by comparing the TDS curves

obtained, where the dominance rates can be seen as a reflection of consensus among judges and therefore a measurement of panel performance (Pineau et al., 2009).

2.3 Multiple-sip TDS experimental procedure

The same tasting protocol applied in the training was used for TDS analysis of two types of yogurt (sugared yogurt and lactose free yogurt), with six terms defined with the focal group (Table 1). Sample tasting started by panelists clicking the start button, putting the sample in the mouth simultaneously, and selecting the dominant oral sensation over time. Each intake had a total duration of 20s. Assessment stopped automatically after final time or individually by the judges, when attributes were no longer dominant. The product was evaluated on the same day, presented in monadic form. The sequence of attribute buttons differed from judge to judge; however, the same sequence was maintained in each session. Panelists were asked not to wash their palates between sips so that the sensory analysis simulated a condition of product consumption. Each of the 23 panelists performed two replications of each product (i.e. 46 trials). After this test of each product, proceeded to the acceptance test using an unstructured scale of 10 cm anchored in the extremes with “dislike extremely” and “like extremely”. The product coded with a random three-digit number were monadically presented to the panelists. They also received a glass of water and were asked to rinse their mouths between each sample.

2.4 DATA ANALYSIS

2.4.1 Multiple-sip TDS curves

For each product, the Dominance Rate (the proportion of subjects that selected each attribute) (DR%) was computed at each time point, and TDS curves were obtained and analyzed using FIZZ software (v 2.40A), represented over the three intakes. Line based smoothing was applied on each curve. In order to facilitate the interpretation of TDS curves, two other additional lines (chance and significance levels) are displayed on each TDS curve. The chance level represents

the dominance rate that an attribute can obtain by chance ($P_0 = 1/\text{number of attributes}$) (Pineau et al., 2009). The significance level represents the smallest value of the proportion being significantly ($p < 0.05$) higher than the chance level ($P_s = P_0 + 1.645[P_0(1-P_0)/n]^{1/2}$, n is the number of runs: judges $\times$ replicates). Two TDS parameters were extracted from TDS curves for each attribute: the time of first citation (Time), computed in relation to the average time the attribute was selected as dominant for the first time, and the total dominance duration over citations (Dominance duration-DD), computed at individual level by adding the time periods during which an attribute was cited as dominant

2.4.2 TDS difference curves

Difference of the TDS curves were used to compare product pairs, displaying the attribute curves of the differences of the dominance rates (DR%) on the same plot, when significantly different from zero. These highlighting the differences between the products over time. The significance of the difference between each curve is calculated for each time point and attribute using the test to compare two binomial proportions (Kiemle, Schmidt, & Berdine, 1995).

2.4.3 Statistical analysis

The average of Time and DD TDS parameters calculated per attribute in each product and were analyzed by T test, compare product pairs at $p \leq 0.05$. The overall liking data were also evaluated by ANOVA and Tukey's Test at $p \leq 0.05$ using IBM SPSS v.22 (IBM Co., New York, New York, USA).

A Principal Component Analysis (PCA) was performed to show sample trajectories in the sensory space over the consumption duration. According to the procedure described by Lenfant, Loret, Pineau, Hartmann, & Martin (2009), the observations of the PCA performed used the DR% of each time-point and for each product. The variables are the sensory attributes and the observations are the DR%. For the evaluation, 5 equally-spaced time points were taken over

the intake period of each sample, being a total of 15 points for each product. Sensory trajectories are shown by linking the five points of time corresponding to a same intake of product: the first score (t_0) is the beginning of a sensory trajectory and the end point (t_{20}). A mapping of the products was performed based on the first two principal components (PCA biplot) carried out using the XLSTAT 2014 (Addinsoft, Paris, France).

3. RESULTS AND DISCUSSION

3.1 TDS curves

TDS curves (Fig. 1-2) show the different perceptions of dominance over the long eating time at a panel level, following the protocol validated in the training session. The data exploration was performed by analyzing the chance and significance levels. Chance level marks the limit of the probability of an attribute checked at random, while the level of significance is the minimum value for the attribute to be considered as significantly dominant (Pineau et al., 2009). An attribute is considered as dominant if the DR% is higher than the significance limit. Chance (18%) and significance (30%) level are represented on the curves. All presented attributes were selected by the panelists during sample evaluation. Overall, temporal profile of both types of yogurts revealed that five of the six evaluated attributes (dairy, sourness, creaminess, cold and sweet) were significantly dominant along the evaluation (70 seconds in total).

Fig. 3 show multiple-sip TDS difference curves, to compare classical and lactose free product, plotted only when significantly different from zero, highlighting the differences between the products over time. These differences enable to highlight the specificities of each product.

Finally, Table 2 shows the temporal dominance parameters obtained from TDS curves (Time and DD)

3.1.1 Multiple-sip Temporal Dominance of Sensations of Classical Yogurt

Fig. 1 shows multiple-intake TDS curves for the three sips obtained for SNY. Cold, sourness and dairy were the dominant attribute whereas the second and third sip were characterized by the dominance of cold, creaminess and dairy yogurt. Cold was the first significant dominant attribute at 4 seconds of the evaluation during the first intake and reaching the highest DR% over 50% along the third intake. Sourness taste was second dominant attribute in the two times during the first intake, before and after the swallow, with a 33% and 36% DR% respectively. In other seconds during the evaluation this attribute presented above chance level, but not as dominant. Dairy flavor was third dominant attribute, it presented in all sip after the swallow, with higher DR% (45%) in 42, 61, 64 seconds, besides being the sensation with longer duration of the evaluation. Creaminess attribute was dominant in second and third sip with greater DR% in the third sip before swallow of 46%. Fermented and sweet were not dominant in any of the sips, but presented above chance level at two moments of the evaluation, sweet in the first and third sip after the swallow, and fermented in the second and third sip before swallow.

Among the six flavor and texture attributes evaluated in the SNY yogurt sample, four were significantly dominant at different times of the multiple-intake TDS evaluation. It is notable that the profile of dominant sensations among the three sips are different, but some similarities are showed. For example, regarding to the cold attribute, which is the first significantly dominant attribute when the evaluators put the samples in the mouth. Bouteille et al. (2013) reported a similar observation, evaluating samples of yogurt by TDS and obtained the first description indicated by a cold sensation. They associate the strong cold in-mouth seems to be positively correlated to the freshness sensation.

Another similarity is in relation to the dominance of the dairy attribute. This attribute is significantly dominant in all three intakes after the sample is swallowed and until the next portion of the sample is consumed. The differences noted between the three intakes are related to the sourness and creaminess attributes. The sourness attribute is significantly dominant

before and after the swallow of the first intake. Creaminess is significantly dominant before the request of swallowing of the second and with greater DR% in the third intake. This fact is due to mouthcoating during successive sips which increases the DR% of this attribute.

Regarding these flavor and taste attributes, the number of intakes had an impact on the perception of mainly sourness, with no significant impact on sweetness and fermented. In the TDS by modality study (M-TDS) carried out by Lesme et al. (2020) with fat-free strawberry yogurt, the influence of the amount of intakes (spoons) on the perception of sourness was also indicated, however, contrary to what was obtained for SNY in this study, there was an influence on the perception of sweetness. Both results indicate the importance of using the multiple ingestion approach when evaluating yogurt, as the perception of some attributes, besides to being influenced by the composition, can be influenced by the amount of ingestion.

3.1.2 Multiple-sip Temporal Dominance of Sensations of Lactose free Yogurt

Multiple-intake TDS dominance curves of lactose-free sugared natural yogurt (SNY-L) is showed in Fig. 2. Creaminess, cold, and sourness were dominant during the first sip, being cold and creaminess those the first significant dominant attributes at 5 seconds. The second sip was characterized by the dominance of five attributes, sourness, dairy flavor, creaminess, cold, and sweetness. Finally, the third intake showed significant dominant rate for dairy flavor, cold, creaminess and sourness. As aforementioned for SNY, cold attribute was significantly dominant along the three sips, displaying its highest dominant rate over 35%, at 8, 28 and 46 seconds. Although cold showed a great presence for SNY-L, these results were lower in comparison with SNY. Regarding creaminess, this attribute was one of the most highlighted for this product (showed in all sips), obtaining the highest dominant rates (34%, 38%, and 58%) at 12, 31, and 49 seconds, being thus the attribute with higher dominant values. As can be seen, if SNY and SNY-L are compared, creaminess appeared significantly earlier (Table 2) and with higher values. The importance of this attribute in yogurt with lactose is probably due to the

quantity of fat, while SNY has 1.7% fat content SNY-L has 3.5%. Sourness showed significant dominances in the second intake with its maximum DR% of 33% at 22 seconds, and 31% at 56 seconds; furthermore, this attribute was one of the longest Dominance Duration (Table 2). Dairy flavor presented the DR% after swallow (same behavior for SNY) with a 40% and 45% DR% at 39 and 56 seconds respectively. Sweetness only was significant with 31% at 34 seconds, and fermented did not reach the level of significant but was presented above the chance level three times during the evaluation.

3.1.3 Influence of lactose content on the dynamic temporal profile with multiple intakes

Regarding the comparison between TDS curves of SNY and SNY-L, Fig. 3 displays the TDS curves of the difference between these two products for each attribute. As Fig.3 shows, DR% is significantly higher for sourness attribute in the original product for the first sip, while at the same time, dairy attribute is significantly higher in the lactose free product. Third sip from SNY presented higher significant values of DR% for dairy, whereas the SNY-L presented DR% results with significant differences for fermented, cold and creaminess. No attribute showed significant difference of dominance between the samples in the second sip.

In a first impression the comparison between the TDS curves showed a similar temporal profile, i.e., with few differences between the dominant sensations during the evaluation of these products. However, it is from the evaluating the profile of each intake that the differences become more appreciable. Evaluating the profile of the first intake, it is highlighted that the DR% is significantly higher for sourness attribute in the product SNY and for dairy attribute in the product SNY-L. Sourness attribute presented dominant for more panelists in less time in the SNY product, and in contrast, attribute sourness presented higher DD values for SNY-L. This can be correlated with the fact that the hydrolysis of lactose influences the sourness of yogurts. This was evidenced by Skryplonek et al. (2017) which obtained significantly higher sourness measured both by the pH method and by titration, for the lactose-free yogurt sample in relation

to the control sample. In others words, even SNY-L being more sourness in relation to SNY, this was not the first perceived dominant sensation for most panelists in the evaluation of this product.

In the first intake, the Time TDS parameter can be taken into account, as aforementioned this parameter indicates the average of the time at which the sensation was selected as dominant for the first time. Differences regarding the Time TDS parameter of the attributes were significant, except for the attribute sweetness (Table 2). Comparatively, the dairy, cold and sourness attributes appeared in a shorter time in the SNY, while creaminess and fermented attributes were those with shorter Time values in the SNY-L. The increasing order of attributes with respect to time that were first cited in the SNY was cold, followed by sourness, sweetness, dairy, creaminess, and lastly fermented. While for SNY-L this order was, first creaminess, followed by cold, sourness, sweet, fermented, and lastly dairy.

There were no differences in the profile of the second intake of these products. In the third intake, the highest difference of dominance of the dairy attribute for the SNY and fermented and creaminess for SNY-L is highlighted. The profile for the SNY product can be explained by the behavior of the dairy attribute throughout the evaluation. This had a significant dominance in all intakes of the SNY product (Fig. 1), but had a longer dominance time at the third intake. Dairy was also the only attribute that presented in the SNY product the DD significantly higher in relation to SNY-L. This attribute was reported as a dominant sensation in other TDS studies of yogurt, being denominated in other terms as milk flavor (Esmerino et al., 2017) or milk taste (Bouteille et al., 2013).

The Dominance Duration of attributes presented similarities and differences during the evaluation of the products (Table 2). In the evaluation of the SNY, DD averages of attributes varied from 11.00 ± 3.45 s (cold) to 21.00 ± 5.12 s (dairy) and for SNY-L ranged from 11.33 ± 3.92 s

(cold) to 17.18 ± 3.80 s (sourness). Cold, fermented, sweetness, sourness, and creaminess attributes, had no difference at 5% significance. Significant difference was found for the total DD of dairy flavor between the two products, with the persistence of this attribute being longest in SNY (21.00 ± 5.12 s) followed by SNY-L (16.76 ± 4.31 s).

As can be observed in Fig. 3, only one attribute (sweetness) doesn't show a significant difference of DR%, also as confirmed by the absence of a significant difference between the parameters Time and Dominance Duration (Table 2). This similarity may be related to the equal sugar content of both products which is 14 g/100g. In general, SNY presented a significantly higher dairy sensation, while the SNY-L sample showed longer Dominance Duration of all other attributes (sweetness, creaminess, cold, fermented, sourness) although these parameters did not show a significant difference (5%).

3.2 Characterization of the products with the sensory trajectories

In order to facilitate the clarity of the results, the PCA was performed on the mean over intakes for each yogurt sample. The sensory trajectories related to attributes perception are represented in Fig. 4. The first two PCA components accounted the 67% of the total variance observed among the samples. PCA evidenced product differences based on DR% regardless of the temporality. The trajectories did not converge towards one point, which showed the existence of clear different profiles of attributes among yogurts. Meanwhile the sweetness, fermented, sourness and dairy attributes are located in the positive quadrant of Dim 1 and 2, the texture and trigeminal attribute (creaminess and cold respectively) are located on the negative axis of Dim 2.

Initially, it is observed that the points related to the beginning of the evaluation of both products (first intake, t_5), are more strongly correlated with the cold attribute, being repeated in the second intake. Rapidly, the perception of the texture attribute clearly differs in time from the

perception of the flavor and taste attributes or even that the perception of texture is closely linking to the perception of flavor. This fact is because the t10 points of all intakes (except for the first SNY intake) are correlated with the creaminess vector, while the points along the after swallow evaluation (t15 and t20), were correlated to the flavor (and taste) attributes, except for SNY in the first and second intake. According to results obtained by Lesme et al. (2020) texture descriptors chosen described in-mouth sensations which were unlikely to cumulate over spoons of yogurt. However, this study showed that when reaching the third intake, it was when the highest DR% was found. This fact can be seen in Fig. 4, where the points corresponding to the third intake are more strongly correlated with the creaminess vector. In yogurt, as in other fermented dairy products, the fermented and sour flavor are the main characteristic attributes and possibly the ones that draw the most attention (Esmerino et al 2017). The taste perception could be conditioned to the behavior of the mixing of the food matrix with saliva (Mosca, van de Velde, Bult, van Boekel, & Stieger, 2012). Thus, the perception of flavor evolved over the period of each intake due to loss of texture, which induced an increase in the perception of flavor compounds in the mouth.

3.3 Overall liking

The average of overall liking to consumers was 6.73 ± 1.42 and 7.35 ± 1.10 for SNY and SNY-L respectively, which represents between slightly and very much liked on a nine-point hedonic scale. The averages obtained are close and did not show any significant difference ($p > 0.05$). According to Esmerino et al. (2017), even with the composition of the yogurt similar, the action of lactic bacteria makes the sensory properties of the products very diversified. Because of this, it is important to know the liking level of these products even though their composition is similar. Some studies indicate that there are factors, for example texture, that influence the overall liking of yogurt. Ares, Dauber, Fernández, Giménez, & Varela (2014) with the intention of identifying drivers of liking yogurt, concluded that smoothness, homogeneity and creaminess

were the main drivers of liking and were responsible for the highest penalization on overall liking. This influence was also recorded by Janiaski, Pimentel, Cruz, & Prudencio (2016), who evaluated four yogurts with different formulations that identified viscosity and smoothness of mouthcoating positively influenced consumer liking. Thus, the present study shows that the similarities found in the temporal sensory profile of both yogurts are probably responsible for this level of acceptability found. Therefore, the decrease in DR% in sourness and the increase in dairy and creaminess after three sips of yogurt suggested that the perception of these attributes varied during the consumption of the product and could impact in consumers liking.

4. CONCLUSIONS

Lactose absence influences the dynamic sensory profile of yogurt. The multiple-sip TDS approach showed an excellent performance to characterize the dynamic temporal profile of the sensory attributes of each yogurt over intakes. The absence of lactose had an impact on the dominance rate of the sourness attributes in the first intake and dairy in the third intake. Regardless of the composition, there was a loss of dominance of the attribute sourness and the increase in dairy and creaminess after three sips. The acceptability level of both products was probably influenced by the similarities between the dominant attributes throughout consumption.

Knowing the factors that can influence acceptability is essential to facilitate the development of new products and/or technologies. Therefore, the present work shows that the use of multiple-intake TDS by the food industry would be recommended, since it allows to assess the effect of the absence of lactose on other dairy products, ensuring that they meet the consumer's nutritional and sensory needs.

5. ACKNOWLEDGMENTS

National Council for Scientific Development (Conselho Nacional de Desenvolvimento Científico – CNPQ, Brazil) for the support to LSO through the PVE scholarships 208398/2017-

1. This study was partly co-funded by FEDER and Junta e Extremadura (project IB16043).

Authors gratefully thank all members of the sensory panel for their participation.

Declarations of interest

The authors declare no conflict of interest

Compliance with ethics requirements

All procedures performed in this study involving human participants were approved on the ethical standards of the Delegation of the Bioethics and Biosafety Commission of the University of Extremadura (Delegación de Comision de Bioética y Bioseguridad de la Universidad de Extremadura) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards with the register number 71/2016.

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Table 1 Definitions of the attributes used for TDS measurements.

TDS session	Commercial name (code)	Brand	Attribute	Description ¹
Training	Custard of vanilla	Carrefour®	Dairy ^f	Flavor sensation associated with milk
			Sweetness ^{ta}	Sensation associated to a sweet taste
			Vanilla ^f	Flavor sensation associated with vanilla
			Creaminess ^{te}	Sensation of creaminess to the mouth
			Cold ^{tr}	Sensation linked to the perceived temperature
Sensory analyze	Sugared Yogurt (SNY)	Carrefour®	Dairy ^f	Flavor sensation associated with milk
	Lactose Free Sugared Yogurt (SNY-L)		Sweetness ^{ta}	Sensation associated to a sweet taste
			Creaminess ^{te}	Sensation of creaminess to the mouth associated with fat
			Cold ^{tr}	Sensation linked to the perceived temperature
			Sourness ^{ta}	Sensation associated to a sour taste
			Fermented ^f	Flavor sensation acid lactic

^{te} = texture; ^f = flavor; ^{ta} = taste; ^{tr} = trigeminal. ¹ Richardson-Harman et al. (2000); Tournier, Martin, Guichard, Issanchou, & Sulmont-Rossé (2007) adapted.

Table 2 Temporal dominance parameters of yogurt evaluation (Mean±SD)

Attribute	Parameters (s)	Products		p
		SNY	SNY-L	
Dairy	Time	13.18±4.64	16.59±3.39	0.0200
	DD	21.00±5.12	16.76±4.31	0.0137
Sweetness	Time	12.84±4.43	16.00±3.29	0.0504
	DD	11.61±3.25	14.71±5.10	0.0741
Creaminess	Time	15.33±6.22	5.58±2.65	0.0000
	DD	12.73±2.31	13.67±3.12	0.3457
Cold	Time	3.44±1.58	6.53±1.62	0.0000
	DD	11.00±3.45	11.33±3.92	0.7851
Fermented	Time	26.25±9.48	16.12±3.18	0.0125
	DD	12.25±3.88	14.37±5.85	0.4066
Sourness	Time	11.05±4.65	14.61±4.56	0.0400
	DD	14.21±5.52	17.18±3.80	0.1150

SNY = Sugared Yogurt; SNY-L = Lactose Free Sugared Yogurt; DD = Dominance Duration.

Figure 1 Multiple-intake TDS dominance curves of sugared natural yogurt (SNY). Two horizontal lines account for chance level (—) and significance level (—) and two vertical lines indicates the time of each intake (—) and the moment of swallowing (---).

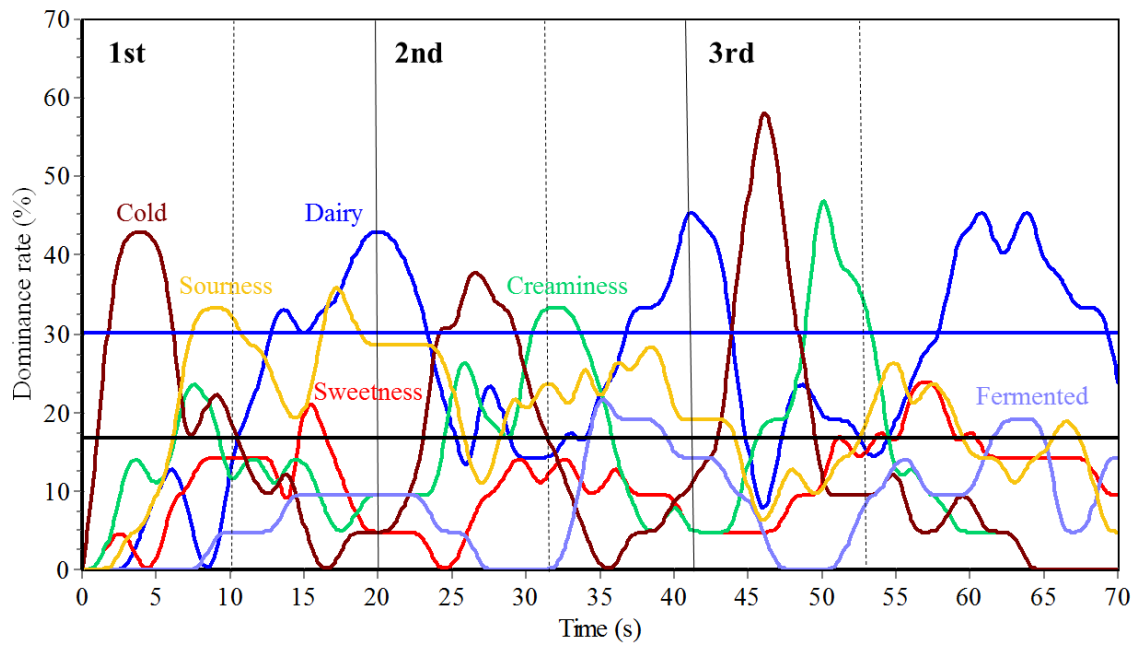


Figure 2 Multiple-intake TDS dominance curves of lactose free sugared natural yogurt (SNY-L). Two horizontal lines account for chance level (—) and significance level (—) and two vertical lines indicates the time of messenger each intake (—) and the moment of swallowing (---).

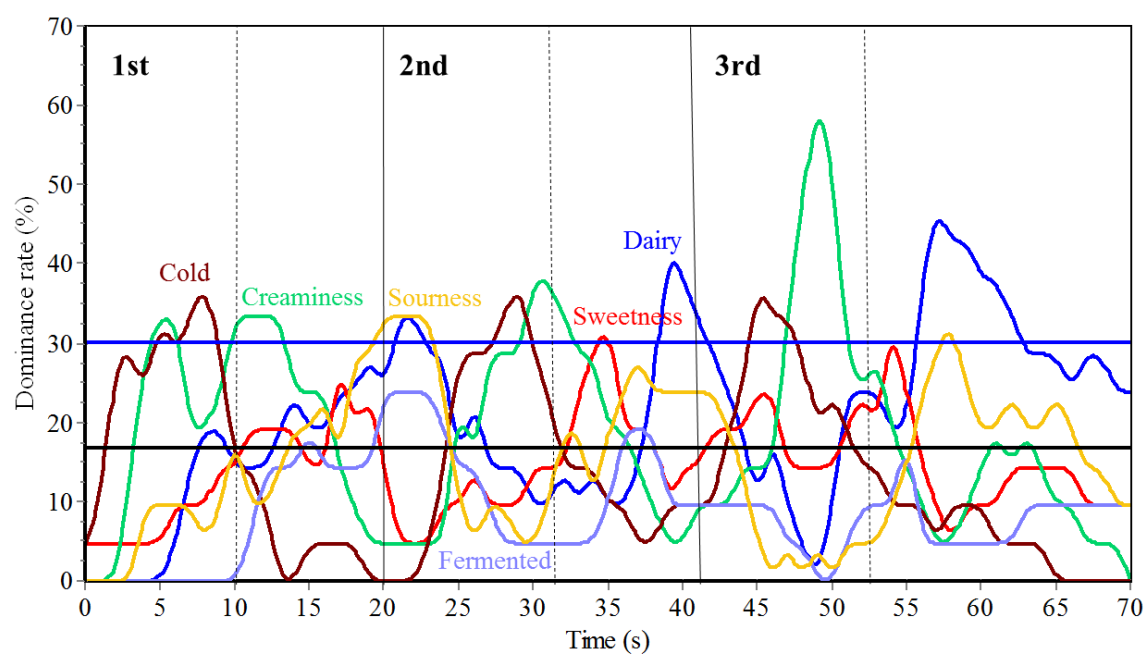


Figure 3 Multiple intake TDS graphical representation for the difference between products classical (SNY) and lactose-free (SNY-L) (filtered level of significance 5%). Two vertical lines indicates the time of each intake (—) and the moment of swallowing (---).

