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GLENDA ANTONIA DA ROCHA NEVES

DESENVOLVIMENTO DE VINAGRE A PARTIR DE FRUTOS DE CAJU-ÁRVORE-DO-CERRADO E SUA APLICAÇÃO EM BEBIDAS MISTAS

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Tese apresentada ao Programa de Pós-Graduação em Ciência e Tecnologia de Alimentos da Universidade Federal de Goiás como exigência para obtenção do título de Doutor em Ciência e Tecnologia de Alimentos.
Orientador: Prof. Dr. Márcio Caliari.
Coorientador: Prof. Dr. Manoel Soares Soares Júnior.

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DEDICATÓRIA

Ao meu filho Noah, meu companheiro de vida Leonardo, meus pais Clever e Eliana
e irmãos Klayton e Fernanda.

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RESUMO

Os frutos de caju-árvore-do-cerrado (*Anacardium othonianum* Rizz) tem potencial para aproveitamento tecnológico. Neste trabalho objetivou-se a produção de vinagre de caju-árvore-do-cerrado (VCAC), avaliando o seu potencial tecnológico-sensorial na aplicação de bebida mista (BM). A polpa, o fermentado alcoólico e VCAC foram comparados quanto suas características físico-químicas (FQ), perfil de minerais e aceitação global (AG) por escala hedônica para acidez de 4 e 6% em vinagrete, e avaliados por ANOVA e teste de médias ($p \leq 0,05\%$). Os compostos voláteis foram identificados. O VCAC foi comparado com vinagres comerciais, quanto aspectos FQ, capacidade antioxidante, AG e questionário cheque-tudo-que-se-aplica (CATA), utilizando análise de fatores múltiplos. Avaliou-se a influência da alegação de saúde (AS) de vinagre na AG. O delineamento de misturas foi utilizado para obtenção de 11 formulações com misturas de suco de uva, maçã e água de coco em diferentes proporções e 15 mL do VCAC para cada 100 mL de BM. Realizou-se análises FQ, intenção de compra e índice de AG. Os resultados FQ foram avaliados por ANOVA e regressão polinomial dos pseudocomponentes.. A função desejabilidade foi aplicada visando a otimização da BM. As 7 formulações de BM diferentes foram sensorialmente e emocionalmente caracterizadas utilizando CATA, além do estudo da influência de AS na AG. A forma como vinagre é oferecido influenciou a AG. O VCAC obteve boa AG quando avaliado em veículo, sendo considerado aceito. Quando comparado com produtos comerciais, teve aceitação similar ao de maçã, sugerindo que pode ser um substituto no mercado. As bebidas com melhor AG foram descritas como deliciosa, suave, frutada, fresca, sabor natural, doce, ácida, e aroma agradável. A AG foi favorecida pelas misturas. AS reduziram associações de emoções negativas nas formulações, que demonstraram viabilidade tecnológica para que empresas do ramo possam oferecer este produto no mercado com segurança e qualidade padronizada.

Palavras-chave: vinagre, fruto do cerrado, bebida mista, caracterização sensorial.

VINEGAR FROM *ANACARDIUM OTHONIANUM* RIZZINI AND THEIR APPLICATION IN A MIXED BEVERAGE

ABSTRACT

Anacardium othonianum Rizz is a cerrado fruit with potential technological use not well studied yet. This study aimed produces *Anacardium othonianum* Rizz. vinegar (AOV), evaluating its technological-sensory potential in the application of mixed beverage (MB). The pulp, alcoholic fermented and AOV were compared by their physicochemical characteristics (FC), mineral profile and overall liking (OL) by hedonic scale for 4 and 6% acidity in a vinaigrette, and evaluated by ANOVA and test of means ($p \leq 0.05\%$). Volatile compounds were identified. The AOV was compared with commercial vinegars for FC aspects, antioxidant capacity, OL, and check-all-that-apply (CATA) questionnaire using multiple factor analysis. The influence of health claim (HC) of vinegar on OL was evaluated. Mixture design was used to obtain 11 formulations with mixtures of grape and apple juice and coconut water in different proportions add 15 mL of AOV to 100 mL of MB. FC, purchase intention and OL index analyses were performed. The FQ results were evaluated by ANOVA and polynomial regression of pseudocomponents. Desirability function was applied for MB optimization. The 7 different formulations of MB were sensory and emotionally characterized using CATA, in addition to the study of the influence of HC on OL. The way vinegar is offered influenced the OL. The AOV obtained good OL when evaluated in vehicle and was acceptable. When compared to commercial products, it had similar acceptance to apple vinegar, suggesting that it may be a substitute in the market. The MB with the best OL were described as delicious, smooth, fruity, fresh, natural flavor, sweet, acidic, and pleasant aroma. OL was favored by the blends. HC reduced associations of negative emotions in the formulations, which demonstrated technological feasibility for companies in the industry to offer this product in the market with safety and standardized quality.

Keywords: Vinegar, Cerrado Fruit, Mix Beverage, Sensory Characterization.

SUMÁRIO

CAPÍTULO I

1. INTRODUÇÃO

O uso de alimentos fermentados é antigo e vastamente utilizado pelo homem como forma de melhorar características sensoriais dos produtos ou ainda para preservação, sendo o vinagre um destes produtos. O vinagre é um condimento produzido pela fermentação alcóolica por leveduras, seguida da oxidação do álcool por bactérias acéticas, sendo sua principal característica a formação de ácido acético. O processo de oxidação também é chamado de fermentação acética e industrialmente é realizado pelo método submerso, devido ao maior rendimento e rapidez quando comparado com método lento (BINOD; SINDHU; PANDEY, 2013).

Pesquisas correlacionam a ingestão de vinagre com diminuição de doenças assintomáticas, e em alguns países o consumo de vinagre é realizado regularmente devido à estas características benéficas (XIA et al., 2020). No entanto, pouco se sabe a respeito das características sensoriais destes produtos, bem como a aceitação global.

O caju-árvore-do-cerrado (*Anacardium othonianum* Rizz.) é uma espécie nativa do cerrado brasileiro e seu uso ainda é restrito à região, sendo sua castanha torrada e o pseudofruto aproveitado como polpa para base de doces, sucos, bebidas alcoólicas e chás. Ele é rico em compostos fenólicos, flavonoides e vitamina C (ALVES et al., 2017)□. Estudos para o aproveitamento integral do fruto são pontuais humana (SANTANA et al., 2020; SILVA et al., 2020), e demonstram que a bebida fermentada deste fruto pode apresentar efeito positivo na saúde humana (SILVA et al., 2020).

O mercado de bebidas que promovem a saúde e o bem-estar vem crescendo anualmente. Estes produtos podem ser encontrados em farmácias ou supermercados e atendem as exigências de consumidores que buscam manter hábitos saudáveis diante de um estilo de vida urbano que é cada vez mais acelerado (CORBO et al., 2014). Para desenvolver produtos que atendam estas exigências, pesquisas têm utilizando metodologias sensoriais descritivas rápidas. A CATA, do inglês check-all-that-apply, ou cheque-tudo-que-se-aplica, é uma destas metodologias que foi criada recentemente. Por meio dela os consumidores podem descrever os produtos avaliados marcando os termos que mais descrevem os produtos. Ela também pode ser usada para estudos emocionais, onde busca-se correlacionar as respostas emocionais com as sensoriais (ALCANTARA; FREITAS-SÁ, 2018).

Com o intuito de promover um melhor aproveitamento tecnológico da polpa de caju-árvore-do-cerrado, este trabalho objetivou a produção de vinagre de caju-árvore-do-cerrado, avaliando o seu potencial tecnológico-sensorial na aplicação de uma bebida mista.

2. REVISÃO DA LITERATURA

2.1 *Anacardium othonianum* Rizzini

Os frutos das espécies nativas do cerrado possuem elevado valor nutricional, além de serem atrativos sensorialmente com cor, sabor e aroma peculiares e intensos. Dentre as espécies de frutos comestíveis do bioma cerrado destaca-se o caju-de-árvore-do-cerrado (*Anacardium othonianum* Rizzini) (CORREA et al., 2008). Também conhecido como cajuzinho e cajuí, este fruto é encontrado no bioma cerrado, predominantemente no Centro-Oeste do Brasil. O primeiro botânico a descrever o cajueiro arbóreo do cerrado foi Dr. Othon Xavier de Brito Machado, por isso este foi denominado cientificamente *A. othonianum* Rizzini, sendo pertencente à mesma família e ao mesmo gênero do *A. occidentale* L., no qual se observa semelhança em algumas de suas características (VIEIRA et al., 2006).

O pedúnculo (pseudofruto) do caju-de-árvore-do-cerrado possui coloração do amarelo ao avermelhado (Figura 1), com 2 cm a 4 cm de comprimento, de peso médio de 7,15g, e sabor ácido e suculento. Rica em compostos fenólicos, flavonoides e vitamina C (ALVES et al., 2017)□, a polpa do pedúnculo de caju é utilizada como matéria-prima para fabricação de sucos, doces, licores e infusão em aguardentes. O fruto (castanha) do caju tem peso médio de 1,84 g, podendo ser consumido após torrado ou mesmo como um importante ingrediente na culinária (CAETANO; SOUSA; RESENDE, 2012; SILVA et al., 2013, SILVA et al., 2017; SOUZA; SILVA, 2015).

Figura 1: Frutos de caju-de-árvore-do-cerrado (*Anacardium othonianum* Rizzini) localizado no cerrado goiano, com pedúnculos de colorações amarelo (A), alaranjado (B) e vermelho (C) (Arquivo pessoal).