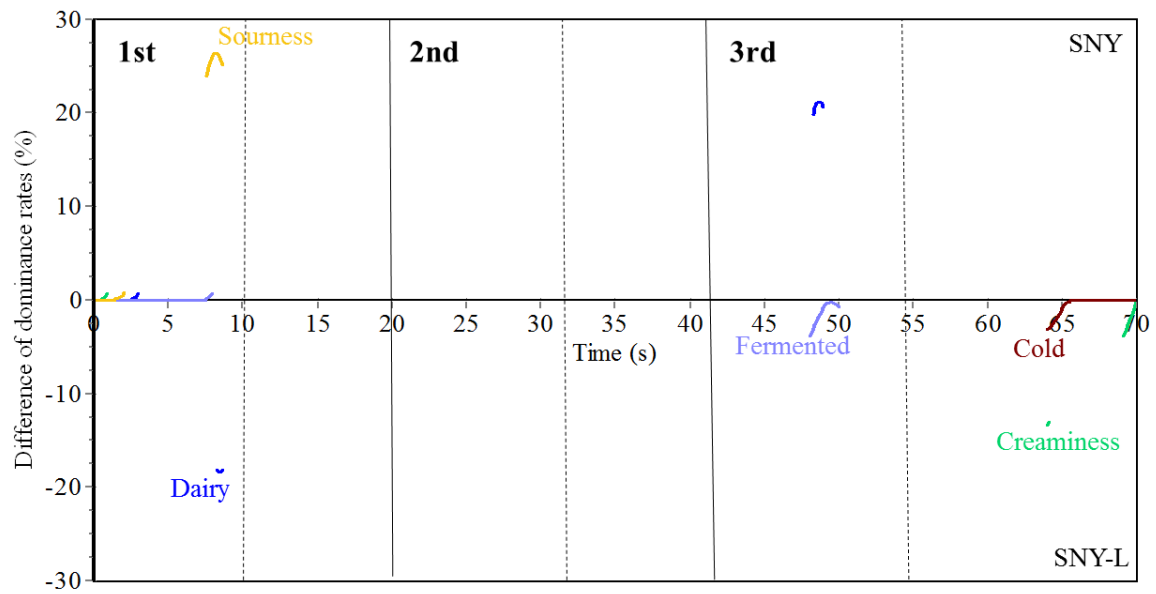
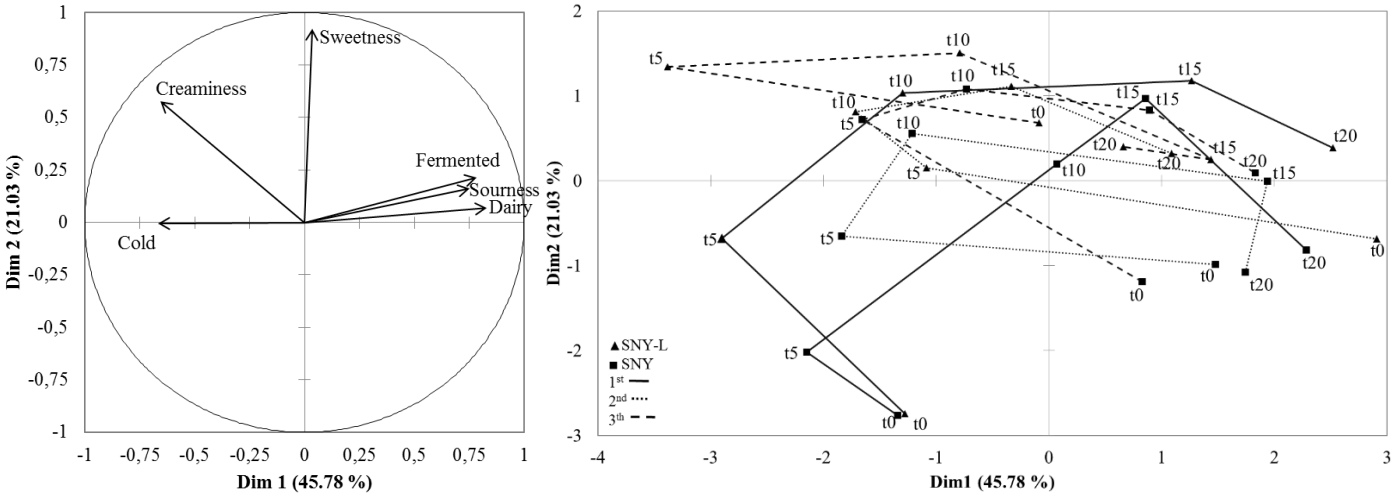


Figure 4 Principal Component Analysis. Biplot representing the trajectories of the two yogurt versions (SNY and SNY-L) over the three intakes.



ARTIGO III: TEMPORAL DYNAMICS OF SENSORY PERCEPTION OF FLAVOR AND TEXTURE IN COMMERCIAL POTATO CHIPS

O artigo será submetido ao periódico *Food Science and Technology – LWT*. (Qualis Capes A1, Fator de impacto 4,006)

Temporal dynamics of sensory perception of flavor and texture in commercial potato chips

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Abstract

The proposed aim of this work was to study the impact of low fat and flavor content on potato chips in relation to the dynamics of sensations perceived during consumption, and additionally to assess hedonic aspects in these products. Three different varieties of commercially available potato chips, ready-salted potato chips (PC-C), light potato chips (PC-L), and ham potato chips (PC-H) were purchased and analyzed by sensory methods. A sensory panel of 22 semi-trained assessors evaluated these group of samples using multiple-intake Temporal Dominance of Sensations (TDS) technique over three intakes, provided information about the sequence of attributes that were dominant for each intake along consumption, showing the differences among PC-C, and PC-L and PC-H. Overall liking and purchase intent tests were also considered. Low fat content in potato chips influenced the temporal dynamic profile, highlighting the dominance of dryness, crispy, f-potato and saltiness attributes, and showing higher dominance values for the texture attributes (residue, dryness, and crispy) when were compared to classic samples. Ham flavor content on samples were highlighted by crispy, residue, umami and smoked, being these flavor parameters significantly dominant in comparison with classic potato chips. Hedonic tests did not show any differences among kind of chips, however, the most influences attributes in consumer liking were found (residue, crispy and dryness). Therefore, the results showed that the low fat content in the potato chips had a great influence on the texture attributes, while the flavor content to the formulation impacted the flavor parameters during consumption with no effect on acceptability.

Keywords: Temporal Dominance of Sensations (TDS); multiple-intake; potato chip; low fat content; ham flavor.

1. INTRODUCTION

Potato chips are processed food defined as a salty and crispy snack product which are consumed globally (Zhang & Peterson, 2018), and comprising a high percentage of snack sales in many countries, such as for example, for USA (Buechler & Lee, 2019). The potato chips industry has been highlighted as a sector that is affected by the trends towards premium and healthier food products (Torrico et al., 2019). Therefore, scientific literature has mainly focused on different reformulations in potato chips, particularly in the reduction or addition of certain components in these products. Fat reduction is one of the most important aspects in order to prevent cases of overweight and obesity (WHO, 2019) being this component associated to cardiovascular diseases (Calabrese & Riccardi, 2019). On the other hand, flavor additions have widely used in potato chips, which allows to modify, increase, or add to an original taste or aroma (Buechler & Lee, 2019). Knowing the impact and the effect of these reformulations are necessary from the industry and market points of view.

The sensory evaluation of foods provides essential information related to the organoleptic profile of a product and/or information associated to consumers' preferences (González-Mohíno et al., 2019). Potato chips have been subjected by many sensory techniques. Many sensory evaluations were associated to the reduction of salt in this product, and related to the consumer acceptability and perception (Buechler & Lee, 2019; Kongstad & Giacalone, 2020; Nguyen & Wismer, 2019; Torrico et al., 2019). Crispy attribute has been highly evaluated due to is an important quality indicators (Kita et al., 2007) which determine the freshness of the product (Saeleaw & Schleining, 2011), being a parameter with prediction nature (Kwak et al., 2019). However, the dynamic sensory profile along potato chips consumption is not yet known. Sensations perceived during food consumption vary continuously due to the breakdown of food structure and the progressive changes in bolus characteristics, releasing stimuli of different

sensations (Puerta et al., 2020). To evaluate these sensations during time, it is necessary to apply dynamic sensory methodologies such as or Temporal Dominance of Sensations (TDS). This technique has the ability to identify and quantify the dominance of a sensory properties over time (Pineau, N., Cordelle, S., & Schlich, 2003), providing a product description and for discovering dynamic/temporal differences among samples (Thomas et al., 2015). In order to determine a more realistic and accurate information associated to the temporal sensory changes during the food consumption, an extension of TDS technique denominated multi-intake TDS can be applied, which consist of a serial of concatenated TDS evaluations (Olegario et al., 2020). Thus, the multiple-intake version provides more solid and real information that can guarantee consumer acceptability. Therefore, only a few studies have used dynamic techniques in potatoes, using Time-intensity (TI) and standard TDS methodologies which were also related to crispness and salt reduction (Luckett et al., 2016; Rodrigues et al., 2016), without the multiple intake approach. Therefore, a more realistic approach must be applied to understand the sensory dynamics of many attributes that have been little studied in potato chips, especially if it is to know the impact of fat reduction and flavor addition on consumers' perception.

The objective of this work was to study the impact of low fat content and flavoring in potato chips in relation to the dynamics of sensory sensations perceived during consumption and hedonic aspects. A better understanding of dynamic perception caused by reformulations in a more realistic scenario can facilitate the development of new approaches in potato chips, helping in market decisions and with the aim of improve the consumer satisfaction and demands.

2. MATERIAL AND METHODS

2.1. Samples

Commercial crunchy snack (*snack crujiente*, Carrefour®, Spain) was purchased and used for training sessions. Different varieties of commercially available potato chips (*ready-salted potato chips* (PC-C)-*patatas fritas al punto de sal*-, *Light potato chips* (PC-L)-*patatas fritas lights*-, *Ham potato chips* (PC-H)-*patatas fritas flavor jamón*, Lays®, Spain) were purchased and analyzed by the Multiple-intake TDS method. Samples correspond to the same production batch and were within the shelf-life period.

2.2. Panel participants

The multiple-intake TDS was carried out by 22 semi-trained panelists (9 males and 13 females), ages ranging from 21 to 55 years old from the Service of Innovation in Products of Animal Origin (SIPA) and Research Institute of Meat and Meat Products (IProCar) of University of Extremadura. Participants had previous experience in dynamic sensory techniques (Time-intensity) but not specifically training for this technique. Panelists were potato consumers interested in participating in the research, with availability and without restrictions on the consumption of such product.

2.3. Multiple-intake TDS technique

No previous study has been carried out using the multiple-intake TDS technique for potato chips, so an evaluation protocol was developed, validated in the training session. Firstly, a focal group session was performed (n=3) in which the selected products to be evaluate were tasting (Olegario et al., 2020). In this session, the total number of three intakes, the total time of 100 seconds of evaluation (28 seconds per intake with a “delay time” of 2 seconds between each intake), the sample amount of one chip (~5g) to be ingested in each intake, and the evaluated sensory attributes were selected and discussed. Selected attributes and definitions are presented

in Table 1. All sensory analysis sessions were carried out in individual booths, under white light and with adequate ventilation. Only one product was evaluated per day of analysis.

2.3.1 Training

The 22 panelists received training to become familiar with the multiple-intake TDS methodology and with the sensory test following the protocol described by Olegario et al. (2020). In the first one, the participants were introduced to the notion of “dominant sensation” illustrated with as analogy a symphony orchestra and images with elements in highlights, and an illustrative protocol of sensory evaluation of dominant sensations. Thereafter, the panelists were then trained to use the computerized TDS data capture system (FIZZ v 2.40A), with crunchy snacks.

At the beginning of TDS training session, each panelist was requested to place the first chip in the mouth and clicked the “start” button and started to evaluate the dominant sensation. The panel could then successively select the dominants attributes from the provided list of sensations. Attribute order within the list was randomized across the panel (Nicolas Pineau et al., 2012). After the third intake, participants were instructed to click the "stop" button to indicate the end of TDS session.

2.3.2 Multiple-intake TDS session

One week after training, the three types of potato chips (classic PC-C, light PC-L. ham PC-H) were evaluated on different days. The same protocol applied in the training was used for TDS analysis, with times and terms corresponding to potato chips to be evaluated. The sequence of attribute buttons differed from judge to judge; however, the same sequence was maintained in each session. Assessment stopped automatically after the final time or individually by the judges when attributes were no longer dominant. Panelists were not requested to clean their

palates between sips so that the sensory analysis simulated a scenario of product consumption.

Each of the 22 panelists performed two replications of each product (i.e. 44 trials).

2.4 Overall liking and purchase intention

For the consumers tests, panellists were asked to rate the overall liking and purchase intention.

They rated the overall liking of the samples using a ten-point hedonic scale ranging from 1

(‘dislike extremely’) to 10 (‘like extremely’), and purchase intention evaluation was made with

a five-point scale ranging from 1 (‘definitively would not buy’) to 5 (‘definitively would buy’).

Samples were labelled using a random 3-digit code. In order to avoid first-position distortions

and possible carry-over effects, the order of presentation within each of the three samples was

randomized, presenting monadically. Among samples, panellists were asked to clean their

palates with unsalted crackers and to rinse their mouths with water.

2.4. DATA ANALYSIS

2.4.1 Multiple-intake TDS curves

TDS curves were obtained and analyzed using FIZZ software (v 2.40A). Line based smoothing

was applied on each curve. For facilitate the interpretation of TDS curves, two other additional

lines (chance and significance levels) are displayed on each TDS curve. The chance level

represents the dominance rate that an attribute can obtain by chance ($P_0 = 1/\text{number of}$

attributes) (N Pineau et al., 2009). The significance level shows the smallest value of the

proportion being significantly ($p=0.05$) higher than the chance level ($P_s=P_0+1.645[P_0$

$(1-P_0)/n]^{1/2}$, n is the number of runs: judges $\times$ replicates).

Two TDS parameters were extracted from TDS curves for each attribute according to as

described by Olegario et al. (2020): Time, computed in relation to the average time the attribute

was selected as dominant for the first time, and Dominance Duration (DD) computed at

individual level by adding the time periods during which an attribute was cited as dominant.

2.4.2 TDS difference curves

Difference of the TDS curves were used to compare three potato group of samples. As described by Pineau et al. (2009), TDS difference curves consist in displaying the differences among dominance rates (DR%) of attributes. These differences are plotted only when significantly different from zero, highlighting the differences between the products over time. The significance of the difference between each curve is calculated for each time point and attribute using the test to compare two binomial proportions (Kiemle, SCH-Midt, & Berdine, 1995).

2.4.3 Statistical analysis

Average, along the three intakes and two replications per panelist, of Time and Dominance Duration TDS parameters were extracted and calculated per each attribute in each product, being these attributes analyzed by T-student test at $p \leq 0.05$. Results from the Dominance Duration of each attribute and the liking (mean scores) of the products of the samples were subjected to principal component analysis (PCA). Plots of scores and loadings were built from the first two principal components. All analysis was carried out using the XLSTAT 2014 (Addinsoft, Paris, France). Finally, the liking and purchase intent data were also evaluated ANOVA following by Tukey post-hoc test at $p \leq 0.05$ for comparing mean scores among evaluated products.

3. RESULTS

3.1 TDS curves

The data was assessed by analyzing the chance and significance levels. Chance level marks the limit of the probability of an attribute checked at random, while the level of significance is the minimum value for the attribute to be considered as significantly dominant (Pineau et al. 2009). Fig. 1, 2 and 3 show multiple-intake TDS curves of the three different potato chips. Each curve represents the evolution of the dominance rate of an attribute over time (Pineau et al. 2009).

Fig. 4 and 5 show multiple-intake TDS difference curves, to compare classic and low fat and ham potato chips, plotted only when significantly different from zero, highlighting the differences between the products over time. These differences enable to highlight the specific and discriminating dominant attributes for each product (Pineau et al., 2009). Table 2 displays TDS parameters of the three potato chips evaluated.

3.1.1 Classical Potato chips

Fig. 1 displays the results of the evaluation of temporal dominance sensation with multiple-intake of PC-C. The temporal profile revealed that four (crispy, saltiness, f-potato, and residue) of the seven attributes evaluated were significantly dominants during the entire evaluation. Along the first intake, crispy was the most dominant attribute reaching a dominance rate over 60% at the beginning of the evaluation period. This attribute was also significantly dominant at the beginning of the second and third intake, reaching a dominance rate of 58.5% and 63% respectively. f-Potato was also dominant along the three intakes during the middle and the final of each intake reaching the maximum dominance rate over 60% when samples was swallowed in the third intake. Residue attribute was dominant at the end of all intakes, with the higher dominance rate reaching during the first one (over 58.5%) at 26 seconds. Saltiness reached lower dominance rates compared to the previous attributes, but it was also significantly dominated during all intakes. Saltiness presented a maximum dominance rate of 48.5% in the second intake at 39 seconds. Dryness was presented above chance level, but not as dominant at the beginning of the first intake.

3.1.2 Light potato chips

Fig. 2 displays the TDS curve of PC-L. Crispy, f-potato, and residue were presented as significantly dominant in the whole evaluation, while saltiness was only obtained significant DR% values at the second and the third intake. Concerning the rest of attributes, only dryness

sensation reached DR% values above the chance level. Crispy was the first attribute chosen as dominant, with a maximum DR% of 73% at 5s, 75% at 35s, and 69% at 63s, which were found at the beginning of the three intakes. F-potato presented the higher DR% at 18s (56%) in the first intake, at 48s (52%) at the second one, and at 77s and 84s (51%) in the third intake, thus this parameter appeared during the middle of each intake. Residue sensation showed a DR% of 52% at 27s in the first intake, 51% at 54s in the second one, and displayed its maximum rate with a 71% at 92s in the third one, being the last sensation significantly dominant for all intakes. Finally, saltiness showed significant DR% values at 39s with 35% in the second intake, and at 68s with 32% at third one.

3.1.3 Ham potato chips

TDS curve of PC-H (Fig. 3) showed that all attributes were selected, and presented a DR% above the chance level, except for dryness. Four attributes had significant dominance in all intakes, crispy, smoked, umami and residue. Crispy was the first attribute selected as dominant, with a 56% dominance rate at 3s of evaluation. This sensation was also significantly dominant at the beginning of the second and third intakes, with a rate of 60% (35s) and 56% (63s). Smoked attribute had DR% of 58% at first intake, 42% at second and 32% in the third intake at different time intervals (15s, 46s, and 79s, respectively). Umami showed significance DR% values of 50% at 26s in the first intake, 36% at 44s in the second, and 41% at 77s in the third one. Regarding residue parameter showed a DR% of 41% at 29s in the first intake, 59% at 57s in the second one, and finally 50% at 85s in the third one, corresponding to the end of the intakes. Saltiness and f-potato were presented above the chance level, but these parameters were not significant.

3.2 TDS differences curves, liking and purchase intent

TDS differences curves of PC-C and PC-L samples are shown in Fig. 4. During the first intake, temporal profile of PC-L was characterized by a significantly higher DR% of residue and dryness attributes whereas for PC-C samples saltiness was the dominant attribute. During the second intake period, higher DR% was obtained for crispy and dryness attributes in PC-L compared to PC-C samples. Finally, in the third intake, PC-L was characterized by a higher DR% of residue at the final of the evaluation period (after-taste) compared to the classic version (PC-C).

Fig. 5 shows TDS differences curves among PC-C and PC-H. Firstly, PC-H was characterized by a higher DR% of smoked and umami parameters along the first intake, and dryness, crispy and saltiness at the middle/end of this period. On the other hand, PC-C presented higher DR% for five attributes, residue, dryness, crispy, saltiness, and f-potato, being these last two highlighted in this intake. In the second one, PC-H showed significant higher DR% values for the attributes smoked and umami in the entire intake, also presenting higher dominance for dryness and crispy attributes at the middle of this period. PC-C was highly characterized by f-potato and saltiness, also showing a higher DR% of crispy at the end of this period in comparison with PC-H samples. Finally, PC-H showed higher values of DR% for the attributes, dryness, umami and smoked during the third intake, whereas PC-C showed higher values for saltiness, f-potato, crispy and residue.

Results of TDS parameters (Dominance Duration and Time) extracted from TDS curves of PC-C and to PC-L are presented in Table 2. In PC-C samples, f-potato showed the longer Dominance Duration followed by saltiness, residue, crispy, umami, and finally the shortest DD corresponded to dryness. Regarding PCL samples the longest sensation was also f-potato, followed by residue, crispy, saltiness, and dryness, being umami the shortest one. Finally, PC-H obtained the higher DD value for smoked attributed, followed by umami, residue, crispy, f-

potato, saltiness, and dryness. Comparing to PC-C, PC-L samples presented significantly higher values of DD TDS parameter for crispy, residue and dryness attribute but lower for saltiness. Concerning the comparison between PC-C and PC-H, only umami attribute was significantly higher in PC-H samples, while saltiness and f-potato were lower compared to PC-C. Regarding Time parameter, saltiness was selected as significantly dominant earlier in PC-C samples while dryness and f-potato were cited for the first time as dominant significantly later compared to PC-L. In comparison with PC-H, PC-C showed that saltiness, residue, and f-potato were significantly perceived earlier than ham samples, the opposite behavior of the umami attribute. In relation to overall linking of chips potatoes, all products presented similar scores for linking with no significant differences were obtained between the three evaluated varieties, PC-C (7.06 ± 1.81), PC-L (7.29 ± 1.59) and PC-H (7.68 ± 1.50). Finally, for purchase intent, the values obtained for PC-C (3.78 ± 0.83), PC-L (3.78 ± 0.99), and PC-H (3.56 ± 1.10) did not provide any differences among them.

3.2 Principal Component Analysis

Exploratory analysis of the data was performed by the PCA in order to obtain the profile of each sample in relation to the dominant sensations and overall linking of samples. The similarities and differences of the product is shown in Fig. 6. The proximity between the vectors suggests the existence of a positive correlation between them, due to which the vectors that are very close, suggest a strong correlation. The first Principal Component (PC1) explained 58.43% of the total variation among the samples and, together with the second one (PC2), explained 100% of the variability among the different attributes. It is evaluated that the attributes residue, crispy and dryness are positively correlated with overall liking, and are those that better characterize PC-L. The smoked and umami attributes are positively correlated and better characterized by PC-H sample, while f-potato and saltiness are positively related and better characterized by PC-C samples.

4. DISCUSSION

4.1 Temporal profile of Potato chips

Similar and partly expected temporal sequence of dominant attributes was obtained in each intake of PC-C evaluation. Firstly, the most dominant attribute was a texture attribute, crispy, then saltiness and f-potato and finally after swallowing the sample residue attribute. These results were coherent with the literature, due to crispy and saltiness, are those more explored and studied for other authors, being these two among the most important attributes in potato chips (Kongstad & Giacalone, 2020; Nguyen & Wismer, 2019). Some differences were detected in the maximum dominance rates reaching by the attributes between the first and the other two intakes. Crispy and residue reaching the highest maximum dominance rate (over 50%) during the first intake. However, during the second and third intake were crispy but also f-potato the attributes reaching the highest dominance rates (over 55%). F-potato increased the dominance rate as intakes number increased. Moreover, dominance of saltiness was perceived during the entire evaluation period although the maximum dominance rate was lower than other dominant attributes as crispy and f-potato and was selected as dominant just after crispy in each intake period. In crispy foods, the measurement of successive bites over a prolonged period allows the sodium supply to continue over time. According to Tian & Fisk (2012), there is a temporal dimension in the perception of salt, which is kept from the time of chewing until all salt is removed from the mouth, and it is possible that a portion of sodium was consumed within a period of time without being perceived by the consumer. This fact suggests that both the content and the mechanism of sodium release may influence the temporal perception of the saltiness attribute in the evaluated potato chips.

4.1.1 Effect of low fat content on temporal profile of potato chips

The comparison between the TDS curves of PC-C and the light version (30% lower fat content) PC-L (Fig. 4) allows highlighting the characteristics of each product, filtered by level of

significance of 5%. PC-L presented significant difference of dryness attribute in relation to Time (minor) and Dominance Duration (larger) parameters of classic product (PC-C), besides presenting significant difference of dominance rate in all intakes. Water loss and oil absorption are the two most important mass transfer processes that occur during food frying. In this process, water is evaporated generating a porous area that is covered by the oil and can generate a physic-chemical effect that affects the sensory attributes, such as texture, in a desirable or undesirable way (Quan et al., 2014). This fact could be explain these results, due to PC-L had less content of fat and therefore less content of fluid to evaporite, facilizing a greater drying process which was perceived by the panel with higher values of dryness in the PC-L compared to the PC-C samples.

Texture in potato chips is one of the most important factor of final product quality together with color, aroma and flavor (Salvador et al., 2009). In the present study, crispy was the texture attribute that showed the greatest difference in the dominance rate between PC-L and the classic product (PC-C) being significantly higher in the first one. Moreover, Dominance Duration TDS parameter of crispy was also significantly higher in PC-L particularly along the second intake. There are several factors that can influence the crispness of potato chips, as moisture and fat content. According to Kita, Lisińska, & Gołubowska (2007), the more contain of water is evaporated and the less quantity of oil absorbed in the processing of the potato chips most effect was observed on crispy attribute. Agreeing with these studies, our results found that dryness and crispy attributes were significant dominant attributes in the temporal profile of light version of potato chips compared to the classic products as reflected the results from difference TDS curves and Dominance Duration TDS parameter. Moreover, Luckett et al. (2016) manipulated the crispness levels of potato chips and reported that this attribute affects the dynamic of taste and flavor perception. In the present study, this influence in the dynamic profile was observed

but particularly for texture attribute, crispy, since PC-L product was characterized by a higher dominance rate for this attribute.

Differences in dominance of saltiness was found between PC-C and the light version, PC-L samples, particularly in the first moments of evaluation (first intake). Moreover, results of saltiness Time and Dominance Duration TDS parameters confirmed these differences. According to previous studies, mechanism of sodium release (Tian & Fisk 2012) and particle size of the used salt mixture (Rodrigues, de Souza, Mendes, Nunes, & Pinheiro 2016) may influence the temporal perception of saltiness attribute in potato chips. However, in the present study, main differences between evaluated potato chips are related to fat content and not to salt characteristics. In this sense, differences in fat content seems not to have a noticeable effect on the saltiness perception in fatty foods (Bolhuis et al., 2016). This scenario suggests that the higher dominance rate of texture attributes in the PC-L sample may have influenced the lower perception of saltiness attribute as dominant in this sample.

Regarding residue, this parameter is quite highlighted in chips, since the microstructure of this product facilitates the formation of a large number of particles with small size (Liu et al., 2017). The significant DR% values of PC-L could be due to the dryness of the product, resulting in a great number of particles which are perceived by the participants.

4.1.2 Effect of flavored on temporal profile of potato chips

As can be observed in Fig. 5 the higher significant differences among PC-C and PC-H were associated to flavor sensations. Smoked presented a high significance for PC-H samples when were compared to PC-C, since this parameter was not included in classic chips composition, being this attributed related to ham flavor. Significant differences with similar behavior than smoked, were found for umami attribute which also showed higher DR% values in PC-H. Umami is described as a primary taste defined as savory or meaty (Hofmann et al., 2003). This

taste is related to different food matrices, including the meat products (Zhang & Peterson, 2018). Thus, these results were coherent with what is described by literature due to the ham flavor content probably increase the umami perception by the panel, leading this increasement to a significant difference between PC-H and PC-C.

Concerning, saltines and f-potato both attributes showed significant higher DR% values on PC-C samples in comparison with ham ones. These results are probably due to that smoked and umami sensations were maskers of the rest of flavor parameters studied, and therefore did not perceive by the assessors. This fact is also possible to observe with DD parameter (Table 2), which displayed that smoked and umami were significantly less perceived in PC-C samples, being therefore the other two flavors the highlights ones: f-potato and saltiness.

Finally, for texture attributes, were showed some significant differences for crispy, dryness and residue parameters, even though no clear trend was found. It is probable that the flavor parameters such as smoked, umami, f-potato or saltiness had the ability to mask the texture attributes as other authors reported (Liu et al., 2017) could explain the obtained results.

4.2 Associations between overall liking and purchase intention with dynamic profile of potato chips

Generally, the overall liking and purchase intention tests indicated that all potato chip samples had a high level of acceptability and willingness to buy, without showed any significant differences among the group of samples. Hence, the different formulations did not influence the hedonic tests. In the case of potato chips, Taniwaki, Sakurai, & Kato (2010) determine that crispness was the most influenced attribute in consumer satisfaction. PCA analysis of the present study (Fig. 6) shows that crispy, residue and dryness attributes were those that best described the PC-L and, furthermore, the acceptability vector was positively correlated with these texture attributes. These results indicated that the longer duration of dominance of these

attributes over the intakes could positively influence potato chip acceptance. Other attributes that best characterized the most dominant sensations in traditional samples are related to flavor and taste but displayed vectors in the opposite direction to the overall liking vector. Likewise, PC-H was positively correlated with flavor parameters. However, PC-H and PC-C had to have crispy, residue, and dryness values sufficient to be well appreciated by the participants.

5. CONCLUSIONS

The TDS approach with multiple intakes for different potato chips highlighted the most influential attributes throughout a more realistic consumption experience simulation. The reduction of fat in potato chips significantly increases texture sensations while the addition of ham flavor increases flavor sensations, compared to the classic version. Overall liking and purchase intent studies did not show significant differences by changes on the potato chips formulations. However, it was possible to know which the most influence attributes on acceptability, being crispy, residue and dryness. Thus, it is recommended to apply this technique to understand the dynamics of consumption over time and to assist in studies of reformulation of classic products for healthier versions, since it can influence consumer satisfaction and demands.

6. ACKNOWLEDGMENTS

National Council for Scientific Development (Conselho Nacional de Desenvolvimento Científico – CNPQ, Brazil) for the support to LSO through the PVE scholarships 208398/2017-1. This study was partly co-funded by FEDER and Junta e Extremadura (project IB16043). Authors gratefully thank all members of the sensory panel for their participation.

Declarations of interest

The authors declare no conflict of interest

Compliance with ethics requirements

All procedures performed in this study involving human participants were approved on the ethical standards of the Delegation of the Bioethics and Biosafety Commission of the University of Extremadura (Delegación de Comisión de Bioética y Bioseguridad de la Universidad de Extremadura) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards with the register number 71/2016.

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Table 1. Attributes and descriptions of each category of products.

Category	Commercial name (code)	Attribute	Description
Potato Chips Lays®	Potato chips traditional (PC-C) Potato chips ham (PC-H) Potato chips light (PC-L)	Umami ^{ta}	Primary taste associated with monosodium glutamate
		Saltiness ^{ta}	Primary taste associated with salt
		Crispy ^{te}	Sensation of noise when biting
		Residue ^{te,m}	Residual food in the mouth after swallowing
		Dryness ^{te,m}	Sensation of dry to the mouth
		f-Potato ^f	Flavor sensation resembling potato
		Smoked ^f	Flavor sensation resembling smoke

^{te} = texture; ^f = flavor; ^{ta} = taste; ^m = mouthfeel; ^{tr} = trigeminal

Table 2. Temporal dominance parameters of potato chips evaluation (Mean±SD)

Attribute Parameters (s)	Product		
	PC-C	PC-L	PC-H
Umami			
Time	55.67±12.66 ^a	43.5±11.00 ^a	8.87±2.69 ^b
Duration	12.00±2.64 ^b	8.5±1.29 ^b	30.73±7.01 ^a
Saltiness			
Time	13.17±4.78 ^c	20.40±6.27 ^b	27.50±4.85 ^a
Duration	18.50±5.99 ^a	13.10±4.76 ^b	9.83±3.43 ^b
Crispy			
Time	4.44±1.82	4.47±1.17	3.58±1.89
Duration	15.63±3.35 ^b	20.84±4.08 ^a	14.26±3.69 ^b
Residue			
Time	23.05±6.14 ^b	24.37±3.80 ^{ab}	27.5±4.99 ^a
Duration	18.28±5.18 ^b	23.63±7.30 ^a	20.39±4.43 ^{ab}
Dryness			
Time	29.80±3.70 ^a	16.60±5.17 ^b	33.80±11.75 ^a
Duration	7.00±2.83 ^b	11.10±2.64 ^a	4.40±1.34 ^b
f-Potato			
Time	14.74±5.98 ^b	11.06±3.31 ^b	25.4±6.22 ^a
Duration	32.58±7.83 ^a	30.33±7.55 ^a	13.00±3.68 ^b
Smoked			
Time	-	-	8.67±3.22
Duration	-	-	31.53±4.26

PC-C = potato chips classic; PC-L = potato chips light; PC-H = ham potato chips. * Means in the same line with different letters are significantly different ($\alpha \leq 0.05$).

Figure 1 TDS curve of classic potato chips (PC-C)

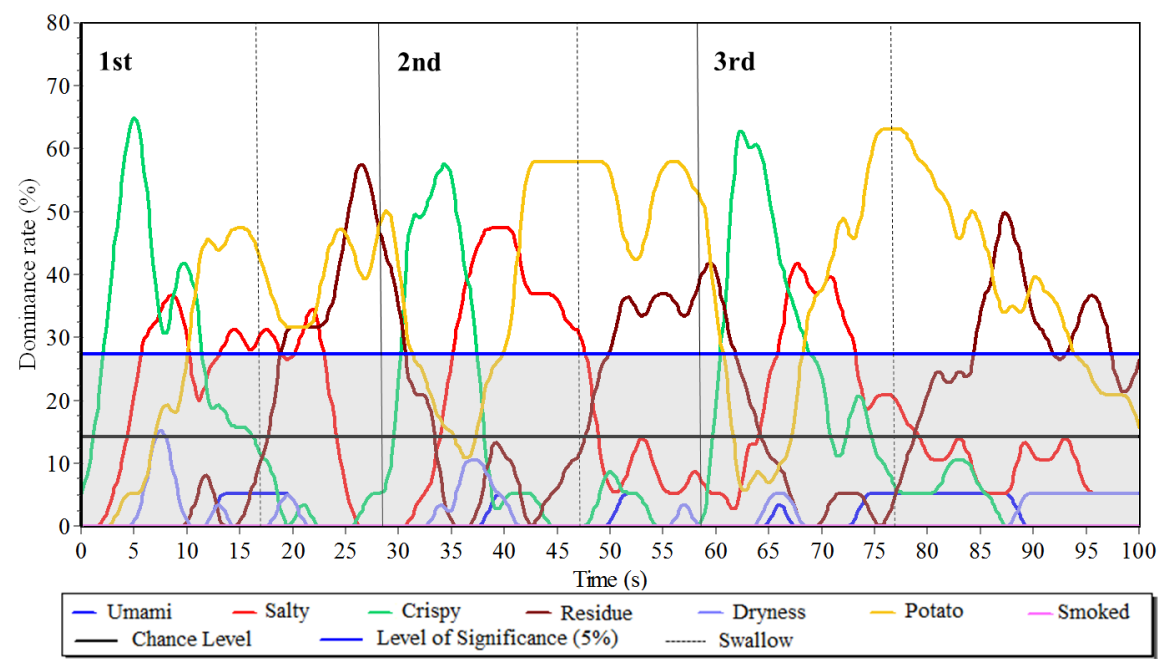


Figure 2 TDS curve of reduced fat potato chips (PC-L).

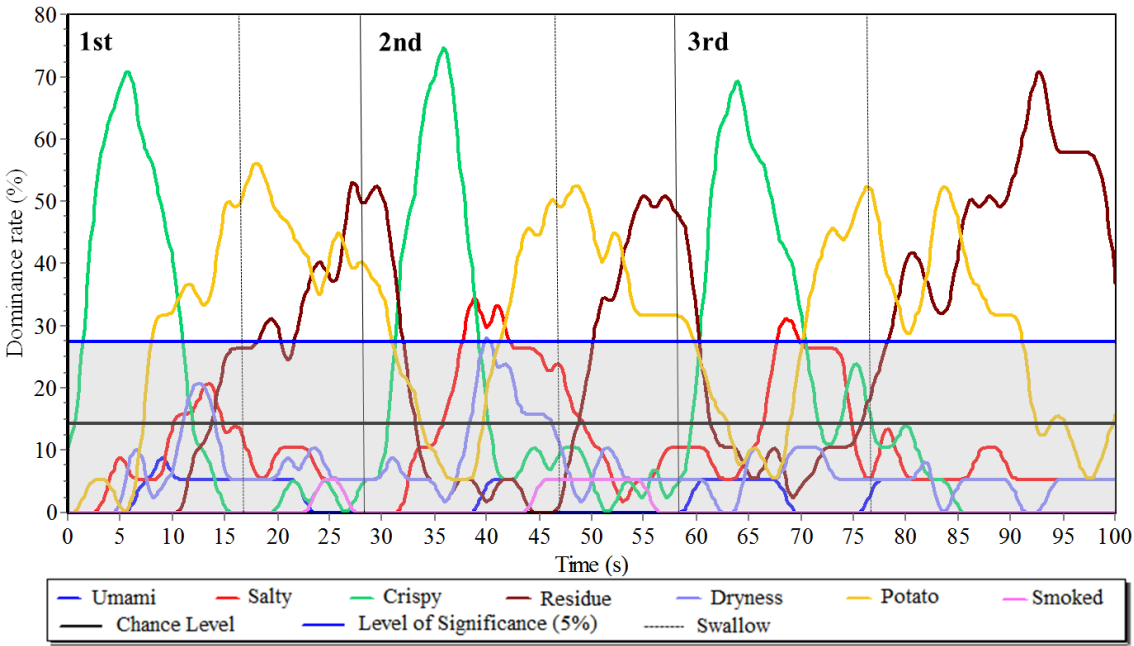


Figure 3 TDS curve of a ham potato chips (PC-H).

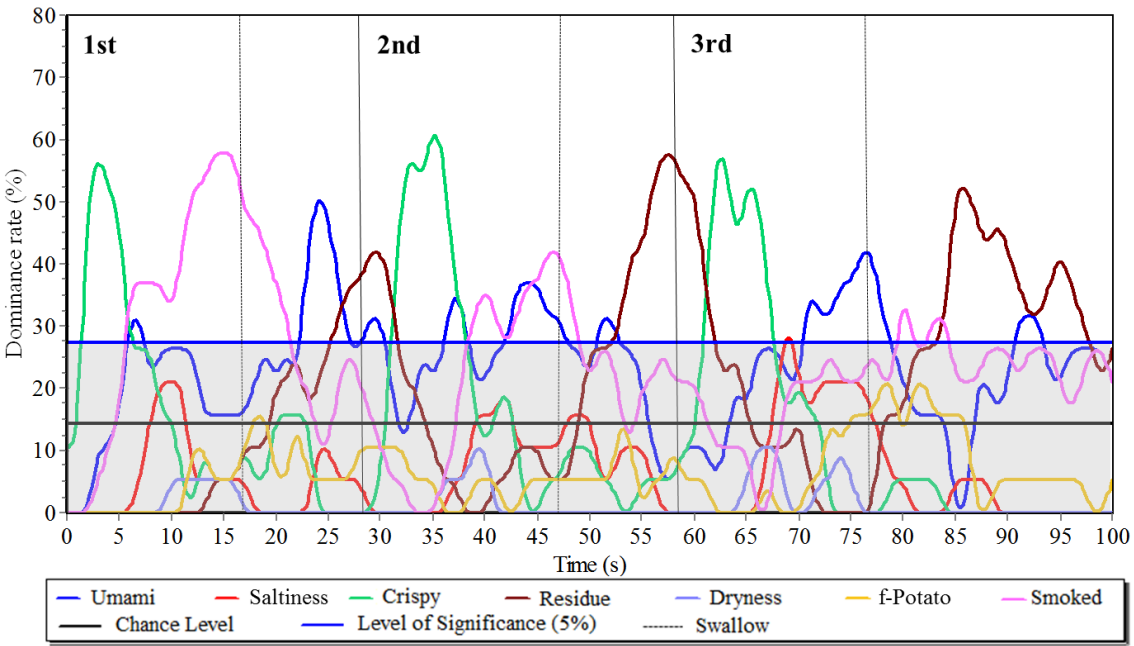
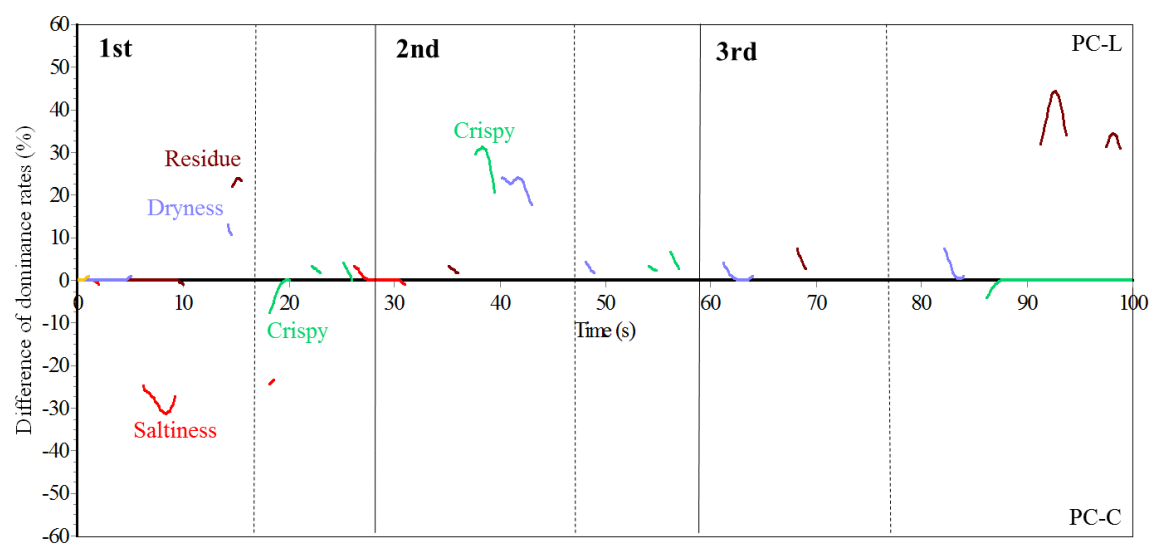
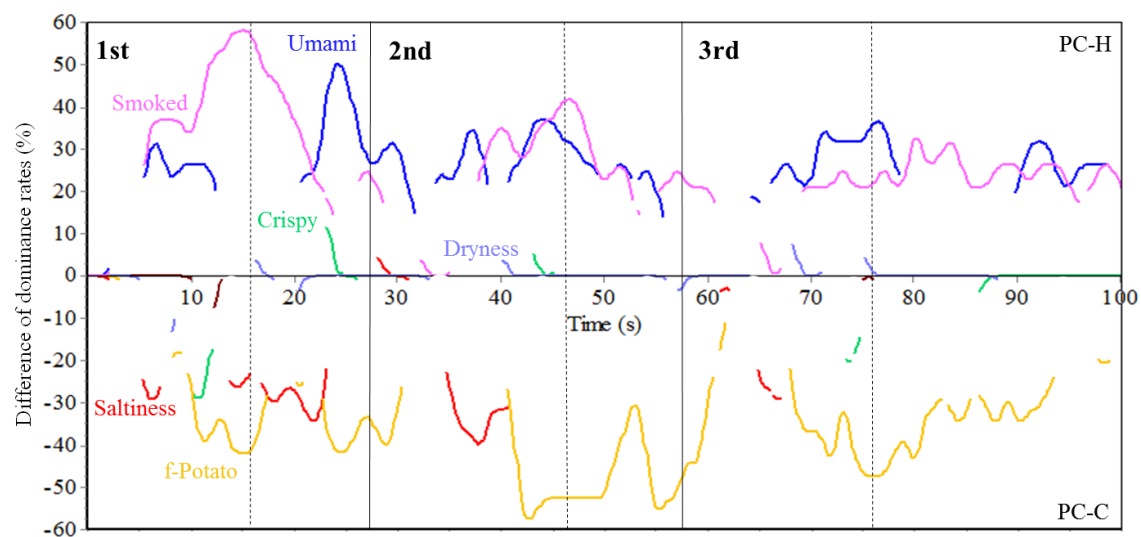


Figure 4 Multiple-intake TDS graphical representation for the TDS difference curves between products PC-L and PC-C (filtered level of significance 5%).



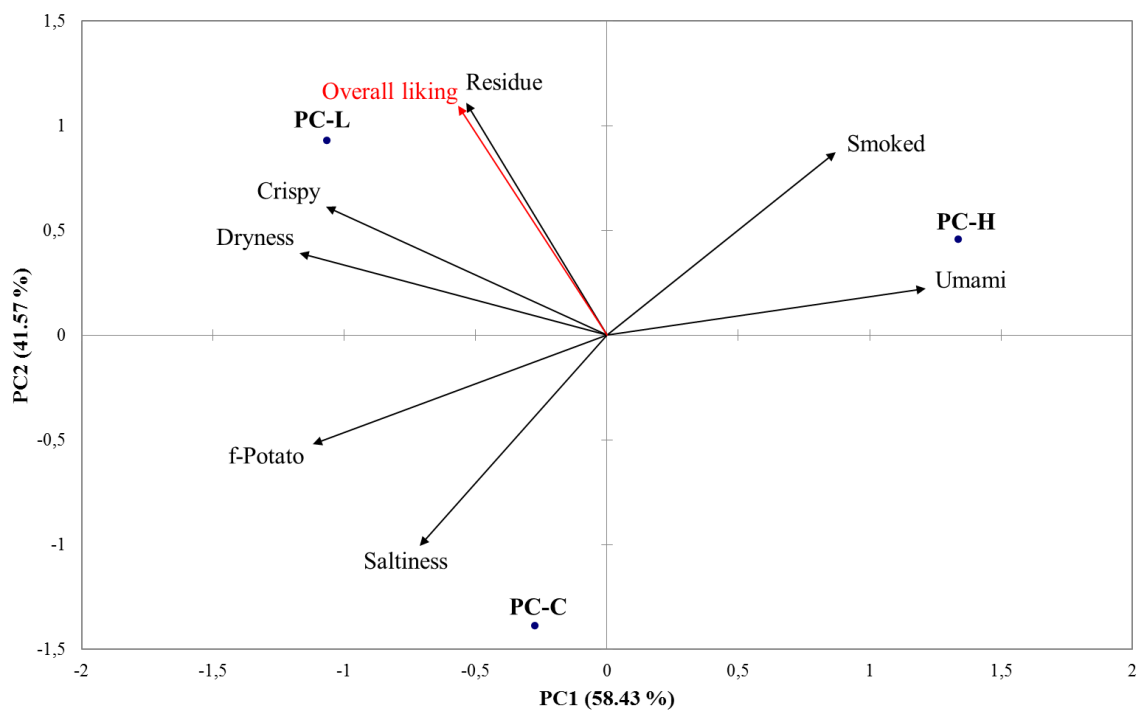
PC-L = reduced fat potato chips; PC-C = classic potato chips.

Figure 5 Multiple intake TDS graphical representation for the difference between products PC-H and PC-C (filtered level of significance 5%).



PC-H = ham potato chips; PC-C = potato chips classic.

Figure 6 Principal Component Analysis of duration parameter of each attribute and liking (AC) of potato chips (PC-C, PC-H, PC-L).



PC-L = reduced fat potato chips; PC-H = ham potato chips; PC-C = potato chips classic.

ARTIGO IV: CROSS-CULTURAL EMOTIONAL RESPONSE TO FOOD STIMULI:
INFLUENCE OF CONSUMPTION CONTEXT

O artigo foi publicado no periódico *Food Research International* (Fator de impacto: 4,972) (<https://doi.org/10.1016/j.foodres.2021.110194>).



Contents lists available at ScienceDirect

Food Research International

journal homepage: www.elsevier.com/locate/foodres

Cross-cultural emotional response to food stimuli: Influence of consumption context

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ARTICLE INFO

Keywords:

Food stimuli
Emotional response
Cultural background
Context
Liking

ABSTRACT

Emotional responses elicited by certain types of food can be influenced by past experiences, frequency of consumption, culture, and other personal preferences. The present research aimed i) to investigate the impact of culture (Brazilian and Spaniard) on consumers' emotional responses and acceptability of different food stimuli, and ii) to explore the influence of evoked contexts. Brazilian (n = 437) and Spanish (n = 397) participants were exposed to three visual food stimuli (image of chocolate, potato chips, and yogurt) in an online survey and reported their emotional responses. Sociodemographic data, liking, and frequency of consumption were also collected. The evoked context in our study were designed and proposed, for each product and culture, based on four dimensions (consumption time, location, social setting, and hungry state). The evoked emotional lexicon was different for each food stimulus and was clearly influenced by the cultural factor. However, there are more similarities between cultures when evaluating the same product category. The evoked contexts were appropriated and influenced the citing frequency of some emotion terms, including positive ones. The most cited emotion terms tended to positively impact product liking ratings, acting as drivers of liking. Consumption level was positively related to liking regardless of cultural interactions for both chocolate and potato chips stimuli. In conclusion, the cultural background demonstrated to be an important impact factor to be considered for understanding the effects of product, consumption occasions, and degree of liking, on emotional responses to foods. These findings offer new possibilities to be explored in marketing messages for interventions or stimuli that guide food choices.

1. Introduction

The emotions evoked by food modulate the consumer's experience in a particular context. Although there is not a unique definition of "emotion" (Coppin & Sander, 2016), a well-accepted definition worldwide is that an "emotion" is a multicomponent phenomenon characterized by five components: expression, action tendency, bodily reaction, feeling and appraisal (Coppin & Sander, 2016). An emotion is an "event-focused, two-step, fast process consisting of (1) relevance-based emotion elicitation mechanisms that (2) shape a multiple emotional response (i.e., action tendency, automatic reaction, expression, and feeling)" (Sander, 2013). These emotions influence food preferences and for this reason, measuring emotional responses can assist the industry in product development and in the search for a

consumer market (Ng, Chaya, & Hort, 2013). Therefore, they can provide valuable information and become a competitive advantage.

The study of the emotions evoked by foods, being a relatively recent approach to sensory sciences, requires a pre-screening of emotional lexicons. An emotion lexicon is a list of words that can be used to identify each emotion (Mohammad & Turney, 2010). It is suggested that emotion lexicons should be selected from the literature of the native language in order to avoid misinterpretation caused by cultural differences (Jiang, King, & Prinyawiwatkul, 2014; van Zyl & Meiselman, 2016). Due to cultural significance, consumers from different regions may also give their distinct emotional responses toward specific foods (Ferdenzi et al., 2011). Due to this influence, commercial research is increasingly interested in the cross-cultural dimension to understand these emotional connections, especially for large international

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<https://doi.org/10.1016/j.foodres.2021.110194>

Received 15 October 2020; Received in revised form 15 January 2021; Accepted 24 January 2021
Available online 6 February 2021

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companies (Meiselman, 2015). There are several studies which reported the influence of culture background in different products categories (Gunaratne et al., 2019; Hu & Lee, 2019; Lim, 2016; Torrico, Fuentes, Gonzalez Viejo, Ashman, Gunaratne, Gunaratne, & Dunshea, 2018; Tsai & Chentsova-Dutton, 2003; van Zyl & Meiselman, 2015; 2016). However, the emotional response to particular food between a “greater emotionality” culture like the Brazilian and a supposedly “closed nature” European culture (Rezende, 2008) like Spaniards is still unknown. Emotional cross-cultural studies (i.e., Brazil and Spain) for regular product categories could be crucial for better understanding food choices and designing suitable strategies to attract and maintain customers in a global market scenario.

Moreover, the emotional response is context-dependent (Piqueras-Fiszman & Jaeger, 2015). The context of actual consumption of a product is not always possible or practical for consumer testing (Hein, Hamid, Jaeger, & Delahunty, 2012). Therefore, the use of a written scenario can facilitate the evocation of emotions as each consumer imagines his own personal consumption context for a particular food product (Dorado, Chaya, Tarrega, & Hort, 2016). In this regard, a context freely defined by a large group of people, influenced by learning, culture, may indicate the sharing of the same idealized situation.