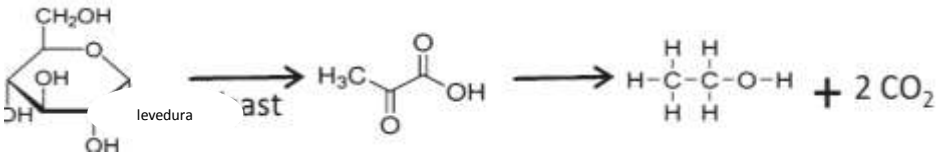
O pseudofruto de caju-árvore-do-cerrado é pouco valorizado e sua utilização para obtenção de suco (SANTANA et al., 2020), suco fermentado (SILVA et al., 2020), vinagre e bebidas destiladas podem ser uma forma de promover o uso da parte suculenta e reduzir os desperdícios advindos do aproveitamento da castanha. A FAO (Food and Agriculture Organization) recomenda a produção de vinagres com fontes agrícolas locais promovendo assim os recursos humanos e matérias-primas regionais (GIUDICI; DE VERO; GULLO, 2017).

2.2 Processo produtivo de vinagre

A fermentação é um processo antigo, e ainda muito utilizado em alimentos que pode ser realizada de forma submersa (meio líquido) ou em estado sólido. A maioria das fermentações industriais são realizadas em meio líquido com infusão de oxigênio, e os processos podem variar entre batelada, semi-batelada, semi-batelada cíclico, semi-contínuo e contínuo (BINOD; SINDHU; PANDEY, 2013).

Um dos produtos que é obtido pelo processo fermentativo é o vinagre, geralmente produzido a partir de matérias-primas de baixo custo e ricas em carboidratos. Sua produção passa por dois estágios, a fermentação alcoólica e a oxidação que também é chamada de fermentação acética (GIUDICI; LEMMETTI; MAZZA, 2015).

Bioquimicamente, a fermentação é um processo que gera energia com o consumo de compostos orgânicos. Na fermentação alcoólica, os produtos obtidos fazem parte de uma reação em cadeia complexa, onde em anaerobiose, as leveduras consomem a glicose para produzir ATP através da glicólise. Após a glicólise, ocorre a formação de piruvato que é reduzido a lactato pela conversão NADH+. Os produtos destas reações são 2 moléculas de etanol e 2 de CO_2 (Figura 2) (DEMAN et al., 2018).



Glicose 2 acido pirúvico 2 Etanol

Figura 2: Conversão da glicose em piruvato e etanol adaptado de Deman et al, (2018).

Na fermentação acética ocorre a conversão do etanol em água, energia e ácido acético através do metabolismo das bactérias acéticas. Parte da energia gerada precisa ser removida e caso o oxigênio não seja suficiente pode haver formação desproporcional de acetaldeído, composto intermediário da reação (BELITZ; GROSCH; SCHIEBERLE, 2009).

A fermentação acética, geralmente, ocorre em meio líquido e pode ser de forma lenta (Orleãns), submersa ou rápida (Alemão). No processo rápido são utilizados materiais de suporte para ventilação (maravalha de madeira), além de orifícios nas paredes. Já o processo lento é geralmente empregado em vinagres tradicionais e pode demorar meses, isso porque o meio não sofre oxigenação e as bactérias acéticas precisam ficar na superfície do fermentador para a produção do ácido acético (GIUDICI; DE VERO; GULLO, 2017).

O processo submerso utiliza um equipamento (acetador) patenteado por Frings em 1949 e é baseado em intensa oxigenação por micro bolhas em um sistema semi-batelada fechado (Figura 3).

Figura 3: Acetador piloto utilizado para produção de fermentado acético (Arquivo pessoal).

O acetador é composto por uma turbina de ar no fundo do um recipiente fechado, tubos onde circulam água refrigerada para controle de temperatura do vinho a ser fermentado e torneiras de entrada e saída. Este processo é o mais utilizado na indústria, pois reduz perdas por evaporação e maior produtividade (RIZZON; MENEGUZZO, 2006).

O processo de fermentação pode ainda ser espontâneo, por inoculação de culturas ou *backslopping*. O processo espontâneo, como o próprio nome indica, utiliza a microbiota bacteriana presente no ambiente e na matéria-prima, a inoculação utiliza microrganismos selecionados (GIUDICI; LEMMETTI; MAZZA, 2015). No *backslopping*, uma isca de fermentação anterior é utilizada para acelerar a fermentação, já que os microrganismos (MO) estão habituados ao meio. Este tipo de inoculação é usado na fermentação acética para a obtenção do vinagre, pois além de as bactérias acéticas serem exigentes é difícil de estabelecer a cultura inicial de obtenção do produto (GULLO; DE VERO, 2009).

As culturas bacterianas usadas são leveduras e bactérias acéticas. Elas podem ser encontradas na própria matéria-prima utilizada para sua produção. No entanto, para aumentar o rendimento, a indústria utiliza microrganismos selecionados (*Saccharomyces cerevisiae*) na produção do álcool. Já as bactérias acéticas são pouco conhecidas, e sua maioria pertence aos gêneros *Acetobacter* e *Gluconacetobacter* (GIUDICI; LEMMETTI; ,MAZZA, 2015).

Pesquisas visando o desenvolvimento de novos vinagres e suas avaliações geralmente utilizam o método lento (HIDALGO et al., 2013; MATLOOB, 2014; RODA et al, 2017) ou escala de bancada utilizando frascos de erlenmeyer (LI; LO; MOON, 2014;

COELHO et al, 2017; BOONSUPA, 2018), sendo o processo de escala piloto ainda pouco estudado (SPINOSA et al, 2015; MIRANDA et al, 2020).

2.3 Mercado e consumo de vinagre

O vinagre é produzido em maior quantidade na França, Itália e Espanha. No entanto, a China também vem despontando como grande produtora (WEI, 2001 appud GIUDICI; LEMMETTI; MAZZA, 2015). Na China existem mais de 14 tipos de vinagre no mercado, que são derivados de diferentes cereais, tuberosas e frutas (Liu et al. 2004). Os vinagres podem ainda ser classificados quanto a qualidade, preço e tipo. Sendo os vinagres destilados ou sintéticos os mais baratos, o vinagre de maçã mais comum e popular, e o balsâmico considerado um produto *premium* (LIM et al., 2019).

Até 2005 o mercado mundial de vinagre era dividido entre 34% de balsâmico, 17% de vinho tinto, 7% de maçã, 4% de arroz, 2% de vinagre branco e 36% de outros vinagres (GIUDICI; LEMMETTI; MAZZA, 2015). A indústria do vinagre teve uma movimentação mundial estimada em 1,26 bilhões de dólares americanos em 2017, com uma taxa de crescimento de 2,1% no período de 2010 a 2017, e com previsão de faturar até U$ 1,50 bilhões até o ano de 2022 (CALLEJÓN et al. 2018).

Até o ano de 2024, de acordo com o relatório *Global Dressing Vinegar Market Analysis and Forecast*, a expectativa é que o mercado mundial atinja a marca de movimentação de 54.772 Mt de vinagre balsâmico, 31.720 Mt de vinagre de vinho tinto, 14.297 Mt de vinagre de vinho branco, 13.427 Mt de vinagre de maçã e 7.539 Mt de vinagre de arroz, sendo o mercado europeu o maior consumidor, seguido da América do Norte e Asia (LIM et al., 2019).

No Brasil, até o momento da elaboração desta pesquisa, a última pesquisa realizada pelo Instituto Brasileiro de Geografia e Estatística (IBGE) divulgou a média individual de consumo do vinagre em litros entre 2008 e 2009, que foi de 1,2 litros para vinagre de álcool, 0,6 para vinagre de vinho e 0,9 para vinagres não especificados, totalizando 2,8 litros por pessoa (IBGE, 2017). Neste mesmo período o Brasil importou cerca de 2.042 milhões de quilos de vinagres e seus sucedâneos obtidos a partir do ácido acético, e esse número subiu

para 2.154 milhões em 2015 e 2016 (ALICE, 2017), indicando um aumento no consumo destes produtos por brasileiros. Segundo a associação de indústrias produtoras de vinagre, em 2009 a expectativa de produção era de 174 milhões de litros, no entanto, não há dados recentes sobre a produção (ANAV, 2017).

2.4 Definição e legislação de vinagre

A definição do vinagre está relacionada ao seu componente de maior importância, o ácido acético. A FAO define vinagre como qualquer líquido que sirva ao consumo humano que seja produzido por processo duplo de fermentação, a partir de matérias-primas amiláceas ou açucaradas com teor alcoólico residual de 0,5% para vinagres de vinho e 1% para demais (CODEX ALIMENTARIUS COMMISSION, 1987).

Nos Estados Unidos o vinagre deve ter 4 g de ácido acético em 100 mL a 20° C (FDA, 1995). Já na União Europeia vinagres de matérias-primas diferentes possuem teores de ácido acéticos diferentes, por exemplo, o de vinho deve ter 60 g em 100 mL (COUNCIL REGULATION, 2008), além disso alguns de seus vinagres são protegidos por regiões e possuem a Denominação de Origem Protegida (DOP), como por exemplo o vinagre de Montilla-Moriles, proveniente da região que o denomina na Espanha.

O vinagre de Montilla-Moriles tem outras características estabelecidas, além do ácido acético (min. 60g/L), como teor alcoólico (máx. 3%), extrato seco solúvel (maior que 3g/L), cinzas (2 e 14g/L), acetoína (maior que 100mg/L) e açúcares redutores (maior que 70 g/L) (COUNCIL REGULATION, 2015). Já para a legislação brasileira o vinagre, exceto o de vinho, deve ser obtido da fermentação acética do fermentado alcoólico de mosto, podendo ser adicionado de vegetais e suas partes, de extratos vegetais aromáticos e de condimentos e deve ter a acidez volátil mínima de 4 g por 100 mL em ácido. Podendo ainda ser denominado de fermentado acético (BRASIL, 2012).

Diferentes matérias-primas podem ser utilizadas para produção de vinagre, e elas denominam o produto final, como por exemplo, vinagre de arroz, de vinho tinto, sorgo, de álcool, frutas, entre outros (CHEN et al., 2016).