Self-reported verbal questionnaires remain one of the most common techniques used to measure emotional response due to their simple, cost-effective and good discrimination approach. The CATA (check-all-that-apply) method, for example, consists of lists of emotions in which consumers classify terms or select only the experienced emotions (Valentin, Chollet, & Lelie, 2012). This type of questionnaire provides more differentiation at the highest levels of emotional frequency for some selected emotions, and the selected emotion terms tend to be the strongest emotions elicited by the stimulus (King, Meiselman, & Carr, 2013).

Therefore, it is important to understand how cultural differences affect the emotional lexicon, perceptions of liking and the contextualization of consumption of different categories of products. Thus, the aim of this study was i) to develop an original emotional lexicon adapted to each culture (Brazil and Spain) for three food stimuli commonly consumed in both cultures: chocolate, potato chips and yogurt ii) to explore and define the most appropriate evoked context for each evaluated food stimulus in each culture iii) to investigate the impact of culture background (Brazilian and Spaniard) on consumer's emotional response to chocolate, potato chips and yogurt stimulus and the effect of pre-designed evoked contexts. In addition, the emotion drivers of liking and disliking were identified for each product stimulus and culture. Finally, the impact of each product's consumption level on emotional responses was also reported and discussed.

2. Material and methods

2.1. Products stimuli selection

Three categories of commercial products were selected as stimuli based on eating habits of both cultures: chocolate (bar), potato chips (bag) and yogurt (single serve cup). Pictures and name of each food category were used as stimuli (Fig. 1) and presented to the participants in an online survey. Coffee stimulus (picture) has been always used as “warm up” sample in the first position to avoid first position effects (data not shown) (Dorado, Pérez-Hugalde, Picard, & Chaya, 2016a). The three stimuli (pictures) samples were monadically presented in randomized order across participants to minimize systematic carry-over effects. The same protocol was applied for all food stimuli evaluation. The selection of food picture as stimulus was decided based on the reported evidence that consumers' emotional responses/associations are similar between the stimulation by food picture and food consumption (Cardello et al., 2012).

2.2. Subjects

Participants were invited to participate via email and asked to complete an online questionnaire using Google forms (Google L.L.C., Mountain View, California, USA). Prior to recruitment, participants were informed of the purpose of the research, the voluntary nature of participation and an informed consent was obtained. Brazilian students and employees from the Federal University of Paraíba participated in Brazil and Spanish students and employees from the Universidad of Extremadura participated in Spain. Three phases were conducted: i) an online questionnaire to generate the list of emotional terms associated to each stimulus with 60 participants in each country; ii) an online questionnaire using the generated list of terms for validation in the three different foods stimuli with 190 Brazilians and 186 Spaniards; iii) an online questionnaire using a pre-designed written context with 187 Brazilians and 151 Spaniards. Different participants took part in each phase. Demographics data related to gender, age, household compositions, family income, studies level and culture were collected in all sessions. The demographic characteristics of the participants are shown in Table 1.

Participants had to declare to be regular consumers of the studied products (chocolate, chips, and yogurt). This evaluation was carried out using the question of frequency of consumption with a 5-point categorical scale (1 = Less than once a month; 2 = One or more times a month; 3 = Twice or more per week; 4 = Once a week; 5 = Once a day or more) and an additional option “Never”. Participants who answered “Never” were excluded from the study.

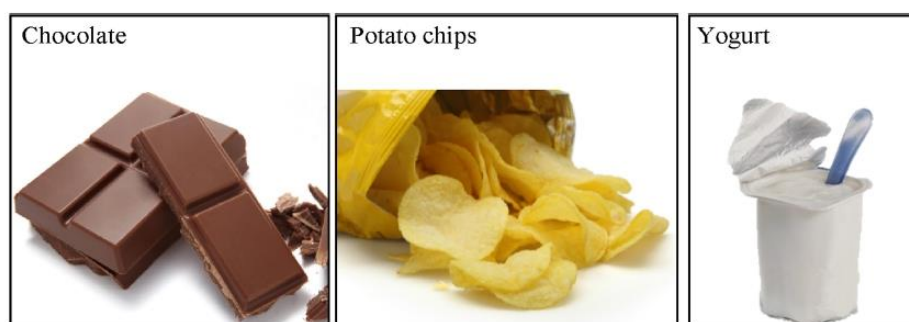


Fig. 1. Images and names displayed for food stimuli on the emotions evoked questionnaires.

Table 1
Socio-demographic characteristics of the subjects participating in the questionnaires.

Gender	Emotional lexicon		Without context		With context	
	Brazil (%) N = 60	Spain (%) N = 60	Brazil (%) N = 190	Spain (%) N = 186	Brazil (%) N = 187	Spain (%) N = 151
Female	60	55	66	62	38	44
Male	40	45	34	38	62	56
Age						
18 to 30 years	60	35	80	29	58	26
31 to 40 years	40	30	20	22	38	21
41 to 50 years	0	5	0	20	4	23
>50 years	0	30	0	29	0	30
People living in household						
1	25	30	7	22	16	8
2	35	25	27	20	37	17
3	0	10	22	18	14	15
4	30	25	24	24	23	18
5	10	10	13	13	6	42
+5	0	0	7	2	6	0
Family income						
Less than a salary	0	0	11	4	3	2
Up to two salaries	0	45	29	36	7	23
Between 2 and 3 salaries	20	25	13	22	21	42
Between 3 and 5 salaries	25	20	16	22	17	17
Between 5 and 7 salaries	10	0	11	9	11	11
More than 7 salaries	45	10	20	7	41	6

2.3. Emotional lexicon generation

Two steps for emotional lexicon generation were performed. The checklist format has been applied as it is considered not too exhaustive as each participant had to complete multiple emotion questionnaires. In both steps, the food pictures and names were presented to the participants and they were requested to respond the CATA questionnaire by the following sentence: "Please tick all the emotions you remember feeling when you consume (chocolate or potato chips or yogurt)". They could also suggest additional terms. In the first step the list of emotional terms presented was the emotional lexicon included in the EsSense25 methodology (Nestrud, Meiselman, King, Leshner, & Cardello, 2016) and also some additional terms based on specific emotional lexicon previously developed for each food category: yogurt (Mojet et al., 2015; Schouteten et al., 2017), chocolate (Gunaratne et al., 2019; Schouteten et al., 2017; Thomson, Crocker, & Marketo, 2010; Torrico, Fuentes, Gonzalez Viejo, Ashman, & Dunshea, 2019) and potato chips (Cardello et al., 2012). All emotional terms were translated from English to Portuguese and Spanish by bilingual researchers and consumers, following the methodology applied by Hu and Lee (2019). A total of 79 emotional terms were listed for chocolate, 64 for potato chips and 65 for yogurt (Table 1SM). The order of emotion terms presentation was randomized among participants, to avoid terms presentation order bias effect.

In the first step, the emotions cited by >5% of the participants were selected (Piqueras-Fiszman & Jaeger, 2014b). Using this criteria, 38 emotions for chocolate, 37 for potato chips and 27 for yogurt were selected by the Brazilians and 42 for chocolate, 33 for potato chips, and 36 for yogurt were selected by the Spanish participants. The selected emotions were applied to the second step to validate the terms following the same evaluation protocol. The results of the second step were also filtered according to the most frequent terms (>5% of citation). With the results obtained in this step (the first one), it was possible to validate the emotional terms and generate a short list of emotions to be applied in the

"without context" and "with context" tests. This study did not consider an established list of general terms related to food consumption, as we believe that emotion terms should be customized for each product category and culture.

2.4. Emotional response without scenario (validation of list of emotional terms)

Once the demographic data (Table 1) of the participants were collected, at the beginning of each product-specific questionnaire, a food picture and name (chocolate, potato chips or yogurt) was displayed to participants and the frequency of consumption was requested using a 5-point categorical scale. Then, participants were instructed to select all the applicable emotions (CATA approach) by the following sentence: "Please tick all the emotions you remember feeling when you consume (chocolate or potato chips or yogurt)". The order of emotion presentation was randomized among participants, but, in order to ease the task, the same order was maintained in each product category for the same participant (King & Meiselman, 2010). Five minutes was the estimated time to complete the questionnaire. After validation procedure, Brazilian participants elected 32 terms for chocolate, 25 for potato chips and 20 for yogurt. Spanish participants elected 29 terms for chocolate, 18 for potato chips and 15 for yogurt. Finally, participants were asked to rate their liking using a 7-point hedonic scale, anchored from "I dislike very much" to "I like very much". The list of emotions were presented before hedonic scale to avoid any effect of liking on the emotional responses (King et al., 2013).

2.5. Design and selection of the evoked contexts

After the validation of emotional list terms and the collection of the emotional responses for the different food stimuli (section 2.4), participants (Brazilians and Spaniards) were asked, in a new online questionnaire, to answer a series of questions to indicate the most common consumption occasions for each evaluated food stimulus. This questionnaire aims to obtain the most common consumption scenarios elicited for each culture and product. Different items were included as the consumption time, location, social setting (company) and hungry state, in order to generate an elicited context for each product stimulus and culture (Table 2). According to Dorado et al. (2016b), the presence of these dimensions in an elicited scenario encourages greater emotional association by the participant. The most frequent occasions (>50%) were selected to create a consumption written context for each food stimulus. These collected responses indicated differences between the frequency of citation of each dimension in relation to the product, therefore considering the most frequent dimensions, different consumption contexts were formulated for each product stimulus and each culture. The elicited contexts for Brazilians were (1) "It is afternoon, you are at home, you are alone, you are not hungry, and you are eating milk chocolate"; (2) "It is the afternoon, you are at the restaurant with your friends or family, you are hungry and you are eating salted potato chips" and (3) "It is morning, you are having breakfast at home, you are alone or with your family, you are hungry and you are eating a yogurt", for chocolate, potato chips and yogurt consumption respectively. The elicited contexts formulated by Spaniard were (1) "It is afternoon, you are at home with your family, you are hungry and you are eating milk chocolate"; (2) "It is afternoon, you are at home with some friends or family, you are hungry and you are eating salted potato chips"; (3) "It is night, you are having dinner at home with your family, you are hungry and you are eating a yogurt" for chocolate, potato chips and yogurt respectively.

2.6. Emotional response under the elicited context

Once the demographic data (Table 1) of the participants were collected, at the beginning of the product-specific questionnaire, a food

Table 2

Dimensions (Location, social setting, time, hungry state) evaluated for context selection by culture and the % of options selection for each product category stimulus.

Dimension	Question	Options	Brazil			Spain		
			Chocolate	Potato Chips	Yogurt	Chocolate	Potato Chips	Yogurt
Time	I usually eat chocolate for...	a. Breakfast	0	0	74	12	0	16
	I usually eat potato chips for...	b. Lunch	9	23	0	12	21	27
	I usually eat yogurt for...	c. Dinner	7	50	19	17	26	86
		d. Between hours	89	24	48	83	74	24
Location	When I'm eating chocolate, I'm usually at (the)...	a. Home	93	27	100	92	63	95
	When I'm eating potato chips, I'm usually at (the)...	b. Work	20	0	14	12	0	7
	When I'm eating yogurt, I'm usually at (the)...	c. Food center (bar, restaurant, etc.)	34	80	9	28	46	0
		d. Leisure Center (cinema, theater, etc.)	43	33	1	7	21	0
Social setting	When I'm eating chocolate, I'm usually with...	a. Nobody (alone)	71	9	71	55	16	41
	When I'm eating potato chips, I'm usually with...	b. My friends	51	73	12	35	74	7
	When I'm eating yogurt, I'm usually with...	c. My family	51	53	47	70	74	65
Hungry state	I usually eat chocolate when I'm...	a. Hunger	23	89	90	54	79	57
	I usually eat potato chips when I'm...	b. Full	79	14	15	34	14	40
	I usually eat yogurt when I'm...							

picture and name (chocolate, potato chips or yogurt) was displayed to participants and the frequency of consumption was requested using a 5-point categorical scale. Then, participants were introduced to the consumption context and were requested to imagine the food consumption experience under the specific context by showing the following sentence: "Imagine that you are experiencing the following situation and answer the questions as realistically as possible". Then, participants were requested to select all elicited emotional terms applicable under the corresponding context following CATA procedure. To evaluate the adequacy of the performed consumption scenario, participants were asked about the appropriateness of the context by answering the following question: "Is this scenario appropriate for the consumption of this product?" using a 7-pt categorical scale (1 = Not at all appropriate; 2 = Inappropriate; 3 = Slightly inappropriate; 4 = Neither appropriate nor inappropriate; 5 = Slightly appropriate; 6 = Appropriate, and 7 = Very appropriate). Right after, they were instructed to check all applicable terms (CATA) while imagining consuming each food under different occasion: "What are the emotions you feel when consuming (chocolate; potato chips; yogurt) in this context?". Participants could also suggest additional terms using the "other" option. The same list of emotional terms used in the previous step (validation test without context) for each product and culture was applied. The order of emotion presentation was randomized among participants. Finally, participants were asked to indicate how much they liked the food using a 7-point hedonic scale (1 = I dislike very much, 7 = I like very much). Five minutes was the estimated time to complete the questionnaire.

2.7. Data analysis

Frequency of each emotion term from CATA questionnaire was calculated in percentage for each food stimulus (chocolate, potato chips and yogurt) for Brazilians and Spaniards under evoked and no-context situations. In order to investigate the effect of the evoked contexts on the emotional responses, Cochran Q-tests were performed on each of the emotions to explore differences among evaluation conditions (with vs without context) for each food stimulus and culture (Brazilians and Spaniards). Moreover, Correspondence Analysis allowed to obtain the emotional profile associated to each culture in the two evaluation conditions and Principal Coordinate Analyses (PCoA) were applied to assess the differences among the food stimuli relative to the selection of the emotion terms and liking levels of each culture. Pearson correlation coefficients (r) among the consumption level and overall liking responses were estimated. A Kruskal-Wallis non-parametric test ($p < 0.05$) was applied to no normal appropriateness of the context data (Shapiro-

Wilk test) followed by a multiple paired comparisons test (Dunn procedure) for comparing the mean differences between products or cultures. Regarding answers on consumption level and liking (normal data, Shapiro-Wilk test) an analysis of variance (ANOVA) using the 5% level of significance was applied, considering the effects of culture (Brazilian and Spanish participants) and evaluation conditions (without and with context) on each product stimulus (chocolate, potato chips and yogurt). All statistical analyses were performed using XLSTAT 2014 (Addinsoft, Paris, France).

3. Results

3.1. Emotional lexicon elicited by Brazilians and Spaniards for different foods stimuli: Vocabulary development

Table 1SM shows all emotional terms used to develop the lexicon evoked by Brazilians and Spanish participants in the evaluation of each product stimulus, translated from English to Spanish and to Portuguese. Brazilian participants elected 32 terms for chocolate, 25 for potato chips and 20 for yogurt. Food stimuli had in common the following emotion terms: *active, affectionate, calm, craving, eager, friendly, good-natured, lazy, pleasant, relaxed, satisfied* and *warm*. Spanish participants elected 29 terms for chocolate, 18 for potato chips and 15 for yogurt. Food stimuli had in common the following emotion terms: *active, calm, care-free, comfortable, happy, friendly, joyful, pleasant* and *satisfied*. In general, Spanish participants selected fewer emotional terms than Brazilian participants for the same product stimuli, but similarities were found in the election of the same 23 emotion terms for chocolate (*affectionate, active, calm, comforting, craving, eager, enthusiastic, friendly, fun, good-natured, guilty, happy, interested, irresistible, lazy, lonely, loving, luxurious, nostalgic, pleasant, satiating, satisfied, sociable, warm*), 13 emotion terms for potato chips (*active, calm, comfortable, craving, eager, enthusiastic, free, friendly, guilty, pleasant, relaxed, satisfied, young*), and 12 emotion terms for yogurt (*active, calm, carefree, comfortable, happy, friendly, joyful, pleasant, relaxed, reliable, satisfied* and *steady*).

3.2. Appropriateness of the freely elicited context

The formulation of the freely elicited contexts aimed at obtaining the context best suited to consumers in each culture. Moreover, results of context appropriateness revealed that more than 50% of participants in Brazil and Spain indicated that the context was between slightly appropriate (5) and very appropriate (7), with no significant differences neither between products ($p = 0.0997$) nor between countries ($p =$

0.3814) by the Kruskal-Wallis test. The means presented by the Brazilian participants for chocolate was 4.65 ± 1.85 , for potato chips 4.13 ± 1.99 and for yogurt 4.72 ± 2.13 , and by Spanish participants was 4.01 ± 2.02 for chocolate, 4.36 ± 2.06 for potato chips and 4.40 ± 1.99 for yogurt.

3.3. Emotional response to chocolate, potato chips and yogurt stimuli by Brazilians and Spaniards under non-context and context scenario

Results from the emotional response (% of frequency of mention) of Brazilians and Spaniards to the evaluated food stimuli (chocolate, potato chips and yogurt) using the validated lexicon list of emotions under the two evaluation conditions (with and without context) are presented in Tables 3–5.

Table 3 summarizes the results obtained by comparing the sum of mentions of the emotional terms reported for chocolate under the two studied conditions (with and without context), evaluated by Brazilians and Spaniards. Among the emotion terms evaluated, the sum of mentions of terms *active*, *calm*, *enthusiastic*, *fun*, *good-natured*, *loving*, *sociable* and *uncomplicated*, were significantly higher in the non-context compared to context condition for Brazilians, as well as the terms *good*, *happy* and *nostalgic* for Spaniards.

Fig. 2 shows the results of the correspondence analysis for Brazilians and Spaniards under the two evaluation conditions (with and without context) for chocolate stimulus in relation to the emotional response (CATA questionnaire). The principal components one (PC1) and two (PC2) explaining a total of 95.84% of the data variability. Clearly the attributes most associated with chocolate evaluated for Brazilians

Table 3

Total number of mentions of selected emotions for the chocolate stimulus with and without context conditions.

Emotion term	Brazil		Emotion term	Spain	
	Without context N = 68	With context N = 68		Without context N = 46	With context N = 46
Active*	30	13	Active	9	6
Adventurous	6	1	Affectionate	7	2
Affectionate	6	10	Calm	7	8
Calm*	20	8	Carefree	6	4
Comforting	11	7	Comfortable	20	15
Confident	12	7	Comforting	10	7
Craving	12	17	Craving	5	4
Eager	12	17	Joyful	8	6
Easygoing	21	16	Eager	5	1
Enthusiastic*	15	5	Enthusiastic	6	1
Friendly	18	10	Friendly	6	4
Fun*	21	9	Fun	3	1
Good-natured*	14	5	Good*	22	11
Guilty	6	6	Guilty	6	6
Happy	44	39	Happy*	23	13
Interested	5	2	Interested	3	1
Irresistible	6	5	Irresistible	5	6
Lazy	8	8	Lazy	5	1
Lonely	6	4	Lonely	3	1
Loving*	24	7	Loving	6	2
Luxurious	8	3	Luxurious	3	4
Nostalgic	11	6	Nostalgic*	9	2
Pleasant	21	15	Pleased	12	7
Powerful	6	3	Pleasant	18	14
Relaxed	30	31	Satiating	8	6
Satiating	17	15	Satisfied	21	14
Satisfied	38	37	Sensual	3	3
Sociable*	14	4	Sociable	38	5
Suffering	8	2	Warm	7	5
Trustworthy	8	4			
Uncomplicated*	9	1			
Understanding	5	1			
Warm	6	10			

Emotion terms which sum of mentions differ significantly across the without and with context conditions according to Cochran Q-test are highlighted marked with * at a significance level of $p < 0.05$.

Table 4

Total number of mentions of selected emotions for the potato chips stimulus with and without context conditions.

Emotion term	Brazil		Emotion term	Spain	
	Without context N = 62	With context N = 62		Without context N = 50	With context N = 50
Active	7	9	Accompanied	10	18
Adventurous	5	1	Active *	7	1
Affectionate	5	3	Calm	3	3
Bad	4	3	Carefree	6	7
Calm	5	3	Comfortable	13	18
Comfortable	23	17	Craving	7	4
Craving	11	10	Eager	5	5
Eager	11	10	Enthusiastic	4	2
Enthusiastic	8	13	Free	4	1
Free	7	7	Friendly	12	8
Friendly*	17	7	Guilty	13	11
Good	8	3	Happy	17	12
Guilty*	8	18	Joyful*	15	6
Hungry	23	21	Pleasant	10	11
Lazy	4	7	Pleased	5	8
Pleasant *	5	19	Relaxed	13	19
Nostalgic	4	2	Satisfied	8	10
Relaxed*	23	10	Young	3	0
Satisfied	31	29			
Steady	7	4			
Warm	5	3			
Whole	7	4			
Worried	4	10			
Young	8	13			

Emotion terms which sum of mentions differ significantly across the without and with context conditions according to Cochran Q-test are highlighted marked with * at a significance level of $p < 0.05$.

Table 5

Total number of mentions of selected emotions for the yogurt stimulus with and without context conditions.

Emotion term	Brazil		Emotion term	Spain	
	Without context N = 57	With context N = 57		Without context N = 53	With context N = 53
Active	5	4	Active	7	3
Affectionate	4	3	Bored	4	2
Calm	9	15	Calm	10	4
Carefree	8	10	Carefree	7	4
Comfortable	24	20	Comfortable*	22	9
Craving*	4	0	Confident	7	2
Eager*	4	0	Friendly*	7	1
Friendly	6	2	Good	24	17
Good-natured	6	5	Happy	11	4
Happy	17	20	Joyful	5	1
Interested	4	1	Kind*	7	1
Joyful	17	20	Pleasant	8	15
Lazy	8	3	Relaxed	14	9
Pleasant	9	12	Reliable	5	6
Polite	5	3	Satisfied	14	16
Understanding	5	2	Steady	3	3
Relaxed	14	11	Healthy	24	27
Reliable	6	10			
Satisfied	37	33			
Steady	9	5			
Warm	4	3			
Young	8	7			

Emotion terms sum of mentions differ significantly across the without and with context conditions according to Cochran Q-test are highlighted marked with * at a significance level of $p < 0.05$.

participants under non-context situation were *fun*, *loving*, *enthusiastic*, *active*, *friendly*, *adventurous*, *confident*, *good-natured*, *suffering*, *trustworthy*, *uncomplicated* and *understanding*, whereas under the evoked context condition were *craving*, *eager*, *happy*, *lazy*, *satisfied*, *easygoing*,

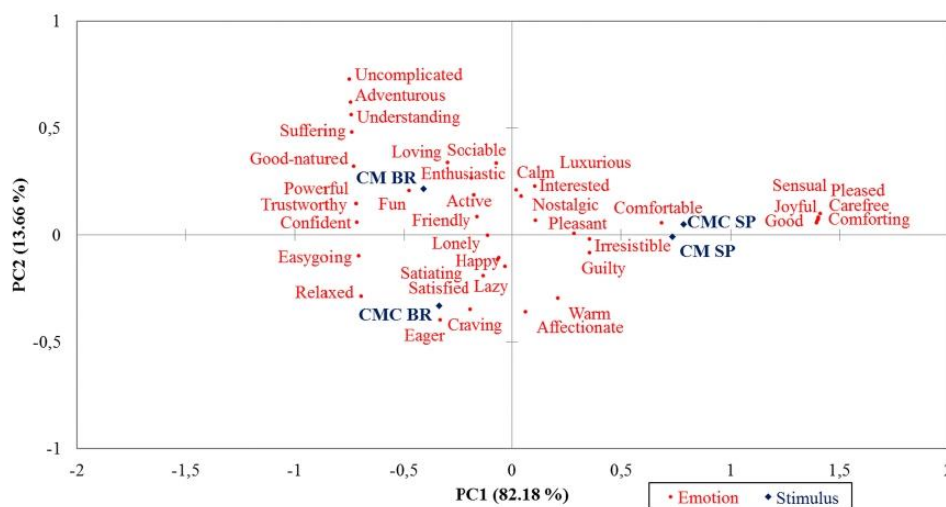


Fig. 2. Correspondence analysis (CA) of CATA terms (emotions) frequencies for chocolate stimulus (CM) in both cultures (Brazil-BR and Spain-SP) under both evaluation conditions (without and with evoked context-C).

relaxed and *satiating*. The emotions associated with chocolate stimulus evaluated by Spanish participants under the evoked context condition were *powerful*, *comforting*, *joyful*, *carefree*, *comfortable*, *good*, *sensual*, *pleased*, *calm*, *luxurious*, *interested*, *nostalgic*, and *pleasant*, while under the non-context situation were *irresistible*, *guilty*, *warm*, *affectionate* and *satisfied*.

Results obtained for the sum of mentions of the emotional terms reported under context and no-context conditions for potato chips evaluated by Brazilians and Spaniards is shown in Table 4. In the evaluation of Brazilians, the sum of mentions of the emotion terms *friendly*, *relaxed* was significantly higher for the non-context condition, while *guilty* and *pleasant* was significantly higher in the evoked context condition. In the assessment of Spaniards, *active*, *joyful* presented a significantly higher frequency of citations in evoked context compared to the no-context condition.

Fig. 3 shows the results of the correspondence analysis for Brazilians and Spaniards under the two evaluation conditions (with and without

context) for potato chips stimulus in relation to the emotional response (CATA questionnaire). The principal components one (PC1) and two (PC2) accounted for 79.39% and 12.56%, respectively, explaining a total of 91.95% of the data variability. Emotional response to potato chips evaluated by Brazilians participants in the non-context condition was characterized by emotions like *adventurous*, *affectionate*, *bad*, *eager*, *good*, *nostalgic*, *satisfied*, *steady*, *warm*, *whole*, while under evoked context condition the emotions *active*, *craving*, *enthusiastic*, *free*, *lazy*, *worried*, *young* were the most frequently cited. Regarding Spanish participants emotional response, the emotion terms *friendly*, *guilty*, *happy*, *joyful* were the most cited under non-context condition whereas *accompanied*, *calm*, *carefree*, *comfortable*, *pleased*, *relaxed* characterized the emotional responses under the evoked context condition.

Table 5 shows the results obtained by comparing the sum of mentions of the emotion terms selected for the yogurt stimulus under context and no-context conditions obtained by Brazilians and Spanish participants. Among the emotion terms evaluated, only for *craving* and *eager*

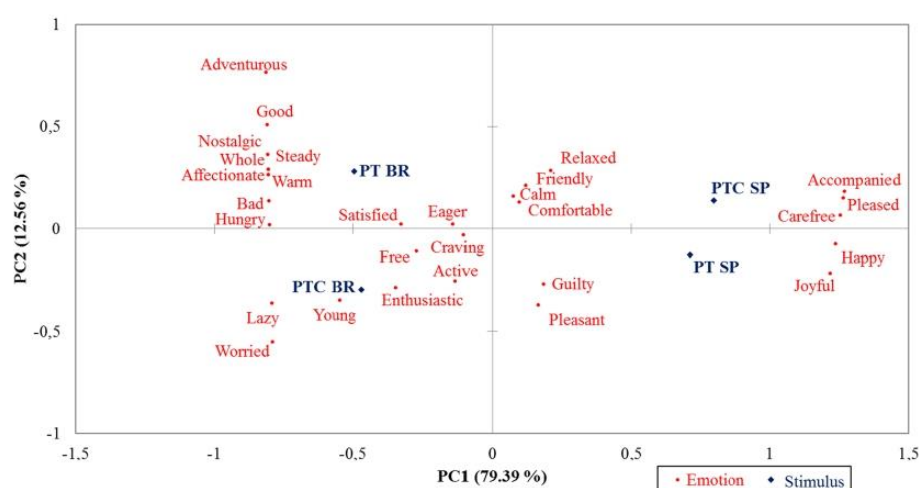


Fig. 3. Correspondence analysis (CA) of CATA terms (emotions) frequencies for potato chips (PT) stimulus in both cultures (Brazil-BR and Spain-SP) under both evaluation conditions (without and with evoked context-C).

emotions significant differences in the sum of mention between the two evaluations conditions were obtained. For Spanish participants, significantly higher frequencies for *comfortable*, *friendly* and *kind* were found in the non-context situation.

Fig. 4 shows the results of the correspondence analysis for Brazilians and Spaniards under the two evaluation conditions (with and without context) for yogurt stimulus in relation to the emotional response (CATA questionnaire). The principal component one (PC1) accounted for 83.99% and with component two (PC2) explaining a total of 92.27% of the data variability. The emotion terms associated with yogurt evaluated by Brazilian under the non-context condition were *affectionate*, *comfortable*, *craving*, *eager*, *good-natured*, *interested*, *lazy*, *polite*, *understanding*, *steady*, *warm*, whereas in the evoked context condition were *active*, *calm*, *carefree*, *happy*, *joyful*, *satisfied*, *young*. For Spanish participants, the emotion terms associated with yogurt stimulus were *bored*, *confident*, *friendly*, *good*, *kind*, *relaxed*, *healthy* in the non-context condition and *pleasant*, *satiating* and *reliable* in the evoked context condition.

3.4. Consumption level and liking

Table 6 shows the ANOVA results (F and p values) for the responses (liking and consumption level) to product stimulus (chocolate, potato chips and yogurt) depending on the effects of participant, culture, context, and the culture*context interaction. The participant effect did not have a significant impact on consumption level ($p > 0.05$), but this effect was significant on liking for chocolate and potato chips ($p < 0.05$). The culture effect was significant ($p < 0.05$) for the liking response of chocolate and for consumption level in the evaluation of yogurt and potato chips. The context effect was significant ($p < 0.05$) only for potato chips. The effects of the interaction (culture*context) were significant ($p < 0.05$) for all responses, except for liking in potato chip. The mean values of the consumption level and sensory liking for each food stimulus in each culture (Brazilian and Spaniard) were calculated. For both cultural groups, chocolate displayed scores above “One or more times a month” (2.55 ± 1.03 vs 2.63 ± 1.23 for Brazilian and Spaniard respectively) in the frequency of consumption scale (5-pt). Conversely, the mean of consumption level of potato chips for Brazilians (1.82 ± 0.72) was significantly lower ($p < 0.05$) compared to the Spaniard (2.18 ± 0.85) with averages above “Less than once a month” and “One or more times a month” respectively. Spanish participants reported significant ($p < 0.05$) higher consumption level scores for yogurt compared to Brazilian participants (3.29 ± 1.28 vs 2.47 ± 1.11 , respectively).

In general, with respect to liking scores, all food stimuli presented

Table 6

ANOVA* table for the liking and consumption level parameters of the products stimuli.

Effects*	Chocolate			
	Liking		Consumption level	
	F Value**	Pr > F**	F Value**	Pr > F**
Participant	1.601	0.009	0.976	0.538
Culture	15.734	0.000	0.201	0.654
Context	29.102	< 0.0001	8.474	0.004
Culture*Context	19.746	< 0.0001	2.981	0.032
Potato chips				
Participant	1.505	0.022	1.364	0.062
Culture	1.225	0.270	6.756	0.010
Context	1.313	0.253	0.013	0.908
Culture*Context	1.209	0.308	3.538	0.016
Yogurt				
Participant	1.021	0.4514	1.180	0.207
Culture	0.463	0.497	17.773	< 0.0001
Context	10.332	0.002	23.669	< 0.0001
Culture*Context	3.634	0.014	15.414	< 0.0001

* ANOVA = Analysis of variance [culture groups (Brazilian and Spanish participants), 2 situations of context (without and with context)].

** F value = Mean square/Mean square error. Effects were considered significant when the probability $Pr > F$ was < 0.05 (Bolded F-values and probabilities).

high average scores with values above “like slightly” in a 7-pt scale. The average presented by Brazilians for chocolate (6.05 ± 1.09) was significantly higher ($p < 0.05$) compared to Spaniard responses (5.12 ± 1.62). On the other hand, the liking scores presented by Brazilians and Spaniards in the evaluation of potato chips and yogurt showed no significant differences between them (5.67 ± 1.12 vs 5.47 ± 1.01 and 5.14 ± 1.57 vs 4.97 ± 1.14 , respectively).

Significant Pearson (r) correlation ($p < 0.05$) coefficients between consumption level and liking scores given by Brazilians were obtained for chocolate ($r = 0.47$), potato chips ($r = 0.27$) and yogurt ($r = 0.58$), while for Spanish participants only significant correlations ($p < 0.05$) were found for chocolate ($r = 0.33$) and potato chips ($r = 0.23$). All reported correlations were positive.

The Principal Coordinate Analysis (PCoA) of the emotion terms elicited in relation to the liking scores is shown in Figs. 5–7 for each culture. For chocolate stimulus in Brazilians participants (Fig. 5A) liking was associated with *good-natured*, *happy*, *relaxed*, *warm* and *affectionate*, and in Spanish participants (Fig. 5B) liking of chocolate stimulus was characterized by emotions as *fun*, *happy*, *pleasant*, *comfortable* and

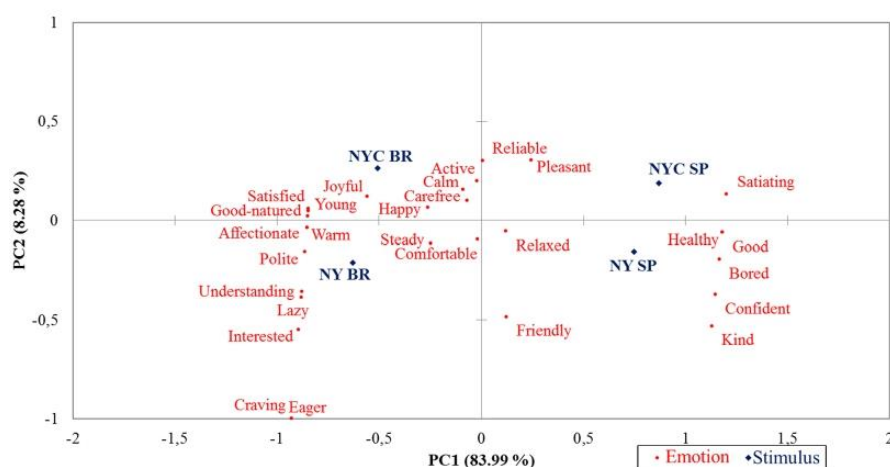


Fig. 4. Correspondence analysis (CA) of CATA terms (emotions) frequencies for yogurt stimulus (NY) in both cultures (Brazil-BR and Spain-SP) under both evaluation conditions (without and with evoked context-C).

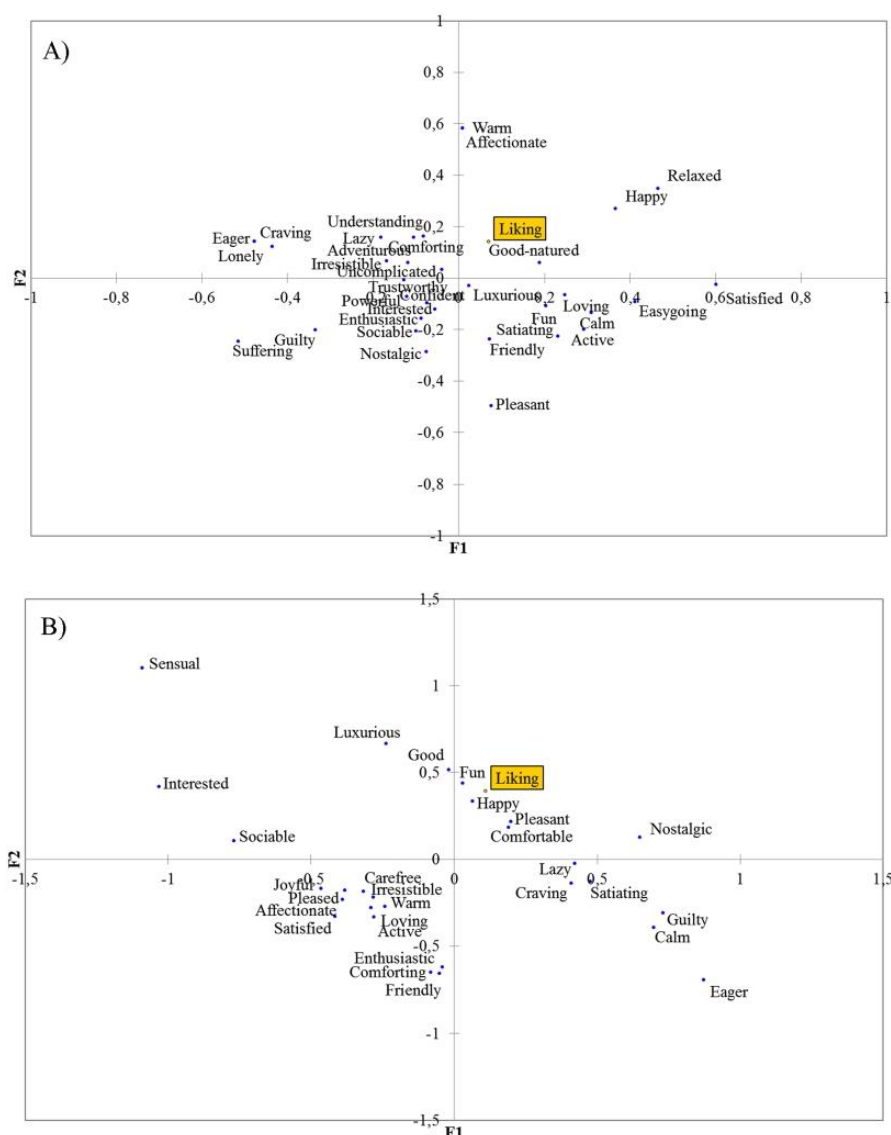


Fig. 5. Principal coordinate analysis of the emotion terms with the liking scores for chocolate stimulus for Brazilians (A) and Spaniards (B).

nostalgic. For potato chips stimulus, Brazilian participants associated liking with *hungry* and *active* (Fig. 6A), and Spanish participants with *accompanied* and *guilty* (Fig. 6B). Finally, for yogurt stimulus, Brazilian participants (Fig. 7A) associated liking with *reliable*, *satisfied*, *comfortable*, *calm*, and Spanish participants (Fig. 7B) with *kind*, *friendly*, *confident* and *good*.

4. Discussion

4.1. Influence of cultural background on the evoked emotional response to different food stimuli

The development of the emotional lexicon, using the CATA approach, allowed participants to intuitively select the emotional terms that they considered relevant when they were stimulated by the picture and name of the selected food categories. According to the emotional

lexicon developed by Brazilian and Spanish participants, the idiosyncratic nature of the emotional responses evoked by the different food categories was highly impacted by culture. The less emotional response obtained for Spaniards compared to Brazilians participants could respond to the previously reported “emotionally closed-off” nature of the Spaniards against the “emotionally expressive” nature of Brazilians.

First, comparing the emotional response to the different stimuli, some particular foods seemed to be “more emotional” than others. For example, the magnitude of the emotional response to ‘chocolate’ and ‘potato chips’ stimuli (name and picture) was greater than that evoked by the ‘yogurt’ stimulus, regardless of the culture. This can be explained because these products (chocolate and potato chips) are not necessarily consumed for their nutritional value, but rather, as an emotional eating strategy or to satisfy cravings (Parker, Parker, & Brotchie, 2006). On the other hand, the ‘yogurt’ stimulus had possibly a lower magnitude of the emotional response as it has been associated with healthy connotations.

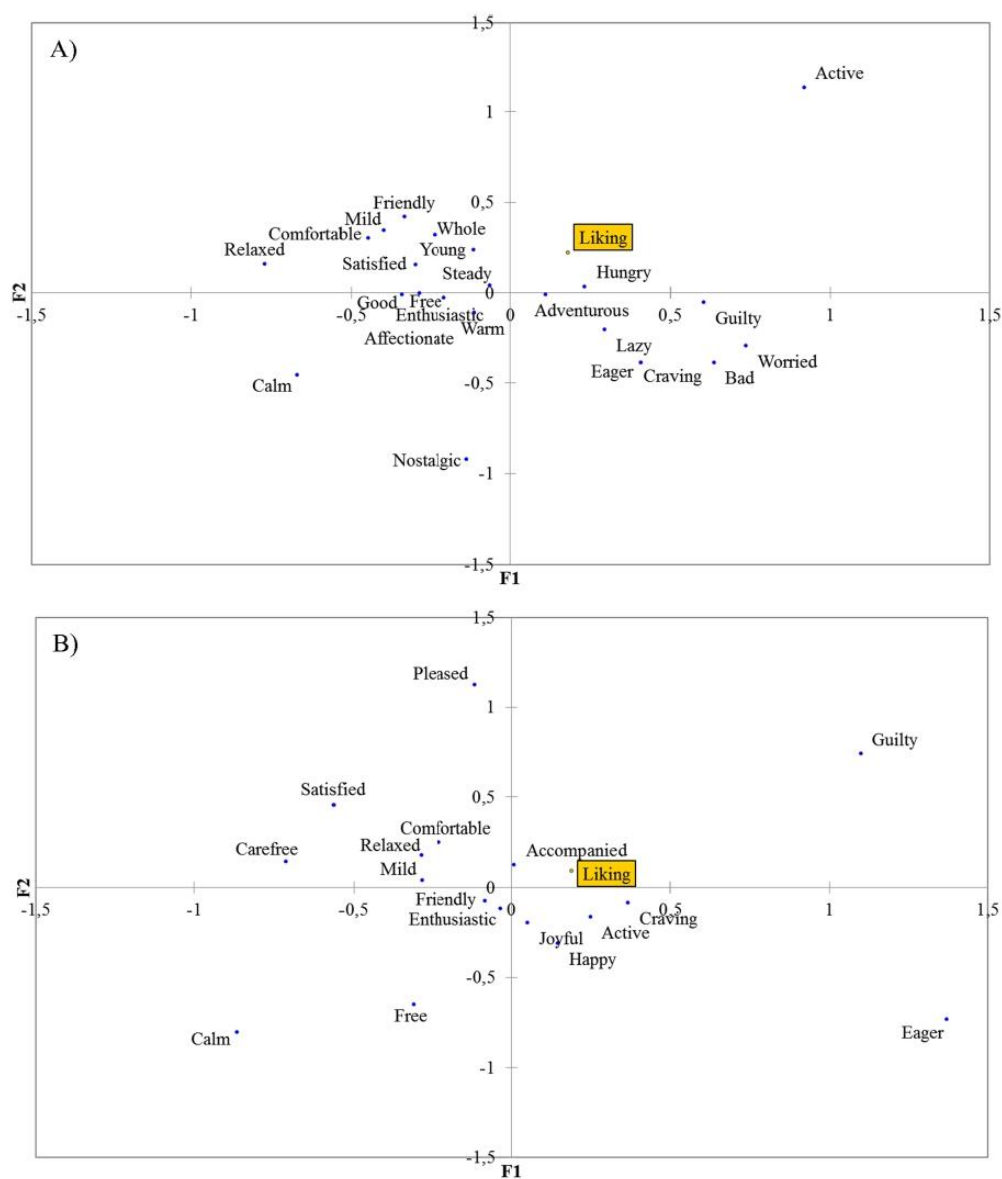


Fig. 6. Principal coordinate analysis of the emotion terms with the liking scores for potato chips stimulus for Brazilians (A) and Spaniards (B).

In fact, and particularly for Spaniards, the emotion term *healthy* was highly mentioned in yogurt emotional profile.

Among the emotional terms evaluated, 15 were common to all food stimuli, but only 6 were also common to both cultures (*active*, *calm*, *carefree*, *friendly*, *pleasant*, *satisfied*). The emotion term *friendly* for example, is not present in the published EsSense25® emotions list, but it has been extensively reported in previous studies evaluated similar products, as apple and chocolate brownie by Spaniards (Piqueras-Fiszman & Jaeger, 2014c), fruit salad by Italian participants (Manzocco, Rumignani, & Lagazio, 2013), potato chips by New Zealand participants (Piqueras-Fiszman & Jaeger, 2014a), and yogurt by Dutch (Mojet et al., 2015). The absence of this term in this procedure reveal a potential lack of efficiency of this list of emotional terms to fully compile the elicited emotional response to food. For that reason, we would recommend a

previous validation step of the list of emotional terms even if the purpose is to apply a pre-defined list as the EsSense25. It is obvious that the creation of an own emotional lexicon allows obtaining a more complete and realistic description of the emotional response. Therefore, it would be highly recommended to include a lexicon development step particularly in studies with different culture background participants as in the present study.

In a study carried out by Cardello et al. (2012) the name 'chocolate' significantly evoked greater intensities of emotional response to the terms *active*, *affectionate*, *happy*, *loving* and *satisfied*. In the present study, these terms were also noticeably present in the evoked chocolate emotional profile reported by both cultures, Brazilians and Spaniards. *Pleased* and *happy* emotions, for example, were also cited by Australian participants with high frequency for 'chocolate' and 'potato chips'

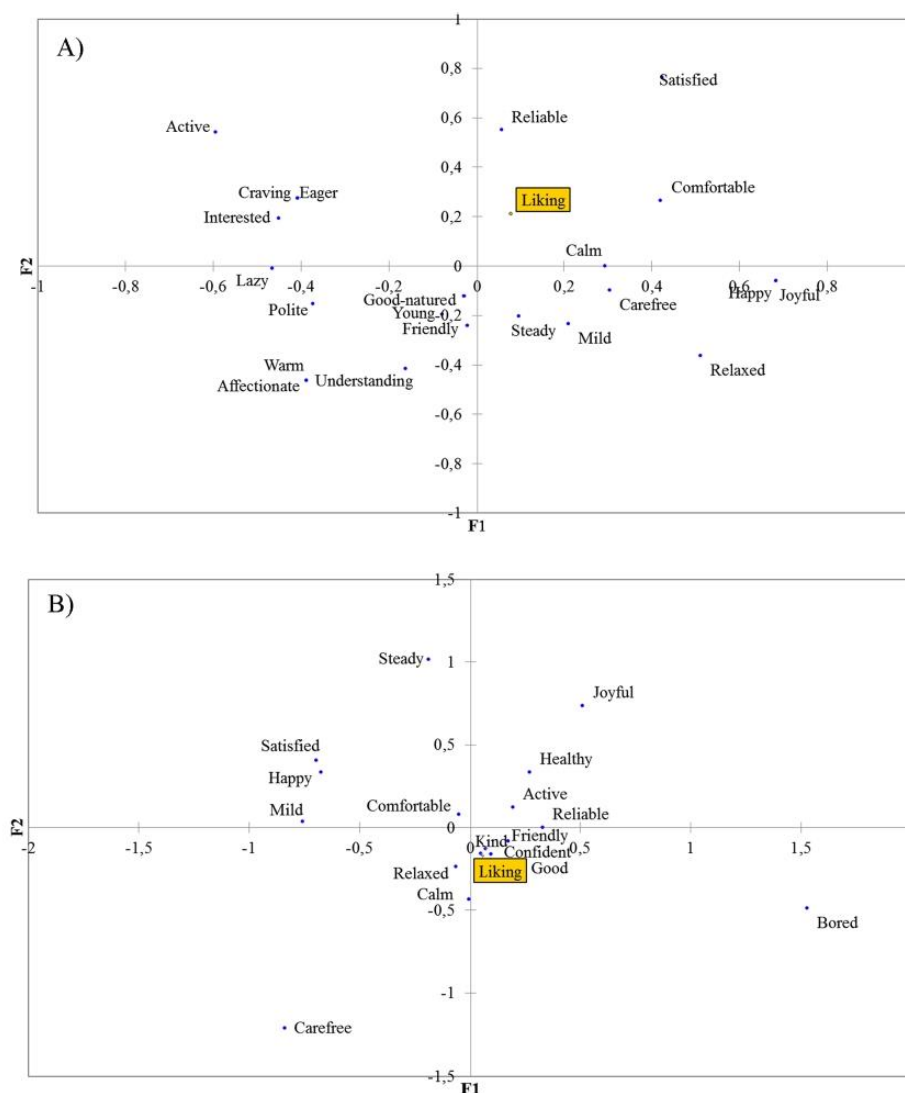


Fig. 7. Principal coordinate analysis of the emotion terms with the liking scores for yogurt stimulus for Brazilians (A) and Spaniards (B).

(Torrico et al., 2019). However, in the present study, these previous emotions varied according to the product or were simply not selected by at least one culture. In the studies carried out by Piqueras-Fiszman and Jaeger (2014c) the emotion terms *adventurous*, *disgusted*, *happy*, *joyful*, and *steady* were highly cited by New Zealand participants for potato chips. In the present study, *adventurous* and *steady* were present in the emotional lexicon elicited by the Brazilian participants and *happy* and *joyful* in the vocabulary elicited by Spanish participants.

It is noticeable that although almost all of the most frequent emotional terms are positive, each culture developed a different emotional profile. According to the evidences stated in the review published by Lindert, Bain, Kubzansky, and Stein (2015), positive feelings are an important dimension of well-being, especially when investigating well-being in relation to food and beverages (Sulmont-Rossé, Drabek, Almlí, van Zyl, Silva, Kern, & Ares, 2019). This scenario is also evidenced by a study described by Ares et al. (2015), where Brazilians and Spanish participants reported affection-related emotion terms such

as *pleasure*, *happiness*, *enthusiasm*, *satisfaction* and *calm* when asked to describe emotional terms related to well-being.

4.2. Free elicited contexts contribute to the emotional response evoked by different food stimuli

The developed contexts for each product category were judged to be appropriate by participants of both cultures. This is convenient because, although the freely defined scenario seems to be highly individual, large groups of people can share the same idealized situation, as they can be commonly influenced by learning, culture and society (Dorado et al., 2016). This was an advantage of the present study, as it is known that a predefined scenario exhibits the risk that participants will not consider this specific scenario appropriate to the consumption of the evaluated foods and, therefore, the emotional response may vary (Piqueras-Fiszman & Jaeger, 2015).

Interestingly, even considering different cultures, the evoked

contexts have in common the dimension social setting 'family' (except for chocolate for Brazilians), the dimension location 'home' (except for potato chips for Brazilians), suggesting that for both cultures the family interactions are important. In addition, the dimension of hungry state 'hunger' (except for chocolate for Brazilians), which are present at the beginning of snack consumption, is an obvious physiological reason that determines the dietary pattern of a living organism in a particular environment (Bellisle, 2014).

The results indicate that the evocation of a context would influence the emotional responses to different product stimuli. However, not many emotion terms showed a significant difference in the frequency of selection between conditions (with and without context). This may indicate that at the time of the non-context evaluation assessment, the participants associated the evoked emotional terms with the food stimuli by recalling their previous experiences in contexts that possibly contained similar or equal dimensions described in the context condition. On the one hand, the context itself may have influenced the frequency of citing some emotion terms, and on the other hand, the stimulation of a four-dimensional context may have caused the inadequacy of at least one dimension, changing the profile of emotions recalled between the two conditions. In the one dimension approach, for example 'time' (e.g., breakfast, lunch, or dinner), the emotion associations can greatly differ when the products are imagined to be consumed in one context or another (Piqueras-Fiszman & Jaeger, 2015).

In the evaluation of chocolate stimulus, 8 terms were significantly most cited by Brazilians and three by Spanish participants in the no-context condition, whereas the rest of the emotion terms showed no significant difference between the evaluation conditions. This means that the impact of the evoked context on the frequencies of the emotional responses of the Brazilian participants is greater in relation to the Spaniards' responses. It is worth mentioning that the frequency of the negative emotion terms, *suffering* and *lonely*, decreased even though there was no significant difference between the conditions. This whole scenario was easily visualized in the correspondence analysis (Fig. 2), where even though each condition was positioned in different quadrants, the conditions evaluated by the Spaniards were close. Another divergence in the impact of the context between both cultures was in relation to the number of associated terms for each condition. While in the evaluation carried out by Brazilians, fewer emotions were associated with chocolate in the evoked context situation, the opposite result was found for Spanish participants, who reported more emotion terms associated with chocolate under the context condition. However, it does not mean that the context negatively influenced the emotions reported by Brazilians, because the terms remained mostly positive.