No Brasil, a classificação do vinagre é dada por sua composição ou forma de obtenção (BRASIL, 2012). A classificação brasileira regulamentada atualmente para o vinagre está apresentada na Tabela 1.

Tabela 1: Classificação e denominação do vinagre

Composição ou forma de obtenção	Classificação	Denominação
Fermentação acética do fermentado alcoólico de mistura hidroalcoólica originária do álcool etílico potável de origem agrícola	de álcool	Vinagre de álcool
Fermentação acética do fermentado alcoólico de uma ou mais frutas	de fruta	Vinagre de fruta
Fermentação acética do fermentado alcoólico de um ou mais cereais	de cereal	Vinagre de cereal
Fermentação acética do fermentado alcoólico de um ou mais vegetais	de vegetal	Vinagre de vegetal
Fermentação acética do fermentado alcoólico de duas ou mais das seguintes matérias-primas: fruta, cereal e vegetal	misto	Vinagre misto de vegetais
Fermentação acética do fermentado alcoólico de mel de abelha	de mel	Vinagre de mel
Fermentado acético adicionado de suco de fruta ou suco de vegetal ou de mel de abelha, em conjunto ou separadamente	composto	Vinagre de (nome genérico do vinagre) composto
Fermentado acético adicionado de condimento	condimentado	Vinagre de (nome genérico do vinagre) condimentado
Fermentado acético de fermentado alcoólico com acidez volátil superior a oito gramas de ácido acético por cem mililitros do produto	duplo	Vinagre duplo
Fermentado acético de fermentado alcoólico com acidez volátil superior a doze gramas de ácido acético por cem mililitros do	triplo	Vinagre triplo

produto

Fonte: BRASIL, 2012.

Adicionalmente, os parâmetros preconizados pela legislação brasileira para o fermentado acético são divididos conforme sua classificação. Um comparativo entre os vinagres de álcool, fruta, cereal e vegetal é apresentado na Tabela 2.

Tabela 2: Parâmetros do fermentado acético no Brasil

Parâmetros	Álcool		Fruta		Cereal		Vegetal/Mel	
	Mín.	Máx.	Mín.	Máx.	Mín.	Máx.	Mín.	Máx.
Acidez volátil (g/100mL)	4,00	-	4,00	-	4,00	-	4,00	-
Álcool (%v/v) a 20°C	-	1,0	-	1,0	-	1,0	-	1,0
Cinzas (g/L)	-		1,00	5,00	1,00	5,00	1,00	5,00
Extrato seco reduzido (g/L)	-		6,00	-	7,00	-	7,00	-
Sulfatos (g/L s.de potássio)	-		-	1,00	-	1,00	-	1,00
Aspecto	Ausência de elementos estranhos à sua natureza e composição.							
Cheiro	Característico.							
Sabor	Ácido.							
Cor	De acordo com a matéria-prima de origem e composição.							

Fonte: BRASIL, 2012.

A produção de vinagres flavorizados com mel, frutas e malte é uma técnica antiga, relatada na época dos babilônios (BUDAK et al., 2014). Na Ásia o vinagre de arroz é bastante utilizado na culinária regional, pois não interfere na aparência dos pratos, além disso, costuma ser condimentado com pimenta, ervas e frutas (YANO et al., 1997).

2.5 Benefícios do consumo de vinagre

O próprio processo fermentativo ocasiona em modificações fisico-químicas significativas na matéria-prima ao longo do processo de obtenção do vinagre, modificando compostos como pigmentos, que tem sua concentração reduzida, e produzindo novos componentes bioativos como ácidos orgânicos, polifenóis, melanoidinas e tetrametilpirazina (XIA et al., 2020). Além disso o processo de envelhecimento do vinagre, usado em alguns produtos, influenciam a presença e concentração destes compostos (LIM et al., 2019). Como exemplo, Liu e colaboradores (2019), ao comparar 23 vinagres de frutas, observaram maior conteúdo de ácidos orgânicos no vinagre de vinho branco e no vinagre de maçã, e maiores concentrações de ácido gálico, ácido protocatecuico, ácido clorogênico, ácido cafeico e ácido p-cumárico foram observadas no vinagre balsâmico de Modena.

Portanto, a produção de vinagre pode empregar diversas matérias-primas como frutas, resíduos agroindustriais ou tubérculos que dão origem a produtos com qualidade diferenciada (PÉREZ-JIMÉNEZ et al., 2010). Neste sentido, estudos sobre o impacto da ingestão de vinagre na saúde vêm sendo realizados para diferentes fontes de matérias-primas e indicam que este produto pode auxiliar no controle glicêmico (GU et al. 2012; SHSHEHBOR; MANSOORI; SHIRANI, 2017), na redução de lesões hepáticas (BEH et al., 2016), na melhoria do sistema imune intestinal (LEE; KIM; SHIN, 2015) e na inibição de proliferação de células carcinogênica (BUDAK et al., 2014). Entre os componentes responsáveis por tais benefícios temos o ácido acético (BOUNIHI et al., 2017), um ácido orgânico que é capaz de solubilizar-se em lipídios e é usado como aditivo na preservação de alimentos, conferindo-os sabor forte e característico (THERON; LUES, 2011).

Já os antioxidantes podem combater a formação de compostos tóxicos, advindos do estresse oxidativo no organismo humano, estes compostos são responsáveis por aumentar a incidência de doenças cardíacas, degenerativas e envelhecimento (GIADA, 2014).

Os alimentos com apelo de promoção de saúde vêm ganhando cada vez mais espaço na indústria, no entanto, para o sucesso destes produtos faz-se necessário novos métodos para seu desenvolvimento em prol do entendimento das necessidades do consumidor (BOJKOVSKA et al., 2015).

2.6 Bebidas a partir de fermentado acético

O mercado de bebidas conta com inúmeros produtos como bebidas carbonatadas açucaradas, sucos artificiais, chás prontos para o consumo, água tônica, energéticos, isotônicos e leites flavorizados além das bebidas alcóolicas. No entanto, grande parte dos produtos mais consumidos contém níveis elevados de açúcar. Estas bebidas estão associadas ao aumento do risco de doenças cardíacas, diabetes e ganho de obesidade (PETTIGREW et al., 2015). Por outro lado, um novo mercado de produtos com características saudáveis vem despontando. Isso pode ser observado nas prateleiras de mercados e também nas pesquisas com produtos que associam-se ao bem estar e saúde (THOMSON et al., 2017).

Nos países asiáticos o consumo de fermentados acéticos adocicados é comum pela população. No Japão o vinagre de arroz é diluído com suco de fruta e consumido como bebida tônica, já na África produtos espontaneamente fermentados (álcool e ácido cético) são comuns na cultura do país e de difícil classificação (GIUDICI; DE VERO; GULLO, 2017).

Alguns exemplos de bebidas consumidas a base de vinagre são: Shrubs (um tipo de picles adocicado), Michelada (drink mexicano), Oishii Su-tamago (vinegared egg-Japão), Umeboshi vinegar (ume plum vinegar – Japão), oxymel (bebida à base de vinagre e mel) e o Switchel, a mais famosa das bebidas que pode ser encontrada em diferentes países, cuja a base é feita de vinagre de maçã e água e pode ter variações com adição de diferentes frutas.

2.7 Atitude do consumidor em relação a bebidas à base de vinagres e bem-estar

É comum que durante a escolha de um produto o consumidor leve em consideração sua qualidade (ALIBABIC et al., 2011). No entanto, qualidade é subjetiva, dependendo do tipo de produto e até a cultura local. Para o vinho, por exemplo, o consumidor é influenciado por aspectos intrínsecos e extrínsecos do produto, além da cultura local e próprio *background* (SOGARI; MORA; MENOZZI, 2016). Seralvo e Ignácio (2004) destacam que dentre os atributos que levam o consumidor a comprar produtos alimentícios, o fato de o produto não fazer mal à saúde, faz com que consumidoras sintam bem-estar por estar cuidando de sua própria saúde e também de estar sendo uma mãe preocupada.

O termo bem-estar (*well-being*) é complexo e não tem uma única definição, podendo ser abordado de forma hedônica (prazer e felicidade) e eudaemonica (quando se vive de acordo com seus valores), ou seja, é um conceito holístico que pode ser abordado

cognitivamente e afetivamente. Um grupo de pesquisadores concluiu que é um conceito multidimensional construído a partir de perspectivas psicológicas, de humor e emoções positivas, saúde física, avaliação global de vida e satisfação em aspectos específicos. (ARES; GIMÉNEZ; DELIZA, 2018)

Neste sentido, estudos sobre o comportamento do consumidor, buscam entender os fatores que o levam a escolha ou rejeição de um determinado produto. Estes estudos auxiliam tanto no desenvolvimento de novos produtos, quanto no relacionamento das empresas com clientes (BASHA et al., 2015; CARRAPISO et al., 2015; POMARICI; VECCHIO, 2014; SPÁČIl; TEICHMANNOVÁ, 2016). Torri et al. (2017) avaliaram percepção do consumidor koreano e italiano com relação ao vinagre balsâmico e os termos usados para descrever, comparando metodologias sensoriais. Os autores concluíram que o nível de familiaridade com o produto influenciou fortemente na descrição deste.

A maioria das pesquisas relacionadas a bebida com vinagre em sua constituição, dizem respeito ao efeito na saúde, sendo indicada para melhoria das funções procinéticas (ENKHSAIKHAN et al., 2018), regulação ovulatória (WU et al., 2013), redução dos riscos de hipertensão (ALI et al., 2018; HONSHO et al., 2005) e redução da sensação de fadiga pós-treino (INAGAKI et al., 2020). Um grupo de pesquisadores investigou a aceitação de bebidas elaboradas com suco de laranja, maçã, pêssego e abacaxi e diferentes concentrações de vinagre de vinho xerez, e observaram que além da concentração do vinagre, o tipo de fruta empregado influenciou a aceitação da bebida (CEJUDO-BASTANTE et al., 2013). Apesar do apelo de saúde, pesquisas que investiguem a aceitação sensorial deste tipo de produto ainda são escassas.