The impact of context evocation on the evaluation of potato chips curiously led to a significant decrease in *friendly* and *relaxed* citation by Brazilians and in *active* and *joyful* mention by Spanish participants. The reduction in the frequency of these positive terms may have been caused by the inadequacy of some dimension that made up the context. In the correspondence analysis (Fig. 3) the emotional profile, besides the culture, was found to be influenced by the context evocation. In addition, it is possible to see that negative terms as *lazy* and *worried* were more associated by Brazilians with potato chips in the evocation context condition although most of the terms associated to this situation were positive emotions.

The effect of context evocation on the evaluation of yogurt by Brazilians was different in relation to the other food stimuli. Two terms (*eager* and *craving*) were never cited under this condition. Moreover, under context condition, Brazilians more frequently selected positive emotion terms and less negative ones (non-significant differences). The correspondence analysis (Fig. 4) illustrates that for both cultures, only positive terms were associated with yogurt under context condition, while *lazy* and *bored* (negative) were cited by Brazilians and Spaniard respectively in the non-context situation. All of these results indicate that the presence of the context may have caused a more positive effect on the emotional responses evoked by this food stimulus, mainly due to

the absence of associated negative terms.

According to literature (Mojet et al., 2015), the prediction of the influence that a given consumption context could have on the emotional profile of a product is not always feasible and some discrepancies regarding the context effect has been described. However, our findings emphasize that the use of a context freely elicited by participants from different cultural backgrounds, according to the product's stimulus, can positively assist in this prediction.

It is important to notice that the low frequencies (<5%) shown for several of the emotion terms in the evoked context condition, do not suggest that these terms are irrelevant for this product category, but under this consumption context. Therefore, they should still be considered for the construction of future questionnaires related to emotion for these product categories.

4.3. Emotions as "drivers" of liking and correlation with consumption level

We consider that a key factor to measure the emotions associated with a product or product category is to know whether the consumer is a frequent consumer of this product. This is because previous studies indicate that the emotion evoked by the food is a crucial factor in predicting the consumer's food preference (Kaneko, Toet, Brouwer, Kallen, & van Erp, 2018). For this reason, in this research we measure the level of liking and the level of consumption. The liking of the evaluated products presented scores ≥ 5 (7-pt scale) for both cultures, indicating that participants 'liked very much' all products. A significantly higher consumption level of chocolate among Brazilians, compared to Spaniards, showed a significant impact of culture on the consumption level of this product. A high consumption level was already expected for sweet and savory products like chocolate and potato chips, for both cultural groups, due to a universal consumer trend, even though there are individual differences between people based on the degree of personal interest in certain foods (Birch, 1999; Xie, Bagozzi, & Østli, 2010).

The relationship between liking and the emotional terms was affected by the food stimuli evaluated and the culture (Figs. 5–7). Participants expressed positive emotions for the chocolate stimulus, neutral and positive for potato chips, and positive for yogurt, in relation to the degree of liking. Overall, liking was clearly associated with positive emotions for all products. However, these terms are not necessarily the most frequently cited emotions for each food stimulus. Previous studies indicate that the expected liking (name of stimulus) appears to have no effect on the projected mood after consumption (tasting of stimulus) (Spinelli & Jaeger, 2019). This indicates that the emotional associations obtained in this study of each culture have a strong influence of memory, and therefore, the emotions measured with the stimuli of the product (name and picture) may be able to predict the expected liking of a given product.

Consumption levels were influenced by culture in potato chips and yogurt stimuli. The correlations between liking degree and consumption level were significantly positive regardless of the culture for chocolate and potato chips. However, it was dependent on the culture for the yogurt product, presenting the same correlation profile only for Brazil. For both cultures, Brazilians and Spaniards, the higher the level of consumption, the higher the degree of liking for chocolate and potato chips. As they are common and culturally appropriate foods, it is proved that the previous sensory experiences were enough for the process of learning to accept these food products, as suggested by Tan et al. (2015).

5. Conclusions

Results from the present work provide the emotional lexicon and elicited contexts of consumption for three product categories (chocolate, potato chips and yogurt) in a cross-cultural approach. The same food stimulus was associated with different emotional profiles depending on the culture and the elicited contexts. For both cultures, the presence of

an evoked context affected the frequency of mention for some terms without influencing the positive profile of emotional associations. In addition, degree of liking and consumption level was positively correlated regardless the cultural interactions for chocolate and potato chips. In general, this study revealed the need for the development of an emotional lexicon for different product categories and different cultures and that the presence of a context can help to obtain emotional responses closer to those that consumer would feel in a real condition. Therefore, these findings can assist in predicting consumer choices and preferences, offering new possibilities to be explored in marketing messages for interventions or product stimuli that drive food choices. The dimensions which have been used in this study for describing the elicited contexts (alone, afternoon, at restaurant, hungry etc.) for each product (milk chocolate, potato chips and yoghurt) could be useful to design advertisement in each culture (Brazil and Spain) assisting to product marketers to generate a pertinent emotional response. Further research should be developed to assess the impact of different versions of the same product category and the scenario (real and imagined) with a cross-cultural perspective.

CRediT authorship contribution statement

Lary Souza Olegario: Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization. **Mario Estevéz:** Resources, Supervision, Writing - review & editing. **Alberto González-Mohino:** Validation, Formal analysis, Data curation, Writing - review & editing. **Marta Suely Madruga:** Resources, Writing - review & editing, Supervision, Project administration, Funding acquisition. **Sonia Ventanas:** Conceptualization, Resources, Writing - review & editing, Supervision, Project administration, Funding acquisition.

Acknowledgments

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001. National Council for Scientific Development (Conselho Nacional de Desenvolvimento Científico - CNPQ, Brazil) for the support to LSO through the PVE scholarships 208398/2017-1. This study was partly co-funded by FEDER and Junta de Extremadura (project IB16043). Authors gratefully thank all consumers for their participation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Compliance with ethics requirements

All procedures performed in this study involving human participants were approved on the ethical standards of the Delegation of the Bioethics and Biosafety Commission of the University of Extremadura (Delegación de Comisión de Bioética y Bioseguridad de la Universidad de Extremadura) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards with the register number 71/2016.7.

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.foodres.2021.110194>.

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ARTIGO V: INFLUENCE OF HEALTH CONSCIOUSNESS ON EMOTIONAL RESPONSE
TO HEALTH FOODS: A CROSS-CULTURAL STUDY WITH CONTEXT

O artigo será submetido ao periódico *Food Quality and Preference* (Qualis A1, Fator de impacto 4.842).

**INFLUENCE OF HEALTH CONSCIOUSNESS ON EMOTIONAL RESPONSE
TO HEALTH FOODS: A CROSS-CULTURAL STUDY WITH CONTEXT**

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13 **Abstract**

14 Reduction in sugar, salt and fat content in processed products is currently an important
15 consumer's concern. Understanding consumers' emotions evoked for these products are
16 important to provide an alternative approach to promoting healthy eating. The aim of this
17 work was to define the emotional response of consumers from different cultures evoked
18 by healthier versions of conventional products and to explore the impacts on hedonic
19 responses and health consciousness. Consumers, over 18 years old, from Brazil (N = 186)
20 and Spain (N = 152) participated in this cross-cultural study. Participants answered a
21 Health Consciousness Questionnaire, an emotional response checklist and self-reported
22 responses to the stimuli of conventional chocolate, potato chips and yogurt and their
23 versions with less sugar, salt and fat content, respectively. Brazilians associated more
24 emotional terms more frequently for all stimuli compared to Spaniards. However, both
25 cultures showed health consciousness close to "slightly agree", higher level of
26 consumption, liking and willingness to buy, and a higher frequency of positive emotional
27 terms for the stimuli of conventional products and lower for their healthier versions. The
28 term *active* showed a strong association with the highest levels of health awareness.
29 Although there are cultural differences, it was evident that knowledge of the consumer's
30 level of health consciousness associated with the emotional and self-reported responses
31 of any food stimulus, can assist strategic actions that activate the disposition of healthier
32 food consumption.

33 **Keywords:** culture; emotion term; liking; consumer health consciousness.

1. INTRODUCTION

Among the different reasons to purchase a food product, health consciousness is an important motive by consumers (Tuorila & Hartmann, 2020), which captures the concerns for their self-health status. Health consciousness has been largely studied for example in functional products (Chen, 2013), organic foods (Lim, 2020) in relation to a consumer preference for nutrition and health claims (Klopčič et al., 2020), eco-labeled products (Jin et al., 2020), and in different food matrices such as wine (Bazzani et al., 2020), or milk (Wu et al., 2020).

Nowadays, consumer's awareness about health is being one of the most important motivations in the food choice globally (Cunha et al., 2018). Healthy food products are increased its interest and demand due to the need to counter unhealthy eating that contributes to the increases of diseases, such as cardiovascular diseases or diabetes (Cheung et al., 2019; Rosi et al., 2017). The global obesity epidemic worsening each year Wang et al. (2020) and concurrently the perception that “what we eat affects our health” has been adopted by consumers as a dogma influenced by health professionals recommendations. In this context, the presence of “healthy” options for most food categories, labelled with “free-from” or “healthy choice”, is continuously increased to fulfill consumer demands emerging a new and expanded health-enhancing food market (Tuorila & Hartmann, 2020; Olegario, González-Mohino, Estévez, Madruga, & Ventanas, 2020).

However, there remains a concern to nudge consumers to adopt interventions for increase healthier choices (Cheung et al., 2019; Otto et al., 2019; Vecchio & Cavallo, 2019). Reductions of sodium, sugar, or fat, for example, are measures to reduce the risk and control the incidence of health issues, being associated by consumers in Brazil and Spain as healthy foods (Block et al., 2017; Doménech-Asensi et al., 2016). Although the

acceptability of this kind of products is usually lower, several studies show that these reductions do not show significant differences in their perception by consumers when original and healthier versions are compared (Delgado-Pando et al., 2019; Heck et al., 2019; Moriano et al., 2019; Nguyen & Wismer, 2019; Samuel et al., 2018; Q. J. Wang et al., 2019).

How consumers feel when a product is consumed also affects food choice (Hu & Lee 2019). These consciously experienced, subjectively focused and reportable feelings build the emotions generated by humans (Paul et al., 2020). Emotions have been defined as a mental state to which people assign a commonsense name (Coppin & Sander, 2016) affecting food choice and preferences and consumers behavior (Gutjar et al., 2015). According to the Motivational Theory Fowles (Fowles, 1994), and that described by other authors (Lanz & Brown, 2020), the emotional part plays an important role during consumer purchasing. Thereby, the study of the emotional response of consumers to food is becoming an important dimension of the purchase choice, due to the importance of the emotions evoked during the exhibition, consumption, and post-consumption of food (Prescott, 2017). Cultural differences play also an important role on food-generated emotions. Cross-cultural works have demonstrated that influence focusing on habits and languages (X. Hu & Lee, 2019; Torrico, Fuentes, et al., 2019; van Zyl & Meiselman, 2015, 2016). Therefore, given the above, a gap is identified in science regarding the lack of knowledge of the influence of health consciousness of different cultures on emotional and hedonic responses to healthier food stimuli.

Thus, this research had as main objectives: i) assess the levels of health awareness of consumers from different cultures (Brazilian and Spaniard); ii) identify the emotions that are evoked by these consumers when thinking about consuming healthier versions of different products (chocolate, potato chips and yogurt) within a context; iii) measure the

influence of each product category and its versions on self-reported responses; iv) correlate health awareness levels with emotional responses and self-reported responses. The results can provide valuable information and become a competitive advantage for positioning food companies.

2. MATERIAL AND METHODS

2.1. Products stimuli

Three categories of commercial products were evaluated: chocolate, potato chips and yogurt. Conventional (Milk Chocolate-MC, Potato chips -PC and Natural Yogurt -NY); and healthy versions (Dark Chocolate-DC, Low sodium Potato chips LS-PC) and Natural Nonfat Yogurt (NF-NY) were considered. All products undergone the same evaluation protocol. Pictures of each food category item were showed to the participants in all questionnaires. Consumers' emotional responses/associations to food stimuli are similar if picture or real food is using as stimulus (Cardello et al., 2012).

2.2. Subjects

A cross-cultural study was carried out in two different countries, Brazil and Spain. The known Mediterranean diet, emerged as a model of healthy diet, consisting of vegetables, fresh fruits, olive oil, seafood, seeds and cereals, is the most extended among Spanish consumers (Díaz-Méndez & Gómez-Benito, 2010; Medina, 2019). The eating habits of Brazilian culture consist in the consumption of rice, beans, pasta, vegetables, fruits, tubers, bread, meat, milk, cheese, eggs, coffee, teas and juices (Brasil, 2014). In addition to differences in terms of the level of human development (UNDP, 2019), Brazil differs from Spain in relation to appreciate “health” claims (Gaspar et al., 2020).

Participants were recruited by email and invited to complete a questionnaire designed using Google forms (Google L.L.C., Mountain View, California, USA). Students and

employees from the Federal University of Paraiba responded to questionnaires and students and employees from the Universidad de Extremadura on the participated in Spain. A total of 338 participants [55% Brazilian and 45% Spanish] balanced between male and female in the age group of 18 to 60 years answered the online questionnaires.

Participants were informed of the objectives and voluntary nature of participation in the research. Only those who declared to consent to the terms and those who declared to be consumers of the products studied (chocolate, potato chips, and yogurt) answered the questionnaire. The socio-demographic characteristics of the subjects participating in the online study are showed in Table 1.

2.3 Emotional terms

The emotion lexicon evoked by each country for each product category was developed and validated in a previous study (Olegario et al., 2021). In total 29 emotional terms were generated by Brazilian for chocolate, 24 for potato chips and 20 for yogurt. 24 emotional terms were generated for chocolate, 24 for potato chips and 14 for yogurt by Spanish participants (Table 2). The order of emotion presentation was randomized among consumers to avoid terms presentation order effects.

2.4 Questionnaire design

2.4.1 Health Consciousness Questionnaire (HCQ)

After the demographic data of the participants were collected, a Health Consciousness Questionnaire (HCQ) was applied containing 8 questions covering the dimensions of Health Self-consciousness and Health Responsibility (C. S. Hu, 2013): A) I reflect about myself a lot; B) I am very self-conscious about my health; C) I am constantly examining my health; D) I am very involved with my health; E) I am aware of the state of my health as I go through the day; F) I am responsible for maintaining a healthy body weight; G) I

should take care of myself to prevent disease and illness; H) My health depends on how well I take care of myself. Response format was a 6-point Likert scale from 1 (strongly disagree) to 6 (strongly agree) according to (C. S. Hu, 2013).

2.4.2 Emotional and hedonic response

The Check-all-that-apply (CATA) has been applied to get the emotional responses because it is considered not too exhaustive as each participant may have to complete multiple emotion questionnaires. At the beginning of the product-specific questionnaire, participants were presented with the product picture and asked about the frequency of consumption with a 5-point categorical scale from 1 (less than once a month) to 5 (once a day or more). After a written contextualization was shown to evoke the specific product consumption by the following sentence: “Imagine that you are experiencing the following situation and answer the questions as realistically as possible”.

The situational/contextual dependence of consumer responses to food products implicitly entails an appraisal of product-context appropriateness (Piqueras-Fiszman & Jaeger, 2014). The appropriate context of consumption elicited by Brazilians and Spanish in previous studies for chocolate, potato chips, and yogurt categories were used (Olegario et al., 2021). Right after, participants were instructed to check all emotions were applied (CATA) when consuming each product at each evoked occasion: “What are the emotions you feel when consuming (milk chocolate/chocolate with 55% cocoa; salted potato chips/low salt potato chips; plain yogurt/plain yogurt with 0% fat) in this context?”. Participants could also suggest additional terms with the “other” option. The order of emotion presentation was randomized among participants.

Finally, after selecting the emotions evoked by each product within a context, participants were asked to indicate how much they liked the food using a 7-point hedonic scale from

1 (I dislike very much) to 7 (I like very much) and the willingness to buy using a 5-point scale from 1 (I would definitely not buy it) to 5 (I would definitely buy it). The list of emotions was shown first to avoid any effect of liking on the emotional responses (King et al., 2013). The emotional response under a “evoked context” is not the same than under “experienced context” but, evoking consumption contexts is a common tool used in sensory studies to help respondents 'frame' their responses and easily approach to a real consumption situation (Hein et al., 2010, 2012).

2.5 Data Analysis

The results of Health Consciousness Questionnaire, consumption level, liking, and willingness to buy data were analyzed using Wilcoxon test out of two paired samples (same culture or between culture) associated with Two-tailed tests significance level of $p \leq 0.05$. Analysis of variance (ANOVA) using the 5% level of significance was applied, considering the effects of gender (male, female), cultures groups (Brazilian and Spanish participants) and food item stimulation (conventional and healthier).

Pearson correlation coefficients (r) among Health Consciousness with the consumption level, overall liking and willingness to buy responses were estimated.

In order to investigate the effect of the product version on the emotional responses, Cochran Q-tests were performed for each of the emotions to explore differences between the frequency of mention of each emotion term among the products in each culture. For the CATA frequency data, Correspondence Analysis (CA) was used to assess the differences among the food items relative to the selection of the emotion terms, and the Principal Coordinate Analyses (PCoA) was applied to the correlation coefficients to visualize similarities between emotions evoked for each food category and Health Consciousness scores.

All statistical analyses were performed using XLSTAT 2014 (Addinsoft, Paris, France).

3 RESULTS

3.1 Health Consciousness of participants

Health Consciousness of participants in each culture was assessed taking into account two dimensions, Health Self-consciousness and Health Responsibility (C. S. Hu, 2013). The results of Health Consciousness Questionnaire for both cultures are shown in Figure 1. For the item “I reflect about myself a lot” there was no significant difference ($p < 0.05$) between cultures, with averages of 3.87 ± 1.08 and 3.63 ± 1.01 of Brazilian and Spanish participants, on the 6-point Likert scale (1-strongly disagree to 6-strongly agree). However, for the items “I am very self-conscious about my health” and “I am constantly examining my health” and “I am aware of the state of my health as I go through the day”, Brazilian participants had significantly higher values (4.30 ± 1.41 , 3.11 ± 1.57 and 2.07 ± 1.03 respectively), while Spanish participants presented significantly higher values for “I am very involved with my health” category (3.46 ± 1.28). Regarding the items related to Health Responsibility (Figure 1), Brazilian participants also had significantly higher means for “I should take care of myself to prevent disease and illness” and “My health depends on how well I take care of myself” categories compared to Spaniards with values 4.88 ± 1.49 and 5.04 ± 1.40 respectively. There was no significant difference for “I am responsible for maintaining a healthy body weight” category with means of 3.71 ± 1.63 and 3.95 ± 1.48 of Brazilian and Spanish participants respectively. Finally, mean value of the Health Consciousness questionnaire (average of the two dimensions evaluated) showed no significant difference between cultures ($p > 0.05$), with values of 3.86 ± 0.93 and 3.28 ± 0.93 of Brazilian and Spaniard respectively.

3.2 Self-reported responses (consumption level, liking, willingness to buy)

Results of consumption level, liking and willingness to buy variables for each food stimuli in each culture (Brazilian and Spaniard) is show in Table 3. For both cultural groups, the

conventional products had a significantly higher consumption level (above “one or more times a month” in the frequency of consumption scale) compared to healthier version of the same food stimuli. Similarly, higher liking scores were obtained for conventional compared to healthy versions in all food stimuli in both cultures, although for chocolate these differences were not significant. Finally, both cultures reported a significantly greater willingness to buy for the conventional version of yogurt than for the healthy version and Spaniards also for the conventional version of potato chips.

The analyses of variance (ANOVA) for the self-reported responses (consumption level, liking and willingness to buy) of the food items are shown in Table 4. The gender effect (male or female) is not significant ($p > 0.05$) for any parameter. The Culture effect (Brazilian and Spanish) was significant ($p < 0.05$) for consumption level of the yogurt product, for liking of the chocolate product, and for willingness to buy of the chocolate and potato chips products. The product (conventional and healthier) effect was significant ($p < 0.05$) for consumption level of chocolate, and for consumption level, liking and willingness to buy of potato chips and yogurt. The interaction (culture*product) effects were significant ($p < 0.05$) for consumption level, liking and willingness to buy of all products.

The Table 5 showed the correlation (r) of Health Self-consciousness and Health Responsibility score in respect of consumption level, liking and willingness to buy for each sample and culture. Brazilian participants had a higher number of significant ($p < 0.05$) among Health Self-consciousness all variables for Plain Yogurt (YN) and Spanish participants among consumption level of PS and liking of YF. Brazilian participants, Health Self-consciousness was positively correlated to consumption level of CM, YN and YF, and negatively of CD, PC, PS, was positively correlated to liking of CM, PS, YN, YF, and negatively of CD, PC, and was positively correlated to willingness to buy of PS,

YN and YF, and negatively of CM, CD and PC. Spanish participants, Health Self-consciousness was positively correlated to consumption level of CD, PC, PS, YF, and negatively of CM and YN, was positively correlated to liking of CD, PC, YF, and negatively of CM, PS, YN, and was positively correlated to willingness to buy of PC, YN, and negatively of CM, CD, PS, YF.

3.3 Emotional response evoked by conventional and health stimuli versions

Figure 2 shows the frequency of emotion terms selected (as % of participants) for each chocolate stimuli. The most frequent emotions (>30%) reported by Brazilians (Figure 2A) were *happy*, *relaxed*, *satisfied* for Milk Chocolate and *satisfied* for Dark Chocolate. Significant differences in the frequency of mention were obtained between milk and dark chocolate for *craving*, *eager*, *fun*, *happy*, *nostalgic* and *relaxed*. The most frequent emotion terms (>30%) evoked for Spanish (Figure 2B), were *comfortable*, *pleasant* and *satisfied* for Milk Chocolate and *comfortable* and *good* for Dark Chocolate. Significant differences (frequency of mention) were obtained for *luxurious* and *satiating* emotions presented between the two chocolate stimuli versions, milk vs dark.

Correspondence analysis bi-plot (Figure 3) shows both chocolate stimuli (milk vs dark) evaluated by both cultures (Brazil and Spain) in relation to the emotion terms evoked using CATA questionnaire. The principal components one (PC1) and two (PC2) accounted for 85.42% and 10.33%, respectively, explaining a total of 95.75% of the data variability. As shown in Figure 3, emotional profiles associated to chocolate stimuli (milk and dark) were clearly different depending the culture. Brazilian participants, associated Milk Chocolate with *happy*, *craving*, *friendly*, *affectionate*, *lazy*, *confident*, *relaxed*, *good-natured*, *eager* and *fun* emotion terms, while Spanish participants reported *calm*, *comforting* and *sociable*. Dark Chocolate were associated with *satiating*, *active*, *satisfied*, *loving*, *luxurious*, *trustworthy*, *enthusiastic*, *easygoing*, *powerful* and *understanding*

emotions for Brazilian participants whereas for Spanish this stimulus was related to *good*, *carefree*, *comfortable*, *irresistible*, *pleasant*, *guilty*, *lonely*, *warm* and *nostalgic* emotions.

The frequency of emotion terms selected (as % of participants) for each potato chips stimuli is showing in Figure 4. The most frequent emotion terms (> 30%) selected by Brazilians (Figure 4A) for Conventional Potato Chips were *hungry*, *pleasant* and *satisfied* and for Low Salt Potato Chips were *hungry* and *satisfied*. *Guilty*, *whole* and *relaxed* presented significant differences in the frequency of mention between conventional and health version (low salt) of potato chips stimuli. For Spaniards (Figure 4B), the most frequent emotions were *accompanied*, *comfortable* and *relaxed*, *comfortable* for Low Salt Potato Chips. Significant differences in *guilty*, *happy* and *relaxed* citations between conventional and healthy version of potatoes chips stimuli were obtained with Spanish participants.

The Figure 5 shows the Correspondence Analysis plot of the two version of potato chips stimuli in relation to the emotion terms evoked using CATA questionnaire by both cultural groups. The principal component one (PC1) accounted for 89.12%, and with the principal components two (PC2) explaining a total of 96.09% of the data variability. The Conventional Potato Chips were associated with the emotions *enthusiastic*, *free*, *lazy*, *worried*, *young* and *active* by Brazilian participants and with *happy*, *joyful*, and *accompanied* by Spanish participants. On the other hand, the Low Salt Potato Chips stimuli version was associated with *eager*, *craving*, *pleasant*, *satisfied*, *hungry*, *nostalgic*, *affectionate*, *good*, *warm*, *steady*, *bad* and *adventurous* terms by Brazilian participants and with *carefree*, *friendly*, *comfortable*, *calm* and *relaxed* terms by Spanish participants.

Figure 6 shows the frequency of emotion terms selected (as % of participants) for each yogurt stimuli. The most frequent (>30%) emotions cited by Brazilian participants for Plain yogurt stimuli were *comfortable*, *happy*, *joyful* and *satisfied*, and for Nonfat Plain

Yogurt stimuli were *satisfied*. *Comfortable, happy, joyful, pleasant* and *satisfied* were most cited in Plain Yogurt compared to conventional yogurt with significant extent Regarding Spanish participants. The most frequent emotions terms were *good, healthy* and *satisfied* but no significant differences in the frequency of mention between conventional and healthy yogurt version were obtained.