2.8 Desenvolvimento de produtos baseados em metodologia sensorial

A resposta do homem às características dos alimentos que consome define a qualidade sensorial de um alimento. A partir deste entendimento, análise sensorial é utilizada como ferramenta pelas indústrias e pesquisadores para avaliar e interpretar respostas provocadas pelos estímulos do consumo de alimentos (PALERMO, 2015). Estas análises deixaram de ser realizadas exclusivamente por provadores treinados, devido ao custo que indústrias com portfólios robustos tinham para a manutenção de um quadro de profissionais

experientes e treinados (VARELA; ARES, 2014). Neste sentido uma nova tendência pode ser observada no desenvolvimento de produtos, utilizando metodologias mais rápidas para a caracterização sensorial com consumidores (VARELA; ARES, 2012). Estas metodologias consideram que o consumidor é capaz de, de forma acurada, descrever o produto de um ponto de vista sensorial. Entre elas tem-se o questionário CATA, Check-all-that-apply, ou em português: marque tudo o que se aplica (VARELA; ARES, 2012).

CATA é uma metodologia sensorial descritiva vastamente utilizada atualmente, principalmente por ser considerada como uma alternativa rápida e simples, podendo ser aplicada para diferentes produtos (CADENA et al. 2014; LEZAETA et al. 2017; OLIVEIRA et al. 2017; TORRES et al. 2017). Ela foi desenvolvida em 2007 e utiliza uma lista de atributos ou frases, onde os consumidores marcam os termos que descrevem a experiência com o produto (MEYNERS; CASTURA, 2014).

Os termos podem incluir respostas emocionais, hedônicas, intenção de compra, aplicações potenciais e posicionamento de produto, além dos termos sensoriais que descrevem a amostra (MEYNERS; CASTURA, 2014). Os termos podem ser obtidos por levantamento bibliográfico ou mesmo com um teste preliminar (grupo foco ou questões abertas) (SILVA; MINIM, 2016).

Existem divergências quanto a quantidade de termos a ser apresentada, mas alguns autores relatam que dependendo quantidade e do tipo de amostras, pode-se utilizar entre 12 e 30 termos (ARES; JAEGER., 2015). Em uma revisão Alcantara e Freitas-Sá (2018), os autores destacam que é interessante incluir termos diferentes de acordo com as características dos produtos analisados, sem portanto, utilizar muitos termos.

A apresentação dos termos deve ser balanceada, ou seja, aleatória entre os consumidores, visando minimizar o efeito *halo* que os primeiros termos podem apresentar nas avaliações (DUTCOSKY, 2019).

A apresentação das amostras é monádica e aleatória e embora não haja investigações suficientes, um número mínimo de 60 consumidores pode ser considerado satisfatório para cada grupo experimental (ARES; JAEGER 2015).

O tratamento dos dados é feito pelo teste não-paramétrico de Cochran Q, através dos dados tabelados em tabela de contingencia. O teste Cochran Q visa detectar diferenças significativas entre as amostras para cada termo do questionário CATA e para comparação

Post hoc pode-se utilizar o Sing test. A visualização dos dados geralmente é dada em uma análise de correspondência, que usa a distância do X^2 (ARES; JAEGER 2015).

3. OBJETIVOS

3.1 Objetivo Geral

Desenvolver vinagre de caju-árvore-do-cerrado e avaliar seu potencial tecnológico e sensorial na aplicação de uma bebida saudável.

3.2 Objetivos específicos

- Elaborar vinagre a partir da fermentação alcoólica do pseudofruto de caju-árvore-do-cerrado;

- Caracterizar físico-quimicamente e sensorialmente o vinagre obtido, comparando-o com vinagres comerciais de arroz, tinto e maçã.

- Avaliar o potencial tecnológico da bebida formulada com o vinagre obtido, a partir da aceitação sensorial de julgadores não treinados por metodologia descritiva rápida;

- Investigar o impacto da alegação sobre promoção de saúde na percepção dos consumidores de bebida mista e de vinagres.

4. JUSTIFICATIVA

O desenvolvimento de novos produtos é um processo que visa inovação aplicando uma tecnologia, que pode ser nova ou tradicional, e buscando matérias-primas com potencial tecnológico. A inovação também pode acontecer quando um produto já consolidado recebe uma nova forma de uso.

Neste sentido, o desenvolvimento de um novo produto alimentício, ou uma nova forma de aplicação de um tradicional, deve, além de estudar seu potencial tecnológico, buscar conhecer a sua aceitação sensorial no mercado. A caracterização sensorial é uma ferramenta importante, essencial e extensivamente aplicada na avaliação sensorial.

Essa investigação de cunho científico e tecnológico pode contribuir para a inovação agregando valor ao vinagre pela incorporação da funcionalidade de consumo, utilizando-o como componente de uma bebida mista com apelo saudável.

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CAPÍTULO II

ARTIGO 1: VINEGAR FROM *ANACARDIUM OTHONIANUM RIZZINI* BY SUBMERGED FERMENTATION

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Vinegar from *Anacardium othonianum* Rizzini using submerged fermentation

Glenda A da Rocha Neves,[a*] Adriana R Machado,[b] Jeisa F Santana,[c] Dayane C da Costa,[a] Nelson R Antoniosi Filho,[a] Leticia F Viana,[c] Fabiano G Silva,[c] Wilma A Spinosa,[d] Manoel S Soares Junior[a] and Márcio Caliari[a]

Abstract

BACKGROUND: *Anacardium othonianum* Rizzini is a native Cerrado fruit, recently described in the literature. Its use is restricted to its native region and there is a lack of studies regarding production of vinegar from the pulp. This work aims to investigate the production of *A. othonianum* Rizzini vinegar using submerged fermentation.

RESULTS: The density, alcohol content, proximal composition, pH, color coordinates, and chromatographic profile of the volatile compounds were analyzed in the slurry, fermented juice, and vinegar produced from the corpulent parts of *A. othonianum* Rizz. Sensory acceptance and willingness to pay were also assessed with vinegar at 4% and 6% of total acidity. The results indicated compliance with European legislation and the presence of volatile compounds such as carbon dioxide, acetic acid, ethanol, and acetaldehyde in the analyzed vinegars. Our results indicate the potential of vinegar production from *A. othonianum*, with 74% and 86% willingness to pay.

CONCLUSIONS: The process of transformation of the fruit pulp into new products can contribute to fruit valorization and consequent preservation of the plant in the Cerrado biome. To the best of our knowledge, this is the first report of volatile compounds and minerals in *A. othonianum* Rizz. slurry. Our observations can be used as a basis for future studies regarding the preparation of vinegars from this species and for investigating their application in cooking and guiding consumer perception.

Keywords: acetic fermentation; Cerrado; hedonic scale; volatile compounds

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CAPITULO III

ARTIGO 2: EFEITO DA ALEGAÇÃO DE SAÚDE NA PERCEPÇÃO SENSORIAL DE VINAGRES: UM ESTUDO COMPARATIVO COM VINAGRE EXPERIMENTAL E COMERCIAL

Artigo a ser submetido para revista LWT - Food Science and Technology

EFEITO DA ALEGAÇÃO DE SAÚDE NA PERCEPÇÃO SENSORIAL DE VINAGRES: UM ESTUDO COMPARATIVO COM VINAGRE EXPERIMENTAL E COMERCIAL

RESUMO

Neste trabalho vinagres comercias (vinho, arroz e maçã) e vinagre produzido experimentalmente de caju-arvore-do-cerrado foram comparados quanto as características físico-químicas, descrição sensorial e a influência da alegação de saúde na aceitação global de consumidores de vinagre. Utilizou-se o teste afetivo de aceitação global por escala hedônica de 9 pontos e o questionário cheque-tudo-que-se-aplica (CATA) com 130 consumidores, divididos em 2 grupos (com e sem informações de alegação de saúde do produto). Análises de acidez, pH, sólidos solúveis, proteínas, antioxidantes, compostos fenólicos totais, cinzas, extrato seco, coordenadas de cor e densidade foram realizadas em triplicata para caracterização. Os dados de CATA foram comparados por regressão lógica e teste Bonferroni, a aceitação e os resultados das análises físico-química foram comparados por ANOVA e Tukey ($p \leq 0,05$). E a análise de fatores múltiplos foi empregada para visualizar possíveis relações entre as amostras e os parâmetros avaliados. Os resultados apontam que os vinagres são diferentes estatisticamente quanto aos sólidos solúveis, pH, e compostos bioativos. No entanto, quanto aos resultados sensoriais o vinagre de caju-árvore-do-cerrado foi estatisticamente similar ao vinagre comercial de maçã, quando os consumidores são informados dos benefícios do produto na saúde.

Palavras-chave: Método rápido; Comportamento do consumidor; MFA

HIGHLIGHTS:

Vinagre de vinho tinto é melhor aceito sensorialmente;

A análise de fatores múltiplos auxiliou na interpretação dos resultados, exceto para termos descritores;

O sabor ácido impactou negativamente na aceitação de vinagre.

1. INTRODUÇÃO

A utilização do pedúnculo do caju para produção de fermentados alcoólicos (vinhos), vinagres e destilados dos fermentados, pode ser uma forma para aproveitar e valorizar a parte suculenta do fruto evitando seu desperdício (Rocha Neves et al., 2020). Na Europa e na Ásia o vinagre consagrou-se como condimento e alimento funcional, embora as suas propriedades funcionais ainda não estejam totalmente esclarecidas, é conhecido seu efeito positivo no controle da pressão arterial e do pH do estômago, assim como o seu efeito bactericida, ação antioxidante nas células e o ataque aos radicais livres (Chen et al., 2017; Shishehbor et al., 2017).

Vinagres de frutas podem ser considerados superiores em qualidades sensoriais e nutritivas, quando comparados a outros tipos de vinagres, apresentando características como sabor e aroma próprios (Lu et al., 1999). Esta qualidade e as propriedades sensoriais do vinagre estão relacionadas aos seus compostos voláteis, estes podem ser derivados, além da matéria-prima, do processo de fermentação (Bakir et al., 2016). Os vinagres comumente encontrados no mercado como maçã, arroz e vinho, apresentam características próprias (Vanin et al., 2012) e podem ter valor comercial diferenciado.

Neste sentido, ao elaborarmos um vinagre novo para o mercado, se faz necessário também, compará-lo aos vinagres comerciais. O questionário cheque-tudo-que-se-aplica (CATA) é uma metodologia sensorial descritiva vastamente utilizada atualmente, principalmente por ser considerada como uma alternativa rápida e simples, podendo ser aplicada para diferentes produtos (Cadena et al. 2014; Lezaeta et al. 2017; Oliveira et al. 2017; Torres et al. 2017). Ela utiliza uma lista de atributos ou frases, onde os consumidores marcam os termos que descrevem a experiência com o produto (Meyners; Castura, 2014). Existem divergências quanto a quantidade de termos a ser apresentada, mas alguns autores relatam que dependendo quantidade e do tipo de amostras, pode-se utilizar entre 12 e 30 termos (Ares et al., 2015). A apresentação dos termos deve ser balanceada, ou seja, aleatória entre os consumidores, visando minimizar o efeito *halo* que os primeiros termos podem apresentar nas avaliações (Dutcosky, 2019).

Com objetivo de nortear o desenvolvimento de produtos, análises físico-químicas são usualmente correlacionadas com respostas sensoriais por análise de preferência multidimensional (Dutcosky, 2019) ou por análise de múltiplos fatores (MFA), que é uma técnica estatística multivariada aplicada a múltiplos conjuntos de dados. Os dados são primeiramente tratados com análises de componentes principais dentro de cada subconjunto e então são normalizados para obtenção dos gráficos de MFA. Ela pode ser utilizada para correlacionar os dados de análises sensoriais e análises físico-químicas (Abdi et al., 2013).

A influência da informação na atitude do consumidor já vem sendo estudada para diferentes produtos comerciais (Carrillo; Varela; Fiszman, 2012; Waldrop; Mccluskey, 2019), e apesar de possuir propriedades terapêuticas (Ling et al. 2019), ainda não há estudos sobre o comportamento do consumidor de vinagre sob alegações de saúde.

O presente trabalho teve por objetivo avaliar a influência da alegação de saúde no comportamento do consumidor de vinagre e comparar vinagres comerciais de maçã, arroz e vinho tinto com o vinagre produzido experimentalmente de caju-árvore-do-cerrado através das suas características descritivas pela metodologia do questionário CATA e suas características físico-químicas utilizando MFA.

2. MATERIAL E MÉTODOS

2.1 Vinagres

O vinagre de *Anacardium othonianum Rizz* foi produzido conforme pesquisa anterior (Rocha Neves et al., 2020), e foi diluído com água filtrada para acidez final total de 4%, a mesma acidez de vinagres comerciais no Brasil.

Os vinagres comerciais foram escolhidos pelos sabores que tinham maior número entre as marcas, e a marca foi escolhida por aquela que apresentava a maior variedade de sabores no mercado (Castelo, São Paulo, Brasil). Vinagres de maçã, tinto e arroz foram adquiridos em comércio local.

2.2 Análise Sensorial

Consumidores

Participaram da pesquisa 120 consumidores, não treinados e maiores de 18 anos, sendo 58% do sexo feminino, 85% com idade entre 18 e 29 anos e 15% com idade entre 30 e 54 anos. Todos assinaram a concordância no termo de consentimento livre esclarecido. Eles foram recrutados dentro do IF Goiano, campus Rio Verde e responderam um questionário rápido sobre o hábito do consumo do produto. Esta pesquisa foi aprovada pelo Comitê de Ética e Pesquisa sob n° 30547120.1.0000.0036.

Análise sensorial

As amostras (15 mL) foram servidas refrigeradas (10° C), de forma monádica e aleatória em copo descartável (50 mL) codificado (Viana et al., 2017) sob luz branca. As análises sensoriais dos vinagres foram realizadas pelo teste de aceitação seguido de análise descritiva rápida questionário CATA (cheque-tudo-que-se-aplica) (Varela & Ares, 2014).

Os consumidores foram orientados a experimentar o produto como se estivesse escolhendo um tempero para comprar. Não sendo obrigatório que bebessem o produto. Água foi oferecida para limpar o palato.

Teste de aceitação

Utilizou-se escala hedônica estruturada de 9 pontos (1 = desgostei extremamente a 9 = gostei extremamente) para avaliar a aceitação global (Lawless & Heymann, 2010). Os participantes avaliaram os vinagres sob duas condições: (a) cegas (n=66), ou seja, apenas avaliaram as amostras recebidas; e (b) informados, receberam, de forma aleatória, a informação de alegação antes de experimentar o vinagre (Pereira et al., 2019).

Alegação de saúde

A alegação de informação foi elaborada a partir de informações observadas em pesquisas prévias e foi apresentada como segue, retirando-se portanto as referências bibliográficas: “Antes de iniciar a análise, por favor leia a informação a seguir: Estudos sobre o impacto da ingestão de vinagre na saúde indicam que este produto pode auxiliar no controle glicêmico (Shishehbor; Mansoori; Shirani, 2017), na redução de lesões hepáticas (Beh et al., 2016), na melhoria do sistema imune intestinal (Lee; Kim; Shin, 2015), na inibição de proliferação de células carcinogênicas (Budak et al., 2014) e na fertilidade de mulheres com ciclos menstruais irregulares (Wu et al., 2013).”

Termos sensoriais

Para o questionário CATA, os consumidores foram convidados a avaliar 15 atributos, assinalando os termos que consideravam mais apropriados para descrever cada amostra. Os termos utilizados foram coletados de estudos prévios disponíveis na literatura: aroma frutado,

límpido, aroma cítrico, sabor azedo, sabor de ácido acético (Fernandes et al., 2018), sabor de vinho (Kharchoufi et al., 2018; Tesfaye et al., 2010), aroma alcoólico, sabor alcoólico (Cejudo-Bastante et al. 2019) e em teste preliminar com grupo focal (Dutcosky, 2019): aroma agradável, aroma apimentado, aroma ácido, aroma suave, prazeroso, visual agradável, saboroso e ruim.

2.3 Características físico-químicas dos vinagres

Sólidos solúveis totais (SST), acidez titulável e acidez volátil foram determinados de acordo com os métodos oficiais para análise de vinhos e vinagres (OIV-MA-AS312-01A, 2012). SST foi determinado utilizando um refratômetro automático com compensação de temperatura (Refractometer Reichert, Buffalo, NY, USA), a densidade foi aferida utilizando um densímetro digital portátil (Anton Paar DMA 45, Anton Paar, Ashland, VA, USA), o pH foi determinado utilizando um potenciômetro de bancada (Luca210, Lucadema, SP, Brasil).

Os teores de Nitrogênio foram determinados por micro Kjeldahl conforme preconizado pela AOAC (2010) e convertidos a proteína multiplicando o valor obtido por 6.25.

Coordenadas de cor

As coordenadas de cor (L, a *, b *) foram determinadas por leitura direta em calorímetro (Colorímetro CR-400, Konica Minolta, São Paulo, Brasil) e o croma e o Hue foram calculados (Tribst et al., 2011) , utilizando 3 repetições para cada amostra.

Compostos fenólicos totais

Utilizou-se a metodologia Follin-Ciocalteau para estimar o conteúdo total de compostos fenólicos. Uma amostra de 200 µL foi utilizada, onde adicionou-se 1,9 mL de reagente Follin-Ciocalteau. Carbonato de cálcio (60 g L^{-1}) foi usado para neutralizar a solução. A absorbância foi obtida a 725 nm após 120 minutos. Os resultados são expressos em equivalente grama de ácido ferúlico (Li et al., 2009).

ABTS

ABTS (2,2′-Azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)) foi determinado baseado na metodologia de Miller et al., (1993) modificado (Rufino et al., 2010). Uma alíquota de 30 µM foi homogeneizada com 3.0 mL de solução do radical ABTS, após 6 min. A absorbância foi aferida a 734 nm em espectrofotômetro UV-Vis, observando os radicais cátions pela mudança de coloração. Os resultados são expressos em µM Trolox/100 mL.

DPPH

DPPH (2,2-Diphenyl-1-picrylhydrazyl) foi determinado de acordo com Brand-Williams, Cuvelier e Berset (1995) com modificações. Homogeneizou-se 3.9 mL de solução de radical DPPH e 1 mL de amostra por 30 min. e então a absorbância foi aferida a 515 nm em espectrofotômetro UV-Vis. Os resultados estão expressos em µM Trolox/100 mL.

2.5 Análise dos dados

As amostras foram caracterizadas pela frequência das respostas do questionário CATA, usando regressão lógica e somente os termos com mais de 15% de frequência foram utilizados para análise de correspondência pelo teste Q Cochran ($p<0.05\%$), e McNemar

como post-hoc (Alexi et al., 2018). Os grupos (cego e informado) foram analisados separadamente. A Seleção de cada um dos termos (0/1) foi considerada variável dependente (D. Oliveira et al., 2020). A percepção da influência da informação (benefícios do produto na saúde) foi avaliada pela aceitação global, estes dados foram submetidos a teste de distribuição das médias a 5% de significância (Kolmogorov-Smirnov), análise descritiva por classificação dos escores hedônicos e histograma.