Correspondence Analysis plot Figure 7 shows the representation of the two version of yogurt stimuli in relation to the emotion terms evoked using CATA questionnaire by both cultural groups. The principal components one (PC1) and two (PC2) accounted for 72.86% and 22.29%, respectively, explaining a total of 95.15% of the data variability. For Brazilian participants, the conventional Plain Yogurt were associated with *polite, understanding, interested, lazy, steady, carefree, active* and *friendly* emotion terms, and Nonfat Plain Yogurt with *satisfied, calm, happy, joyful* and *good natured*. Similar emotional profiles were obtained for conventional and healthy yogurt stimuli for Spanish culture, with *healthy, bored, good, confident* and *kind* emotion terms being the most representative of both stimuli. In contrast, Brazilian's participants reported different emotional profiles for conventional and healthy version of yogurt stimuli as shown Figure 7.

3.4 Health consciousness and emotions terms

The Principal Coordinate Analysis (PCoA) of the emotion terms concerning the Health consciousness of the each product category is shown in Figure 8. The screen plot indicates that the two first dimensions are sufficient to interpret relationships between emotions. For the chocolate consumers (Figure 8A), the high Health consciousness score was associated with *pleasant, active, joyful, carefree, nostalgic* and *guilty*, emotion terms. On the other hand, low Health consciousness score was related to *affectionate, understanding, uncomplicated, lazy, good-natured, relaxed, easygoing, satiating* and

loving. For the potato chips consumers (Figure 8B), the high Health consciousness score was associated with *relaxed, active, pleased, happy, joyful* and *accompanied*, while low HCQ score was associated with *whole, warm, steady, affectionate, good, hungry, young* and *enthusiastic*. Finally, for the yogurt consumers (Figure 8C), the high HCQ score was related with *happy, active, joyful, young, affectionate* and *warm*. Still, low HCQ score was related with *friendly, comfortable, steady, reliable, calm* and *satisfied*.

4 DISCUSSION

4.1 Gender, Culture and product effects on self-reported responses (consumption level, liking, willingness to buy) of healthier products

Brazilians and Spaniards have higher consumption level, liking and willingness to buy for the stimuli of conventional products and smaller ones for their healthier versions. The gender can influence the relationship with food (Gaspar et al., 2020), however, in the present study, gender effect did not influence self-reported responses.

For both cultural groups, the consumption level is influenced for the version of product. This reflects the current world scenario of consumption habits, greatly influenced by the availability of food, in which they encourage the consumption of conventional products instead of the consumption of food in healthier versions. This was already expected, because, although there are already healthier versions of several product categories, these are still less available and generally have the highest price.

The stimulus of potato chips and yogurt, low salt and nonfat respectively, influenced the liking level of both cultures. Any substantial reduction in sodium content is likely to result in less acceptance of a product (Kongstad & Giacalone, 2020), and perhaps this is the first association made by the consumer when he receives the information stimulus of a product with low salt content. This indicates that the consumer certainly has less acceptability to the stimulus of a product reduced in salt, as occurred for the stimulus of low-salt potato

chips (PS). The loss of sensoriality generally caused by the reduction of salt shapes consumer preferences, despite having already been indicated by Torrico, Nguyen, et al. (2019) that it is possible to reduce NaCl by up to 40% without affecting consumer acceptability, thus requiring a higher level of information to consumers.

The total reduction of fat content in plain yogurt, can cause changes in texture and flavor characteristics (Coggins et al., 2008), no change in acceptability (Westcombe & Wardle, 1997). However, the stimulation of Nonfat Plain Yogurt resulted in less acceptance by participants of both cultures. Johansen, Næs, & Hersleth (2011), on the contrary, they found positive attitudes towards nonfat yogurt among Norwegian, Danish, and Californian consumers. These scenarios indicate that the loss of sensoriality by the reduction of the salt content and elimination of fat in these products is expected by consumers. To overturn these beliefs, it is necessary to educate consumers and develop healthier products that are able to maintain sensory characteristics at the same level of acceptability.

For chocolate versions this does not seem to affect. This does not mean that the reduction of sugar in the dark chocolate (CD) version does not influence the sensoriality, but that there is no information on the label that indicates this lower sugar content. The Culture effect influenced both liking and willingness to buy, with the highest levels recorded for Brazilians.

In general, the willingness to buy was influenced by the same effects that influenced the level of liking for all products, except for potato chips, which was influenced by the culture effect, being the highest level for Brazilians. The stimulus of the products did not include their price; however, it is known that consumer may prefer reformulated products reduced in fat, salt and sugar than commercial brands, but are not willing to pay more for it (Romagny et al., 2017).

4.2 Health Consciousness of each culture and the influence on consumption level, liking, willingness to buy of healthier products

The online Health Consciousness Questionnaire (HCQ) results showed that Brazilian and Spanish participants are similar in their health consciousness score, representing a level close to “slightly agree”. The correlations between these scores and self-reported responses are influenced differently in relation to culture and product. High health consciousness leads individuals to place greater importance on desirable (for example, vitamins, minerals) and undesirable (for example, saturated fat, sugar) nutrients (Hoefkens et al., 2011), that is, health consciousness is a substantial driver of healthy eating.

High levels of positive correlations stood out in the evaluation of the yogurt category for both cultures, indicating that the higher the health awareness, the higher the consumption level, liking and willingness to buy yogurt. Among the three product categories evaluated, yogurt is the only one considered to be a healthy and functional product. Previous studies have revealed that a high health consciousness group had higher willingness to use functional foods and acceptance (Bimbo et al., 2017; Chen, 2013), and that fat content does not influence acceptability (Bayarri et al., 2010). Since many years ago, low-fat and fat-free dairy products are preferred by consumers due to health benefits (Barr, 1990).

Chocolate is highly hedonic-liked, but the actual purchase or desire to eat chocolate varies across individuals and situations (Jiang et al., 2014). Health consciousness seems to be an individual factor that negatively influences the consumption level, liking and willingness to buy of both versions of chocolate in the responses of both cultures. This is because most of the correlations obtained between health consciousness and self-reported responses with the chocolate stimulus were negative. In a study by Gunaratne et al. (2019) it is clear that there is a greater preference for the conventional (sweet) version of

chocolate, however dark chocolate is the second most preferred by participants from Australia, attributing this to owing perceptions of the potential health benefits due to the antioxidants available in dark chocolate. There are actually some health benefits attributed to chocolate due to compounds contained in cocoa (Katz et al., 2011). Including, an extensive study by (Veronese et al., 2019) mapping 84 studies with chocolate consumers, weak evidence was found that chocolate consumption associated with lower cardiovascular disease death, acute myocardial infarction, stroke and diabetes. Moreover, as shown by a study in Germany people, persons eating more frequently chocolate had more frequently an unhealthier diet, e.g. they eat less frequently vegetables and fruits and introduce less amounts of fibers (Buijsse et al., 2010), which leads us to understand that chocolate consumption is not necessarily associated with a high health consciousness.

There are no studies that indicate health benefits associated with the consumption of potato chips. What exist are versions with less salt or fat content that give healthier characteristics to this product. Although there was a negative influence of the health consciousness level on the consumption level of both versions of potato chips (except for PC in the Spaniards' response), there was a positive influence for liking and willingness to buy. This result agrees with the findings of (Levis & Chambers, 1996) which indicated slightly higher overall liking scores when a concept (low-salt or low-fat) was associated with several versions of potato chips, than when the chips were tested without a concept.

For both cultures, the greater the health consciousness, the greater the willingness to buy low-salt potato chips. Danes too, even without intending to change their diet salt intake, have a high willingness to buy food products with reduced salt content (Mørk et al., 2019). Obese people with dissatisfaction with their body image are even more willing to pay

more for healthy potato chips (low-salt) than non obese people with dissatisfaction with their body image (de-Magistris et al., 2016).

All the results found indicated that consumer expectations and hedonic responses can be influenced by a variety of factors including health consciousness. This knowledge helps to understand that food stimuli can offer reliable responses to assess consumers' food preferences and behavior, even for different cultures. This is because, consumers' expectations of either sensory or hedonic characteristics can be generated by a variety of factors and play an important role in food selection and consumption (Bayarri et al., 2010).

4.3 Influence of culture on the emotional response evoked by conventional and healthier products

All emotions evoked by Brazilians and Spaniards were stimulated by a context, generated by participants from the same cultures in a previous study (Olegario et al., 2021), and assessed by them as appropriate for the consumption of each food category. Thus, participants more easily remember previous experiences directly relating to the emotions experienced.

It has been proven that different products evoke different emotions, which are also dependent on culture (Olegario et al., 2021). In addition, in the present study we found that Brazilian and Spanish participants had different selections of emotions terms for also for healthier versions of each product, with Brazilians associating more emotional terms with food stimuli. Really “greater emotionality” is a characteristic of Brazilian national identity, especially when compared to the supposed “closed nature” of some Europeans (Rezende, 2008), and this is probably reflected in dietary stimuli. However, both cultures registered higher positive emotional frequencies for conventional versions of the products. Brazilian participants expressed their more satisfaction with conventional

chocolate and yogurt, and Spaniards with conventional chocolate and potato chips make them feel “happy”. This term is more strongly associated with milk chocolate and plain yogurt in the evaluation of Brazilians, when compared with the responses of the Spaniards. As seen in the CA (Figure 3), happy and relaxed associated with conventional chocolate (milk chocolate) for Brazilian, but for Spaniard, *comfortable*, *pleasant* and *satisfied* does not differ between versions. For potato chips (Figure 5), other terms more frequent for Brazilians, such as *hangry* and *satisfied*, are not significantly affected when stimulated by the healthy version (low-salt), also for Spaniards in relation to the terms *comfortable* and *accompanied*.

The terms *satiating* and *luxurious* showed a higher frequency of citation for the milk chocolate version in the evaluation of the Spaniards, however these emotions were associated with dark chocolate in the evaluation of the Brazilians. These trends reflect cultural divergences between the common terms associated with these products. Still among the common terms evoked by both cultures in the evaluation of chocolate, *craving*, *loving*, *nostalgic*, *pleasant*, *satisfied*, *sociable*, *warm* stand out. These positive emotional responses seem to be due to the sensory pleasure experienced after consuming the chocolate bar (Macht & Mueller, 2007) remembered by both cultures.

Brazilians evoked eight more emotional terms for stimulating potato chips. *Satisfied* was the most prominent emotional term in the evaluation of Brazilians for both versions, while *comfortable* was for Spaniards. Despite the differences in the frequency of citing some emotional terms evoked by both cultures, *calm*, *guilty* and *pleasant*, they have a similar frequency. These terms were also associated with potato chips by participants from Belgium, noting that the statement of high kcal increased the intensity of *guilty* and had the opposite effect for terms *pleasant* and *satisfied* (Oliveira et al., 2020). These results

give us indications that the term *guilty* may be one of the most stimulated by the less healthy versions of potato chips for different cultures.

The emotional disadvantages usually presented for healthy food stimuli did not significantly affect the emotions evoked by the Spaniards for the two versions of yogurt. However, they selected a negative emotion (*bored*) for both versions with similar frequency. Among the other common terms, in addition to *happy*, selected by both cultures with the stimulus of yogurt, most (*active, calm, carefree, comfortable, relaxed, satisfied, steady*) were selected more frequently by Brazilians, with no difference in the selection of reliable, and less frequency of pleasant compared to Spaniards. It is clearly observed that the healthier version was less emotional than the conventional version in the evaluation of Brazilians, and in turn presented frequencies similar to those reported by Spaniards in the evaluation of the two versions. In the particular case of yogurt, these emotional responses to the fat-free versions vary according to the culture, but they may or may not vary according to the flavored added to the product, as demonstrated in the study by Mojet et al. (2015) with Germans.

4.4 Emotional terms associated with high Health Consciousness

High levels of health consciousness are not always converted into real consumption behaviors, however, the higher this level, the greater the willingness to consume healthier products. Therefore, knowledge of the emotional terms associated with health consciousness can be an indispensable tool for strategic actions that activate the consumption disposition of these consumers.

The relationship between Health Consciousness and the emotion terms was also different depending of the consumer group of chocolate, potato chips or yogurt (Figure 8). Among all the emotional, positive and neutral terms, which were most positively associated with

health consciousness, the term *active* is common for all stimuli. Unhealthy eaters produce stronger emotional responses to images of junk food (Yeghyan & Bailey, 2016), however, emphasizing positive emotions can be successful, encouraging changes in dietary patterns (Sulmont-Rossé et al., 2019). Therefore, the stimulation of positive emotions associated with the consumption of healthier products can induce both unhealthy eaters and healthy eaters to the consumption of a certain product category.

This gives us indications that *active* is the term most often associated by healthy eaters for these products. In other words, to encourage participants with greater health consciousness to consume chocolate, potato chips or yogurt, this emotional term must be excited, in addition to the specific emotions associated with each category. It is worth mentioning that in the particular case of potato chip consumers, the cultural effect influenced more strongly. This is because two terms of different valences have been associated with health consciousness, *active* (activation) and *relaxed* (pleasurable deactivation) (Jaeger et al., 2019). So, it is possible to affirm that the term *active* contributed positively in the association of Brazilians and *relaxed* in the assessment of Spaniards, in view of the emotional responses elicited by these cultures to this product (Figure 5). Chocolate, potato chips and yogurt are often consumed as snack products although the health perceptions for these product categories differ (Sosa et al., 2015).

5. CONCLUSIONS

The stimuli of conventional versions of chocolate bar, potato chips and plain yogurt products are more emotional than their healthier versions, but there is a variable impact on the responses of each culture. The “greater emotionality” characteristic of Brazilians reflects associations of more emotional terms and a higher frequency of citation in relation to Spaniards. The findings indicate that health consciousness can positively influence the frequency of consumption, acceptability and willingness to buy, mainly of a product

considered genuinely healthy, such as yogurt. Active was the emotional term identified as the main one to stimulate consumers with greater health consciousness in addition to the positive emotions associated with each category. Finally, food stimuli can provide reliable responses to assess consumers' emotions, preferences and eating behavior, even for different cultures. Future research must be developed using these emotional stimuli to induce healthy practices associated with greater food pleasure.

6. ACKNOWLEDGMENTS

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001". National Council for Scientific Development (Conselho Nacional de Desenvolvimento Científico – CNPQ, Brazil) for the support to LSO through the PVE scholarships 208398/2017-1. This study was partly co-funded by FEDER and Junta de Extremadura (project [IB16043](#)). Authors gratefully thank all consumers for their participation.

Declarations of interest

The authors declare no conflict of interest

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Table 1. Socio-demographic characteristics of the subjects participating in the online study.

	Brazil (%) N=186	Spain (%) N=152
Gender		
Female	48	44
Male	52	56
Age		
18 to 30 years	57	46
31 to 40 years	38	21
41 to 50 years	4	23
More of 50 years	1	10
Household compositions		
1	16	8
2	37	17
3	14	15
4	23	18
5	6	42
+5	6	0
Family income		
Less than a salary	3	2
Up to two salaries	7	23
Between 2 and 3 salaries	21	42
Between 3 and 5 salaries	17	17
Between 5 and 7 salaries	11	11
More than 7 salaries	41	6

Table 2. Emotional terms evoked by Brazilians and Spaniards in the evaluation for each product category.

Terms	Chocolate		Potato chips		Yogurt	
	Spain	Brazil	Spain	Brazil	Spain	Brazil
Accompanied			*			
Active	*	*	*	*	*	*
Adventurous		*		*		
Affectionate	*	*		*		*
Bad				*		
Bored						*
Calm	*	*	*	*	*	*
Carefree	*		*		*	*
Comfortable	*		*	*	*	*
Comforting	*	*				
Confident		*			*	
Craving	*	*	*	*		
Eager	*	*	*	*		*
Easygoing		*				
Enthusiastic	*	*	*	*		
Free			*	*		
Friendly	*	*	*	*	*	*
Fun	*	*				
Good	*			*	*	
Good-natured		*				*
Guilty	*	*	*	*		
Happy	*	*	*		*	*
Healthy					*	
Hungry				*		
Interested	*	*				*
Irresistible	*	*				
Joyful	*		*		*	*
Kind					*	
Lazy	*	*		*		*
Lonely	*	*				
Loving	*	*			*	
Luxurious	*	*				
Nostalgic	*	*		*		
Polite						*
Pleasant	*	*	*	*	*	*
Pleased	*		*			
Powerful		*				
Relaxed		*	*	*	*	*
Reliable						*
Satiating	*	*				
Satisfied	*	*	*	*	*	*
Sensual	*					
Sociable	*	*				
Steady				*	*	*
Suffering		*				
Trustworthy		*				
Uncomplicated		*				
Understanding		*				*
Warm	*	*		*		*
Whole				*		
Worried				*		
Young			*	*		*

¹ Terms based on Olegario et al (2021) study.

Table 3. Mean and standard deviation values* of the consumption level, sensory liking and willingness to buy parameters of each product for each culture (Brazilian and Spaniard).

Product	Consumption level**		Liking**		Willingness to buy**	
	Brazil	Spain	Brazil	Spain	Brazil	Spain
Milk chocolate	2.40±1.14	2.46±1.46	5.77±1.61	4.41±2.12	4.25±1.18	2.91±1.63
Dark chocolate	1.61±0.95	1.85±1.36	5.10±1.88	4.60±1.83	3.96±1.29	3.18±1.46
Potato Chips	1.94±0.99	2.02±0.97	5.65±1.40	5.29±1.35	4.15±1.11	3.58±1.35
Low-salt Potato Chips	1.46±0.68	1.51±0.89	4.62±1.53	4.11±1.61	3.79±1.23	3.00±1.48
Plain Yogurt	2.23±1.29	2.78±1.55	4.82±2.03	4.61±1.70	3.78±1.41	3.73±1.46
Nonfat Plain Yogurt	1.55±0.91	2.17±1.54	3.70±2.16	3.67±1.96	3.08±1.56	2.96±1.61

* Mean ± standard deviation values; ** Bold mean values were significantly different ($p<0.05$) between Conventional and Health products on the same culture.

Table 4. ANOVA* table for the consumption level, liking and willingness to buy parameters of each product stimuli.

Effects*	Consumption level**		Liking**		Willingness to buy**	
	F Value***	Pr > F***	F Value***	Pr > F***	F Value***	Pr > F***
<i>Chocolate</i>						
Gender	0.072	0.789	1.871	0.173	0.064	0.800
Culture	0.201	0.654	15.734	0.000	30.342	< 0.0001
Product	18.315	< 0.0001	0.800	0.372	0.001	0.974
Culture*Product	6.394	0.000	6.929	0.000	13.388	< 0.0001
<i>Potato chips</i>						
Gender	1.484	0.225	0.497	0.482	0.435	0.511
Culture	6.756	0.010	1.225	0.270	7.010	0.009
Product	19.984	< 0.0001	31.431	< 0.0001	6.707	0.010
Culture*Product	6.899	0.000	12.312	< 0.0001	8.132	< 0.0001
<i>Yogurt</i>						
Gender	0.777	0.379	1.179	0.279	0.286	0.594
Culture	17.773	< 0.0001	0.463	0.497	0.044	0.835
Product	12.455	0.001	15.330	0.000	13.070	0.000
Culture*Product	8.040	< 0.0001	5.182	0.002	4.394	0.005

* ANOVA=Analysis of variance [2 genders (male and female), 2 culture groups (Brazilian and Spanish participants), 2 product item stimuli (conventional and healthier)].

** Consumption level of different stimuli was assessed using a 5-point categorical scale (1= less than once a month, 5= once a day or more); Liking of different stimuli was assessed using a 7-point hedonic scale (1=dislike very much, 7=like very much). Willingness to buy of different stimuli was assessed using a 5-point categorical scale (1=less than once a month, 5=once a day or more);

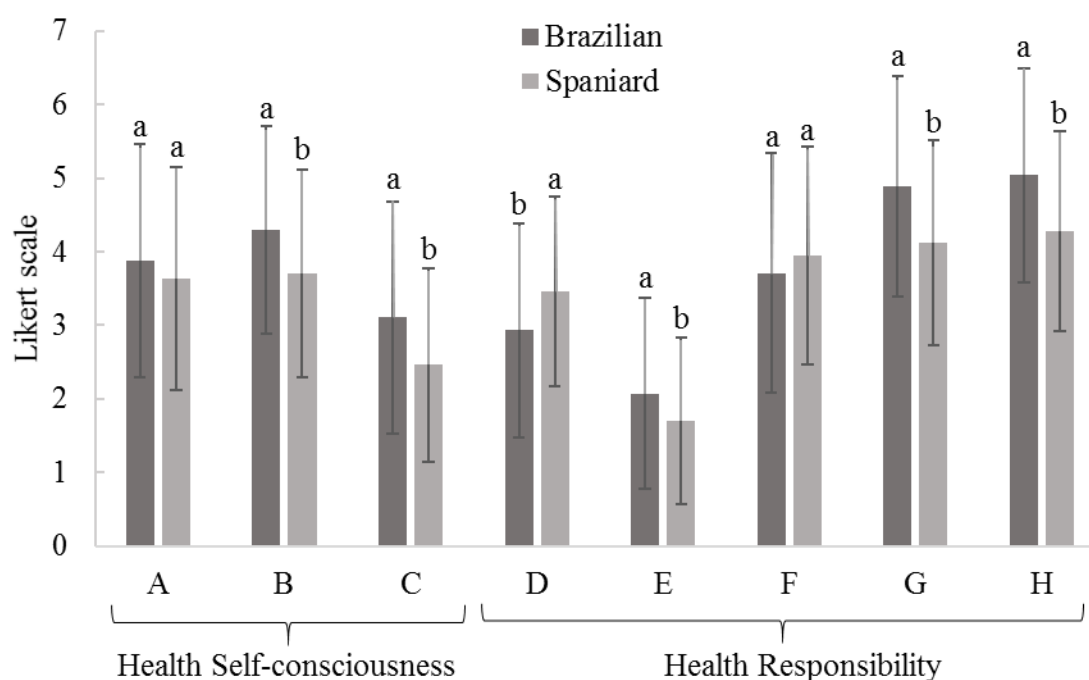
*** F value=Mean square/Mean square error. Effects were considered significant when the probability Pr > F was <0.05 (Bolded F-values and probabilities).

Table 5. Pearson correlation coefficient (r) among health-conscious score with consumption level, liking and willingness to buy for each sample and ethnicity.

Product	Health consciousness			
	Country	Consumption Level	Liking	Willingness to buy
Milk chocolate	Brazil	-0.0510	-0.0380	-0.0309
	Spain	-0.0737	-0.0850	-0.1047
Dark chocolate	Brazil	-0.0443	-0.0844	-0.0364
	Spain	0.1008	0.0123	-0.0130
Potato chips	Brazil	-0.1248	-0.1096	-0.2298
	Spain	0.1794	0.2229	0.0787
Low-salt potato chips	Brazil	-0.1168	0.0529	0.0409
	Spain	-0.0750	0.2319	0.2220
Plain Yogurt	Brazil	0.2789	0.3536	0.3561
	Spain	0.0881	0.1461	0.1394
Nonfat plain yogurt	Brazil	0.1902	0.1833	0.2066
	Spain	0.1907	0.3167	0.2405

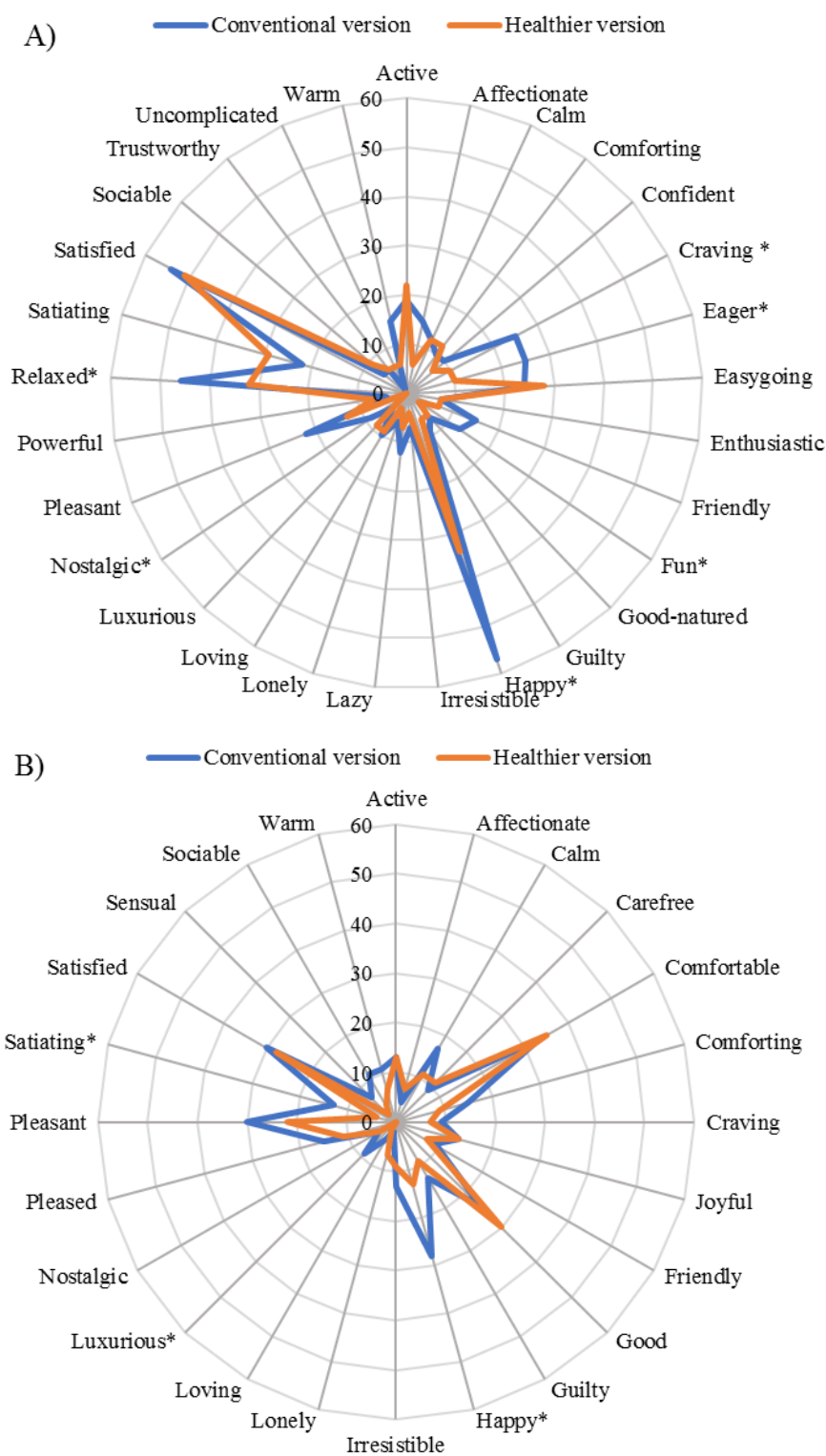
Values in bold are different from 0 with a significance level $p \leq 0.05$.