Os resultados das análises fisíco-químicas foram analisados por ANOVA, Tukey e comparados com os dados de análise sensorial utilizando análise multivariada MFA (Abdi et al., 2013). As variáveis foram agrupadas em sete tabelas, sendo elas aceitação (notas individuais para os grupos cego e informado), acidez (médias de pH, acidez volátil, acidez fixa e acidez total); bioativos (médias de teores de compostos fenólicos e os compostos antioxidantes por DPPH e ABTS); cor (coordenadas de cor obtidas para L, a*, b*, Croma e Hue); descrição (soma das frequências totais dos termos descritores) e sólidos (médias de teores de cinzas, proteína, densidade, extrato seco e sólidos solúveis - ° Brix). A aceitação global e descrição foram utilizadas como variáveis suplementares. Todas as análises estatísticas foram realizadas usando pacote estatístico XLSTAT (Addinsoft, 2020).

3. RESULTADOS E DISCUSSÕES

3.1 Análise sensorial

As médias de aceitação global foram significativas na ANOVA, porém devido aos valores de desvio padrão (Tabela 1) e a aparente segmentação dos consumidores observadas na Fig. 1 (A e B), realizou-se o teste de distribuição de médias (Kolmogorov-Smirnov) à 95% de confiança. A distribuição das médias foi significativa, exceto para o vinagre de maçã. Devido à falta de distribuição normal, realizou a análise descritiva dos dados a partir dos escores hedônicos, representados na Fig. 1 (C e D), onde podemos observar que o vinagre de arroz foi melhor aceito no grupo informado e que no grupo cego o vinagre mais aceito foi o de vinho tinto. O vinagre de maçã foi o mais rejeitado para os dois grupos e o vinagre de caju apresentou comportamento similar para ambos os grupos e com valores próximos aos resultados do vinagre de maçã.

A influência da informação na atitude do consumidor já vem sendo estudada para diferentes produtos comerciais (Carrillo; Varela; Fiszman, 2012; Waldrop; Mccluskey, 2019; Włodarska et al., 2019). Com relação a informação dos benefícios do vinagre na saúde, no comportamento do consumidor, este é um estudo pioneiro, onde observamos que se pode minimizar a rejeição dos vinagres quando informamos o consumidor sobre os benefícios do produto. Esse comportamento também é observado em pesquisas com diferentes produtos como queijos (Schouteten et al., 2015), iogurte de cupuaçu (Costa et al., 2017) e bebidas não alcoólicas (Kim; House, 2014).

Nesta pesquisa o vinagre de caju-árvore-do-cerrado apresentou média de aceitação global de 5.36 e 5.64 para os grupos cego e informado, respectivamente. Valores inferiores aos encontrados em nossa pesquisa anterior, onde o vinagre de cajú-arvore-do-cerrado com 4% de acidez, foi avaliado individualmente em vinagrete e apresentou aceitação global média de 7.1 (Neves et al., 2020). Este resultado pode ter sido influenciado pela forma como o produto foi oferecido, já que na pesquisa anterior o vinagre foi servido como tempero em um vinagrete.

Já o vinagre de maçã apresentou média de 5.16 e 5.36, respectivamente para o grupo cego e informado. Em pesquisa anterior, realizada por (Viana et al., 2017) o vinagre de kefir de maçã e o vinagre de maçã comercial apresentaram aceitação global média de 7.4 e 7.2, respectivamente.

Com relação ao vinagre tinto, nesta pesquisa as médias de aceitação foram 5.99 para o grupo cego e 5.78 para o grupo informado. Sendo, portanto, o vinagre com menor taxa de rejeição, exceto pelo vinagre de arroz no grupo informado (Fig. 1 C e D). Em trabalho anterior, vinagres de vinho tinto comerciais foram avaliados ao longo do tempo e apresentaram médias de 3.7 a 7.2, no referido estudo as diferenças foram observadas principalmente entre amostras estudadas e não foram percebidas ao longo de 12 meses (Kang et al., 2020).

O vinagre de arroz, nesta pesquisa apresentou média de 5.36 e 6.69 para os grupos cego e informados, respectivamente. Portanto, este foi o vinagre que apresentou maiores médias de aceitação. Chung et al., (2017) observaram médias de aceitação para o *flavour* de 4.19 a 7.32 (valores convertidos de escala de 5 pontos) para vinagres comerciais de arroz.

Os resultados da presente pesquisa, quando comparados com a literatura, sugerem que a forma como o vinagre é apresentado, influencia na aceitação sensorial.

O vinagre é um produto que recentemente vem ganhando mais atenção quanto a pesquisas sensoriais (Kharchoufi et al., 2018; Ünal Turhan & Canbaş, 2016; Yıkmış et al., 2020). O desenvolvimento de metodologias rápidas para análise sensorial podem facilitar a análise deste produto, permitindo que ele seja ofertado na sua forma pura (Fernandes et al., 2019; Lalou et al., 2015; Ubeda et al., 2017; Viana et al., 2017). De fato, este produto ainda é avaliado em misturas que servem para atenuar o sabor pungente do ácido acético (Boonsupa, 2019; Kang et al., 2020; Rocha Neves et al., 2020; Yıkmış et al., 2020), no entanto é interessante pontuar, que essas substâncias podem mascarar o sabor do vinagre, caso a intenção seja avaliar a aceitação do produto em si.

Quanto aos resultados dos termos descritores, no grupo cego observa-se os termos aroma alcoólico, aroma de vinho, límpido, sabor alcoólico, sabor de vinho e visual agradável diferiram estatisticamente ($p \leq 0.05$). As principais características sensoriais que apresentaram maiores frequências atribuídas foram: aroma ácido, aroma cítrico, sabor azedo e visual agradável.

Com 93,2% de representação (Fig. 2 A), a análise de correspondência para o grupo de consumidores sem informações sobre os benefícios do produto na saúde (condição cega), indica que o vinagre de arroz ficou posicionado próximos ao termo ruim, bem como aroma cítrico e sabor ácido, assim como o vinagre de caju-árvore-do-cerrado. Essa avaliação é condizente com as respostas da aceitação global. O vinagre de vinho tinto aparece próximo aos termos positivos: aroma agradável, sabor alcoólico e saboroso, que pode indicar uma

correlação do produto com a bebida alcoólica que o origina, melhorando sua percepção sensorial.

Além da correlação com bebida alcoólica o consumidor pode relacionar as cores do produto com sabores. O vermelho é associado ao sabor doce (Spence, 2019), podendo portanto ter afetado a aceitação do vinagre de vinho tinto de forma positiva. Assim como os vinagres com pouca saturação na cor podem ter o seu sabor ácido percebido de forma mais forte (Pomirleanu et al., 2020).

Na análise de coordenadas principais (Fig. 1 C e D) e também na análise de atributos com impacto significativo na média (Fig. 1 E e F), observa-se que para o grupo cego, a aceitação global está relacionada aos termos aroma agradável e visual agradável e também o termo saboroso. De fato, a percepção de sabores dos vinagres está associada aos aromas que o mesmo possui, que por sua vez pode ser influenciado pelo método de obtenção do produto (Cejudo-Bastante et al., 2018).

No grupo informado sobre os benefícios do vinagre na saúde, os termos significativos foram aroma de vinho, límpido, prazeroso e sabor de vinho. As maiores frequências são observadas para os termos aroma ácido, sabor ácido e visual agradável (Tab.3).

Na análise de correspondência (Fig. 2 B) os termos para as amostras de vinagre de maçã e de arroz, estão próximas no quadrante inferior esquerdo, com termos descritivos como apimentado e sabor ácido, já o vinagre de caju-de-árvore-do-cerrado aparece no quadrante superior esquerdo com termos como límpido, aroma cítrico e visual prazeroso. Já o vinagre de vinho tinto aparece próximo aos termos saboroso, prazeroso e sabor de vinho. Portanto, o

grupo informado apresentou comportamento similar ao grupo cego, relacionando o vinagre de vinho tinto com características de vinho e também com melhor sabor (termo saboroso).

Na análise de coordenadas principais (Fig. 2 D) e também na análise de atributos com impacto significativo na média (Fig. 2 E) observa-se que a aceitação global do grupo informado está relacionada aos termos aroma frutado, prazeroso e sabor de vinho. E neste grupo de consumidores (informados) o sabor azedo apresentou impacto negativo na média da aceitação global. O sabor azedo ativa um dos mecanismos de sobrevivência no homem, fazendo que ele tenha aversão ao sabor (Krashes & Chesler, 2019). Fato que pode explicar a baixa aceitação do produto em provadores não treinados, independente da informação sobre os benefícios do produto.

As pesquisas sensoriais com vinagre, buscam principalmente a caracterização dos produtos, sob aspectos como a vida de prateleira (Kang et al., 2020), a aceitação (Rocha Neves et al., 2020) e descrição de um novo produto (Boonsupa, 2019; Chen et al., 2017; Fernandes et al., 2019; Ubeda et al., 2017).

Em uma das poucas pesquisas comparando vinagre produzido de romã com vinagres comerciais de vinho tinto e branco, os provadores treinados identificaram que os vinagres avaliados apresentaram características similares (Kharchoufi et al., 2018). Já o vinagre de morango, quando comparado com vinagre comercial de vinho tinto e branco, foi melhor avaliado por provadores treinados (Ubeda et al., 2017). Já o vinagre de kefir de maçã, também avaliado por provadores treinados, não apresentou diferenças estatísticas quando comparado com vinagre comercial de maçã (Viana et al., 2017). Esse comportamento pode ocorrer devido a qualidade sensorial de vinagres ser afetada tanto pela cultura de microrganismos

usada na fermentação acética (Chen et al., 2017), quanto para o método de fermentação usado (Ubeda et al., 2017), bem como o tempo de prateleira do produto (Kang; Ha; Lee, 2020).

3.2. Análises físico-químicas e compostos bioativos

Na Tabela 4, observa-se os resultados das análises físico-químicas para os vinagres avaliados. Os vinagres apresentaram diferenças significativas ($p \leq 0.05$) para parâmetros como sólidos solúveis, pH, compostos fenólicos, DPPH e ABTS. Essas diferenças são esperadas, visto que os produtos avaliados são provenientes de diferentes matérias-primas

3.3 Análise de fatores múltiplos (MFA) para correlação das análises físico-química e sensorial dos vinagres.

A MFA é uma técnica recente, relatada inicialmente em 2001, e ainda há poucos trabalhos utilizando para comparação de dados na área de alimentos (Heo et al., 2019; Kostov et al., 2013; Ramírez-Rivera et al., 2018).

A MFA apresentou 87,2% de representação para as duas dimensões do plano (Figura 9, 10, 11 e 12) e a aceitação global aparece mais relacionada as coordenadas de cor nas duas dimensões (Figura 11), principalmente para o grupo cego. Já para o grupo informado a

aceitação aparece mais próximo ao parâmetro de acidez. As coordenadas de cor (a*, b*, croma e hue) aparecem mais próximas dos compostos fenólicos na dimensão 1 (Fig 11).

Na Fig. 9 e 10 observa-se que o vinagre de vinho tinto aparece na mesma posição (quadrante esquerdo superior). Neste quadrante também aparecem a maioria dos descritores e os parâmetros de compostos bioativos. Os termos descritores também estão mais próximos dos parâmetros acidez volátil, densidade e luminosidade.

Quando as amostras são comparadas quanto aos aspectos físico-químicos, observa-se que as amostras ficaram distintas nos quadrantes, comportamento esperado para as diferentes amostras e que corrobora com os resultados de análise sensorial por CATA, em que os consumidores foram capazes de diferenciar as amostras. O mesmo comportamento foi observado em uma pesquisa com café gelado (Heo et al., 2019), onde os autores caracterizam a bebida por questionário CATA e avaliaram o conjunto de dados com as características físico-químicas por MFA.

Na Figura 12 os pontos projetados indicam que os vinagres de arroz e caju apresentaram parâmetros similares para a cor, já os vinagres de arroz e tinto apresentaram parâmetros similares para o teor de sólidos solúveis (° Brix) e o vinagre de maçã apresentou parâmetros similar ao vinagre de vinho tinto para os compostos bioativos.

4. CONCLUSÕES

Com o presente trabalho observou-se que a informação sobre os benefícios do vinagre na saúde afetou a aceitação global dos produtos, no entanto, os consumidores apresentaram comportamento segmentado.

O vinagre de caju-árvore-do-cerrado apresentou avaliação sensorial próxima ao vinagre comercial de maçã, indicando potencial para comercialização. Em termos de... Descrever parâmetros.

Para o grupo informado o vinagre-de-caju-árvore-do-cerrado teve melhor avaliação sendo descrito como límpido, aroma suave, aroma cítrico, visual agradável e sabor de ácido acético e com aceitação global superior ao vinagre de maçã, ou seja, esse resultado indica que a informação afetou a aceitação do produto.

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Tabela 1. Aceitação global para os grupos de consumidores cegos e informados e teste de distribuição dos dados (K-means).

	Aceitação global				
Vinagres	Cegos[1]	K-means	Informados[1]	K-means	Ambos
Maçã	5.16±49	0.006	5.36±37	0.020	5.25±44
Caju-do-cerrado	5.36±40	0.117*	5.64±37	0.025	5.49±38
Arroz	5.36±47	0.006	6.68±26	0.001	5.96±38
Tinto	5.99±40	<0.0001	5.78±28	0.001	5.88±35

Média seguida do desvio padrão; Cegos[1] refere-se o grupo de consumidores que não receberam quaisquer informação sobre os benefícios do produto na saúde e Informado[2] refere-se aos consumidores que receberam a informação de alegação dos benefícios do consumo do produto para a saúde. * não significativo pelo teste de médias.

Tabela 2: Frequência e teste Cochran e Bonferroni para os termos com mais de 15% de frequência para o grupo cego

Termos	Vinagre				teste Cochran Q p-values
	Maçã	Caju	Tinto	Arroz	
Aroma ácido	27	23	27	21	0.572
Aroma alcoólico	20	8	12	15	0.028
Aroma cítrico	20	20	22	28	0.335
Aroma de vinho	10b	3b	35a	10b	< 0,0001
Aroma suave	12	14	13	12	0.957
Saboroso	13	15	20	14	0.422
Límpido	8ab	10ab	5b	17a	0.001
Aroma agradável	17	18	28	23	0.075
Prazeroso	11	11	10	11	0.988
Ruim	10	13	5	15	0.062
Sabor alcoólico	9	11	20	11	0.016
Sabor azedo	32	29	24	37	0.071
Sabor de ácido acético	14	12	9	13	0.609
Sabor de vinho	5b	2b	32a	6b	< 0.0001
Visual agradável	28	26	36	22	0.019

Letras diferentes indicam diferenças estatísticas na mesma linha pelo teste de Cochran

Tabela 3. Frequência e teste Cochran e Bonferroni para os termos com mais de 15% de frequência no o grupo cego

Termos	Vinagres				p-values
	Maçã	Caju	Tinto	Arroz	
Aroma ácido	17	18	9	19	0.088
Aroma alcóolico	14	5	15	12	0.054
Aroma cítrico	15	18	12	15	0.557
Aroma de vinho	4^{b}	2^{b}	31^{a}	5^{b}	< 0.0001
Aroma frutado	13	6	17	7	0.005
Aroma suave	13	18	13	17	0.507
Saboroso	11	17	21	13	0.097
Límpido	11^{ab}	16^{a}	5^{b}	16^{a}	0.002
Aroma agradável	16	14	18	12	0.586
Prazeroso	6	13	17	7	0.008
Sabor alcóolico	9	7	15	10	0.179
Sabor ácido	30	22	20	27	0.120
Sabor de ácido acético	12	13	11	8	0.591
Sabor de vinho	2^{a}	6^{a}	30^{a}	4^{a}	< 0.0001
Sabor picante	10	7	9	10	0.820
Visual agradável	24	31	27	27	0.461

*Letras diferentes indicam diferenças estatísticas na mesma linha pelo teste de Cochran

Tabela 4. Análises físico-químicas e compostos bioativos para os vinagres de arroz, caju-árvore-do-cerrado, maçã e tinto.

Parâmetro	Vinagre			
	Arroz	Caju	Maçã	Tinto
Sólidos Solúveis (°Brix)	3,27±0,11^{c}	2,77±0,04^{a}	3,5±0,00^{b}	3,07±0,04^{c}
pH	2,91±0,0^{b}	2,68±0,0^{d}	2,96±0,0^{a}	2,86±0,0^{c}
Ac titulável (meq.L^{-1})	10,84±0,06^{a}	10,035±0,06^{b}	10,60±0,06^{a}	10,08±0,03^{b}
Ac volátil (meq.L^{-2})	0,47±0,01^{c}	0,75±0,01^{a}	0,49±0,01c	0,51±0,01^{b}
Ac Fixa (meq.L^{-3})	10,36±0,01^{a}	9,28±0,01^{b}	10,11±0,01^{b}	9,57±0,01^{a}
Densidade (g. cm^{-3})	1,003±0,00	1,004±0,00	1,002±0,00	1,001±0,00
Cinzas (g.100g^{-1})	4,01±0,31^{ab}	0,99±0,03^{c}	3,75±0,45^{a}	1,84±0,52b^{c}
Luminosidade	88,26±0,85	24,71±0,19	76,48±0,87	38,34±0,25
a*	-1,47±0,01	-0,37±0,63	-2,09±0,07	36,63±1,19^{a}
b*	1,69±0,07^{c}	7,71±0,20^{b}	10,74±0,38^{b}	31,39±1,31^{a}
Croma	2,25±0,04^{c}	7,75±0,19^{b}	10,94±0,39^{b}	48,24±1,75^{a}
Hue	-48,82±1,31	-27,11±0,32	-79,01±0,29	40,58±0,27
CF (g.100g^{-1})	13,27±0,02^{c}	39,88±1,23^{b}	42,07±0,57^{b}	48,62±0,34^{a}
DPPH(µM Trolox. 100 mL^{-1})	-15,75±6,67^{d}	38,42±2,78^{c}	1006,75±6,67^{b}	1290,92±6,11^{a}
ABTS(µM Trolox. 100 mL^{-1})	383,67±8,89^{d}	37,01±4,44^{c}	1402,56±16,3^{b}	1973,67±4,44^{a}
Extrato Seco (g.100g^{-1})	1,82±0,09^{b}	1,37±0,01^{c}	2,67±0,02^{a}	1,97±0,09^{b}

Médias das triplicatas, seguidas de desvio padrão. Letras diferentes indicam diferenças estatísticas entre as amostras ($p \leq 0,05$) pelo teste de Tukey. CF: compostos fenólicos.