Figure 1. Health Consciousness assessment of consumers with the statements: A) I reflect about myself a lot; B) I am very self-conscious about my health; C) I am constantly examining my health; D) I am very involved with my health; E) I am aware of the state of my health as I go through the day; F) I am responsible for maintaining a healthy body weight; G) I should take care of myself to prevent disease and illness; H) My health depends on how well I take care of myself.



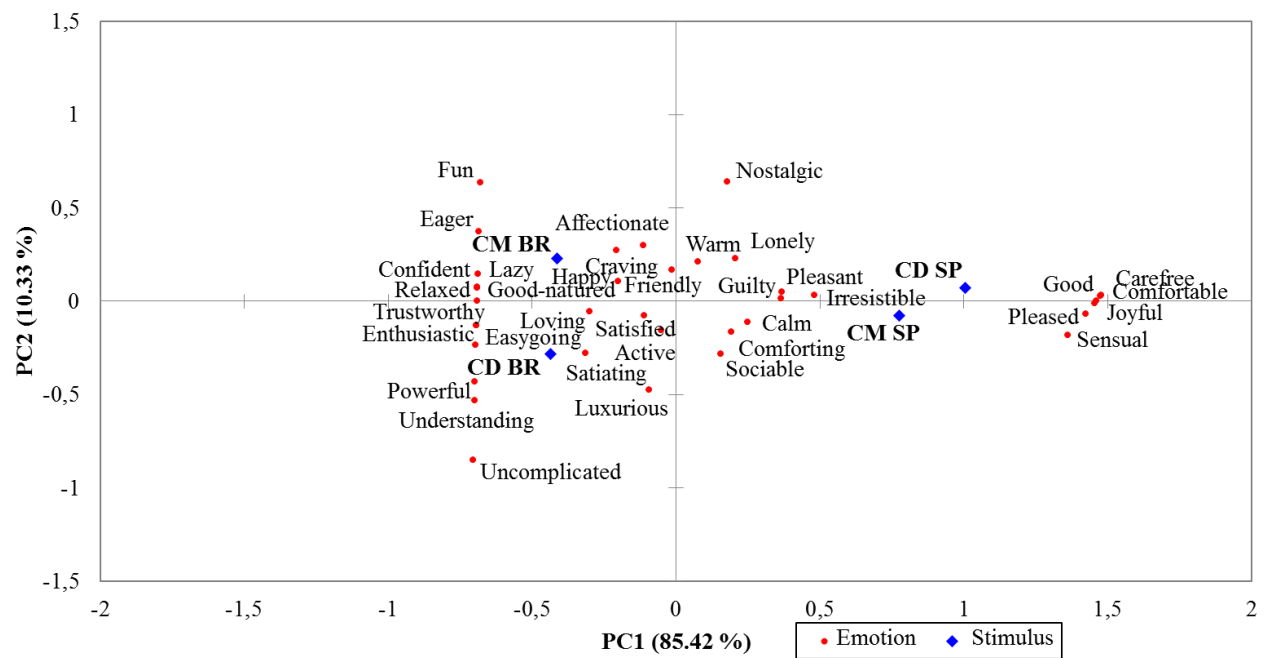
Footnote: ^{a,b} Mean values within the same statements followed by different superscript letters significantly differ by the Two-tailed tests ($p < 0.05$).

Figure 2. Frequency (%) of emotion terms selected for each chocolate stimulus for Brazilian (A) and Spaniards (B).



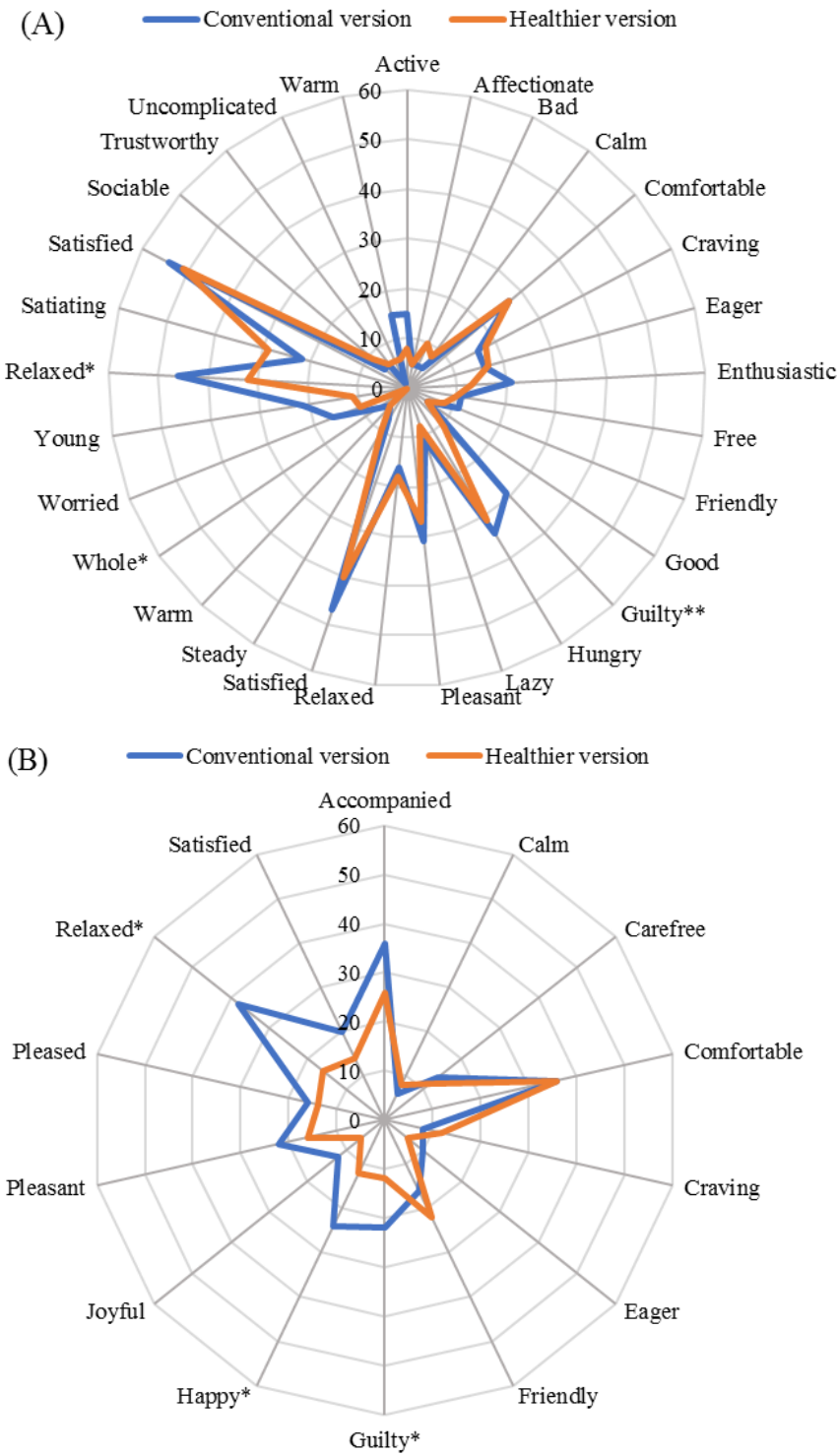
Emotion terms which frequencies differ significantly across the conventional and healthier product according to Cochran Q-test are highlighted and marked with * at a significance level of $p < 0.05$.

Figure 3. Correspondence analysis of the emotional response from the Check-All-That-Apply test with the chocolate stimulus in both cultures (Brazil and Spain).



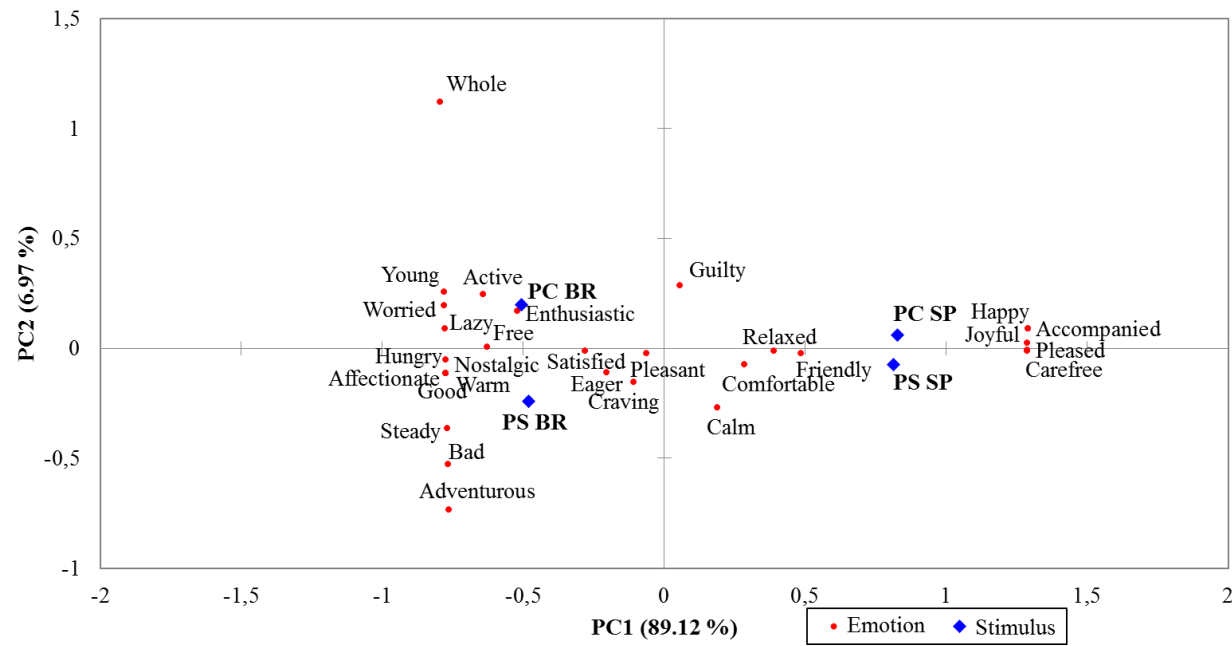
Footnote: CM BR = Milk chocolate for Brazilian participants; CD BR= Dark chocolate for Brazilian participants; CM SP = Milk chocolate for Spanish participants; CD SP= Dark chocolate for Spanish participants.

Figure 4 Frequency (%) of emotion terms selected for each potato chips stimulus for Brazilian (A) and Spaniards (B).



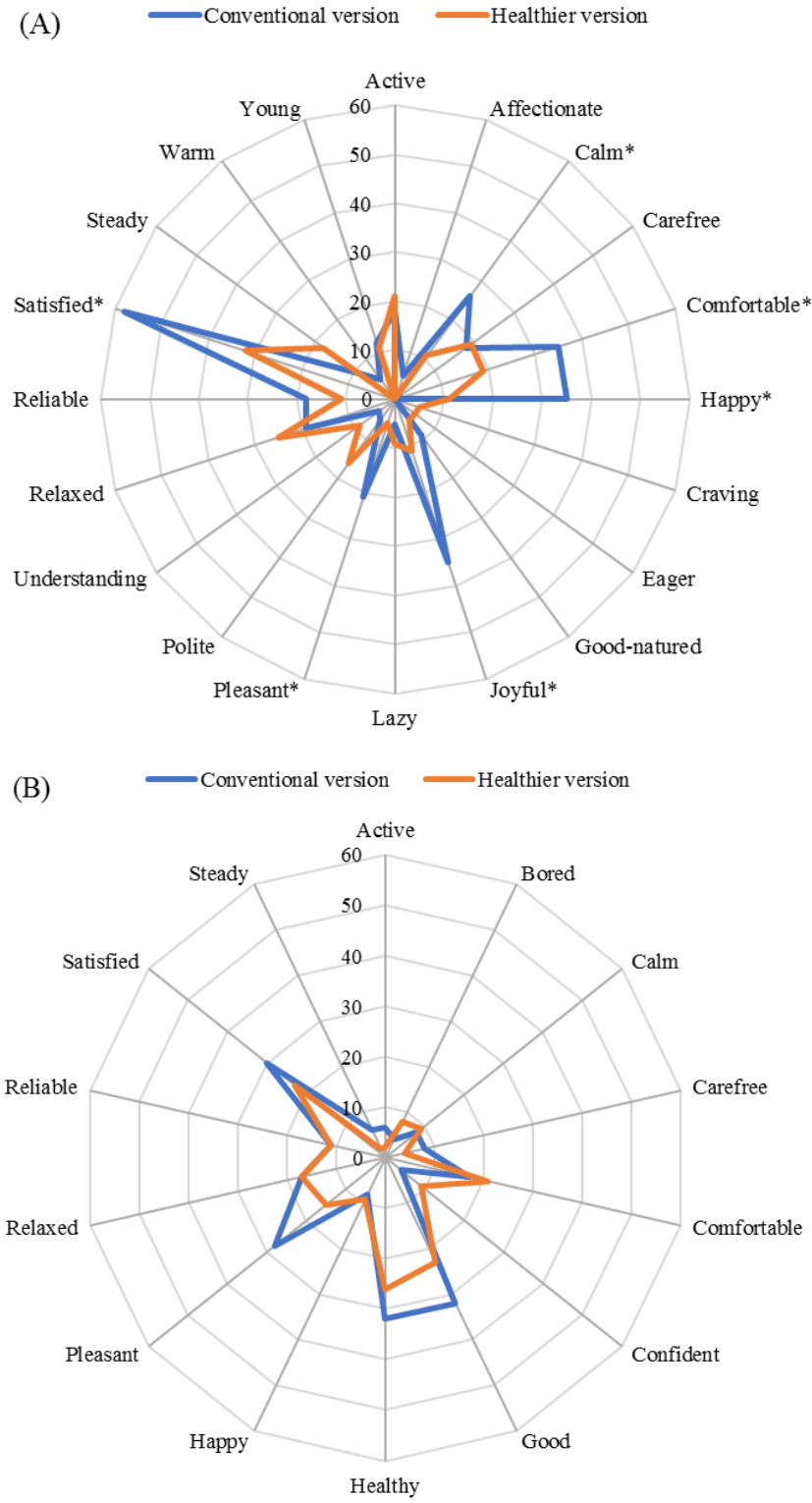
Footnote: Emotion terms which frequencies differ significantly across the conventional and healthier product according to Cochran Q-test are highlighted are marked with * at a significance level of $p < 0.05$.

Figure 5. Correspondence analysis of the emotional response from the Check-All-That-Apply test with the potato chips stimulus.



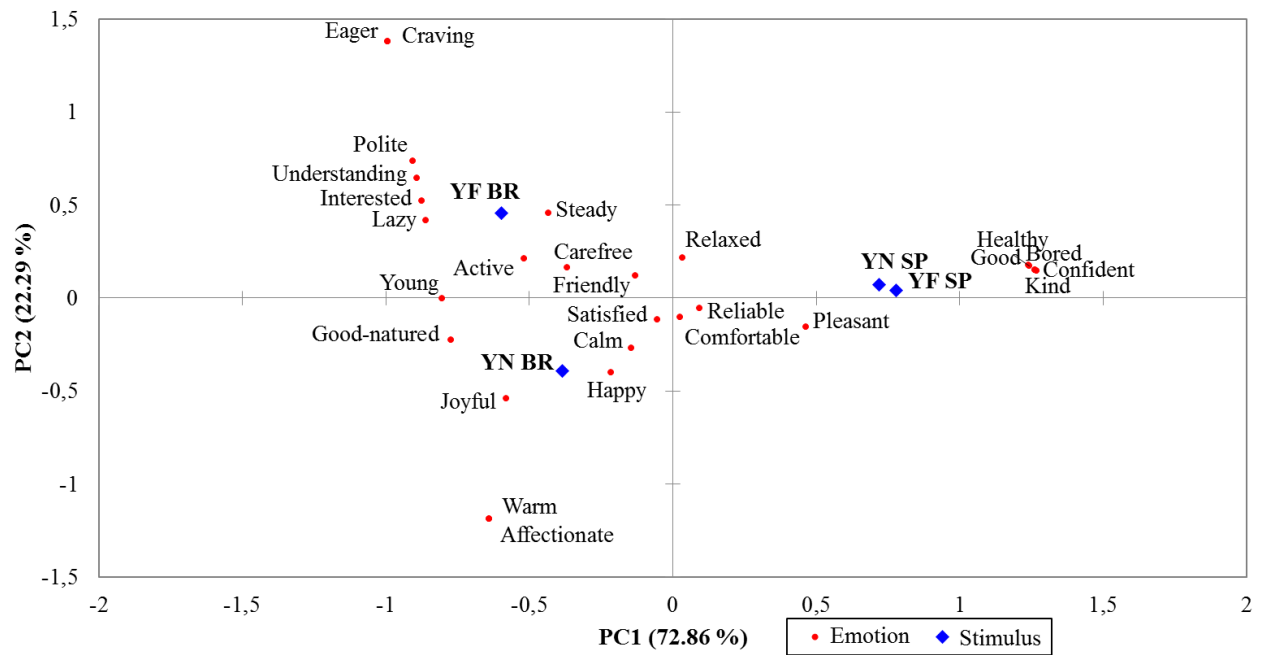
Footnote: PC BR = Conventional Potato chips for Brazilian participants; PS BR= Low sodium Potato chips for Brazilian participants; PC SP = Conventional Potato chips for Spanish participants; PS SP= Low sodium Potato chips for Spanish participants.

Figure 6. Frequency (%) of emotion terms selected for each yogurt stimuli for Brazilian (A) and Spaniards (B).



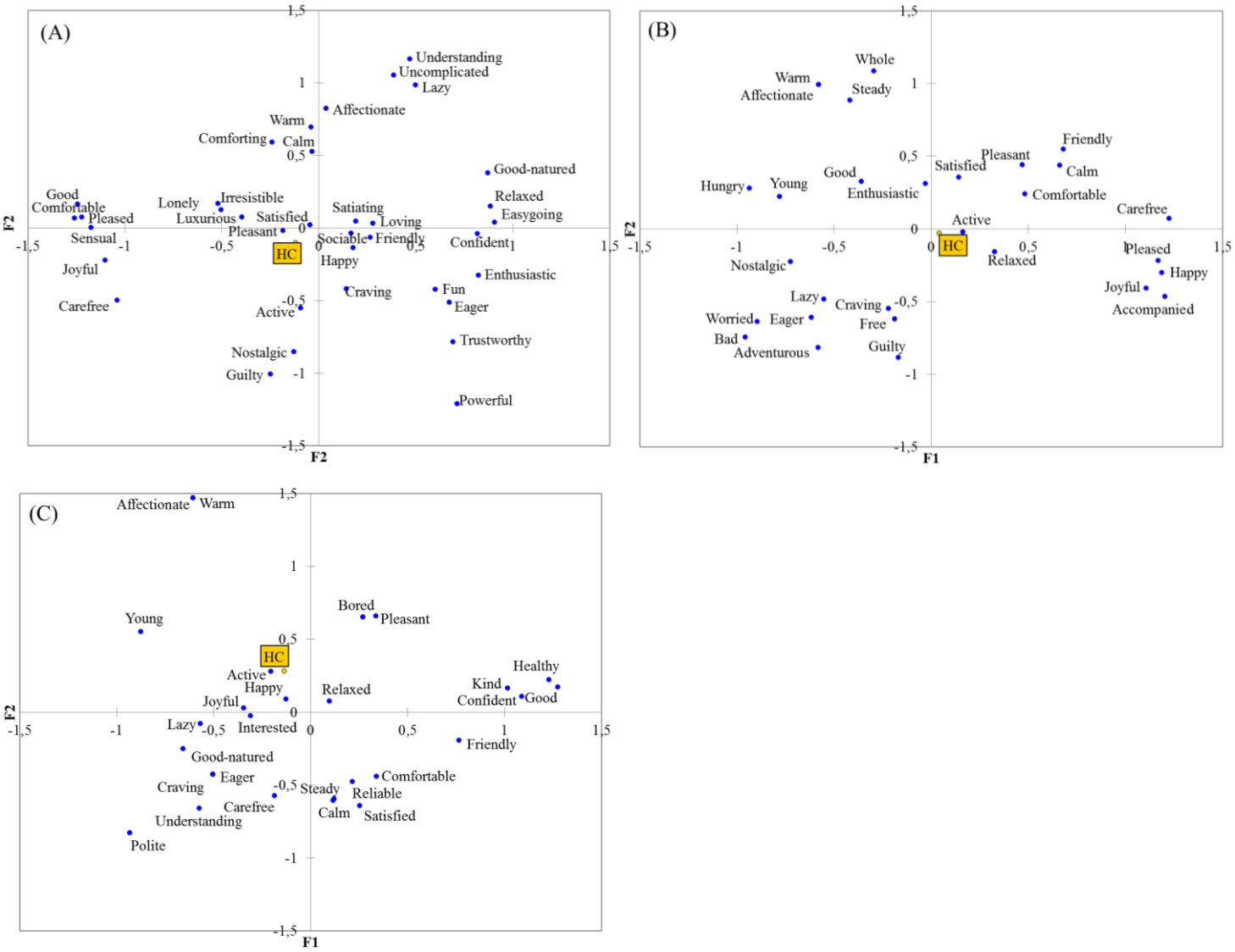
Footnote: Emotion terms which frequencies differ significantly across the conventional and healthier product according to Cochran Q-test are highlighted are marked with * at a significance level of $p < 0.05$.

Figure 7. Correspondence analysis of the emotional response from the Check-All-That-Apply test with the yogurt stimulus.



Footnote: YN BR = Plain Yogurt for Brazilian participants; YF BR= Plain Nonfat Yogurt for Brazilian participants; YN SP = Plain Yogurt for Spanish participants; YF SP = Plain Nonfat Yogurt for Spanish participants.

Figure 8. Principal Coordinate Analysis (PCoA) of the emotion terms with the Health Consciousness (HC) scores for each product category. A) chocolate; B) potato chips; C) yogurt.



6 CONCLUSÕES GERAIS

Conforme os resultados obtidos dos experimentos realizados, pode-se concluir que:

- A avaliação sensorial utilizando a Técnica de Dominância Temporal das Sensações a partir de uma abordagem de múltiplas ingestões, permitiu medir mudanças na percepção de atributos de gosto, sabor e textura, em uma situação de consumo mais realista de diferentes matrizes alimentares (solida, semissólida, líquida). Permitiu identificar diferenças significativas de atributos dominantes ao longo do consumo de produtos clássicos e suas versões “mais saudáveis”. As associações com teste de aceitabilidade fornecem indícios dos possíveis atributos que influenciam as preferências do consumidor.
- A percepção temporal de diferentes alimentos sólidos como chocolate e batata chips seguem o mesmo protocolo de avaliação temporal. O aumento do cacau e a redução do teor de lactose influenciam principalmente a dominância dos atributos doçura, leite, cacau, crocante e amargo. A redução de gordura em batata chips aumenta significativamente as sensações de textura enquanto a adição de sabor presunto aumentam as sensações de sabor, comparados à versão clássica.
- A redução de açúcar adicionado e a ausência de cafeína influenciam fortemente a percepção temporal, o perfil de ingestão múltipla e a aceitabilidade de café. O maior teor de açúcar pode influenciar na taxa de dominância do atributo doce, enquanto o menor teor de açúcar pode influenciar na maior dominância de sabor café e gosto amargo.
- A ausência de lactose em iogurte impactou na taxa de dominância dos atributos acidez na primeira ingestão e lácteo na terceira ingestão. Independentemente da composição, houve perda do domínio do atributo acidez e aumento do lácteo e cremosidade após três ingestões.
- O desenvolvimento de um léxico emocional para barra de chocolate, batata chips e iogurte natural por consumidores do Brasil e Espanha, revelou que o mesmo estímulo alimentar é associado a diferentes perfis emocionais dependendo da cultura, bem como os contextos de consumo mais adequados. Brasileiros associam mais termos emocionais aos estímulos alimentícios em relação aos espanhóis. As versões clássicas são mais emocionais do que as versões mais saudáveis. O nível de consciência de saúde dos

participantes influencia positivamente a frequência de consumo, aceitabilidade e intenção de compra, principalmente de um produto considerado genuinamente saudável, como o iogurte. Este cenário indica a importância da abordagem dos termos emocionais baseados não só no alimento, mas também ajustadas à cultura dentro de uma ocasião mais real de consumo.

Sugere-se que pesquisas futuras podem ser realizadas replicando o protocolo de avaliação TDS *multiple intake*, para compreender as mudanças temporais na percepção sensorial causadas por reformulações de outras matrizes alimentares. Esta avaliação permitirá o desenvolvimento de novos produtos em versões mais saudáveis que exibam características sensoriais esperadas e alta aceitabilidade do consumidor. Ainda, pesquisas futuras podem ser desenvolvidas usando os estímulos emocionais para induzir práticas saudáveis associadas a um maior prazer alimentar respeitando as particularidades culturais.