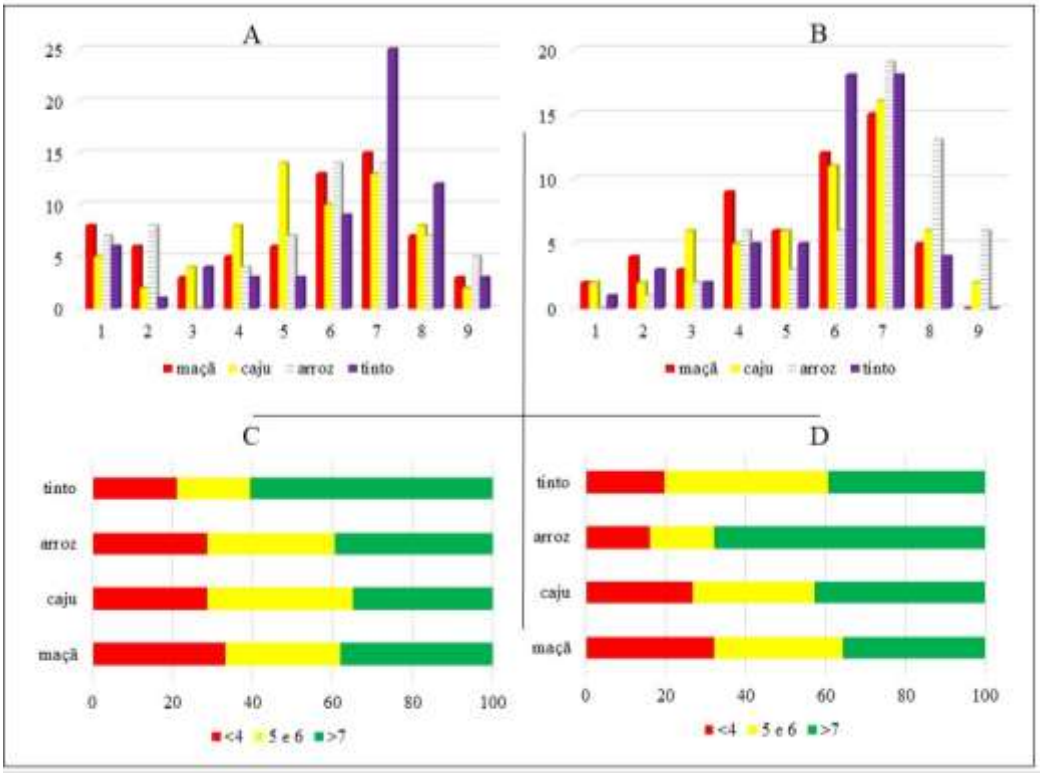

Figura 1. Histograma dos escores hedônicos de vinagres para o grupo cego (A) e informado (B)

E classificação (%) dos escores hedônicos para o grupo cego (C) e informado (D).

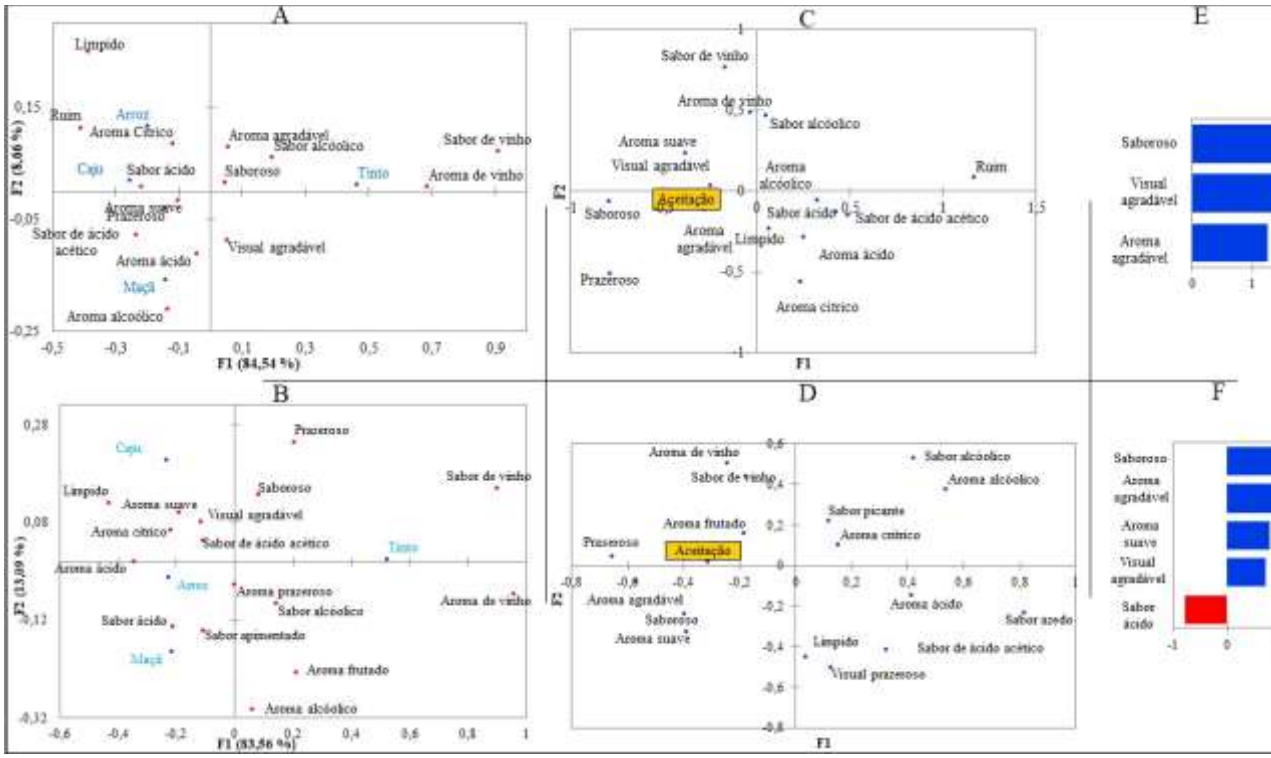

Figura 2. Análise de correspondência para os vinagres (azul) e termos descritivos para os grupos cego (A) e informado (B), análise de coordenadas principais com a aceitação global e os termos descritivos para o grupo cego (C) e informado (D) e atrubutos com impacto significativo na média para o grupo cego (E) e informado (F).

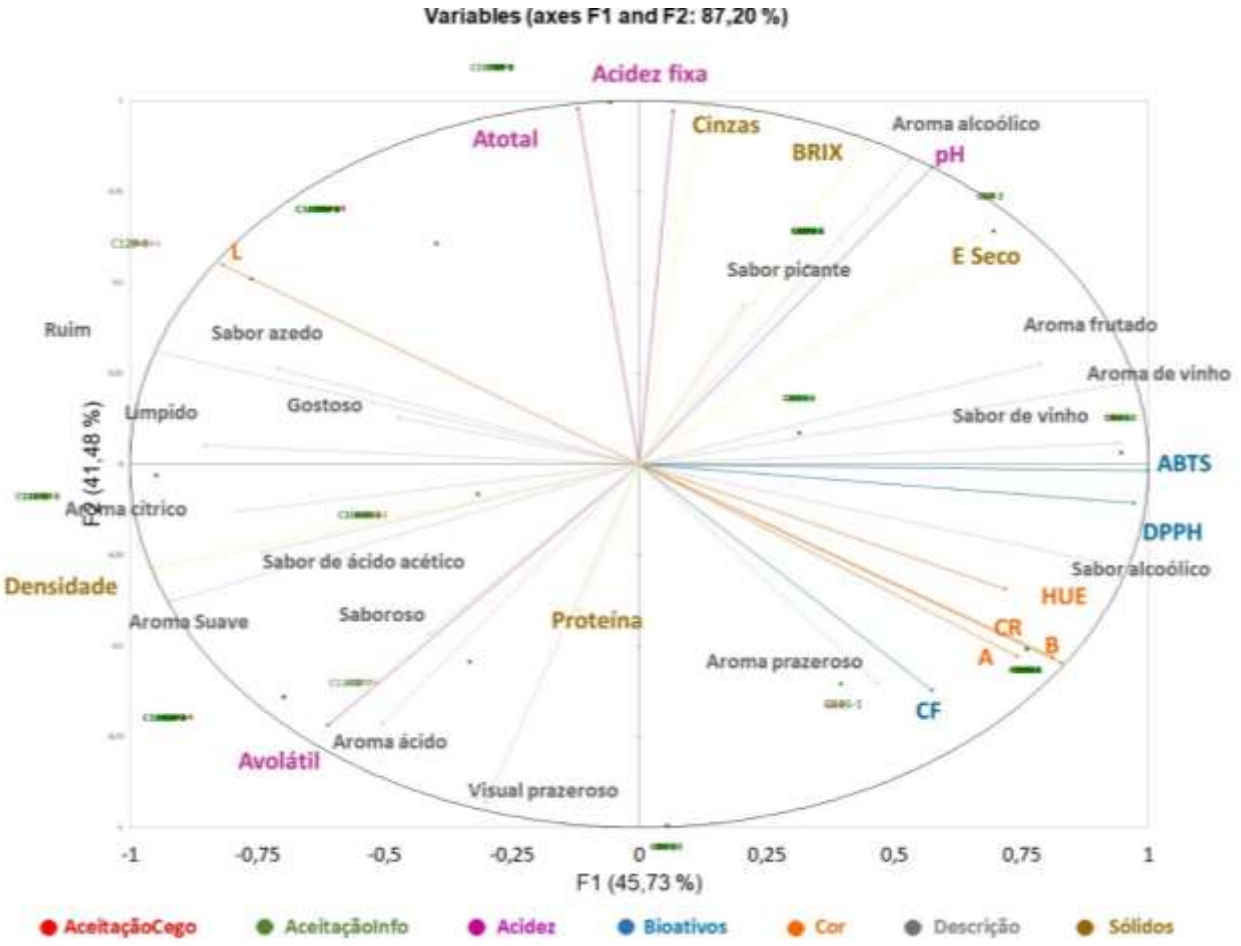

Figura 3. Correlação das variáveis qualitativas, quantitativas e tabela e frequência dos termos descritores para os vinagres avaliados, onde o grupo aceitação representa as notas individuais para os grupos cego e informado; Acidez representa as medidas qualitativas de pH, acidez volátil, acidez fixa e acidez total; Bioativos representa as respostas da determinação de os compostos fenólicos e os compostos antioxidantes (DPPH e ABTS); Cor representa as coordenadas de cor obtidas para L, a*, b*, Croma e Hue; Descrição representa as soma das frequência dos termos descritores total e Sólidos representa as análises de Cinzas, proteína, densidade, Extrato seco e sólidos solúveis.

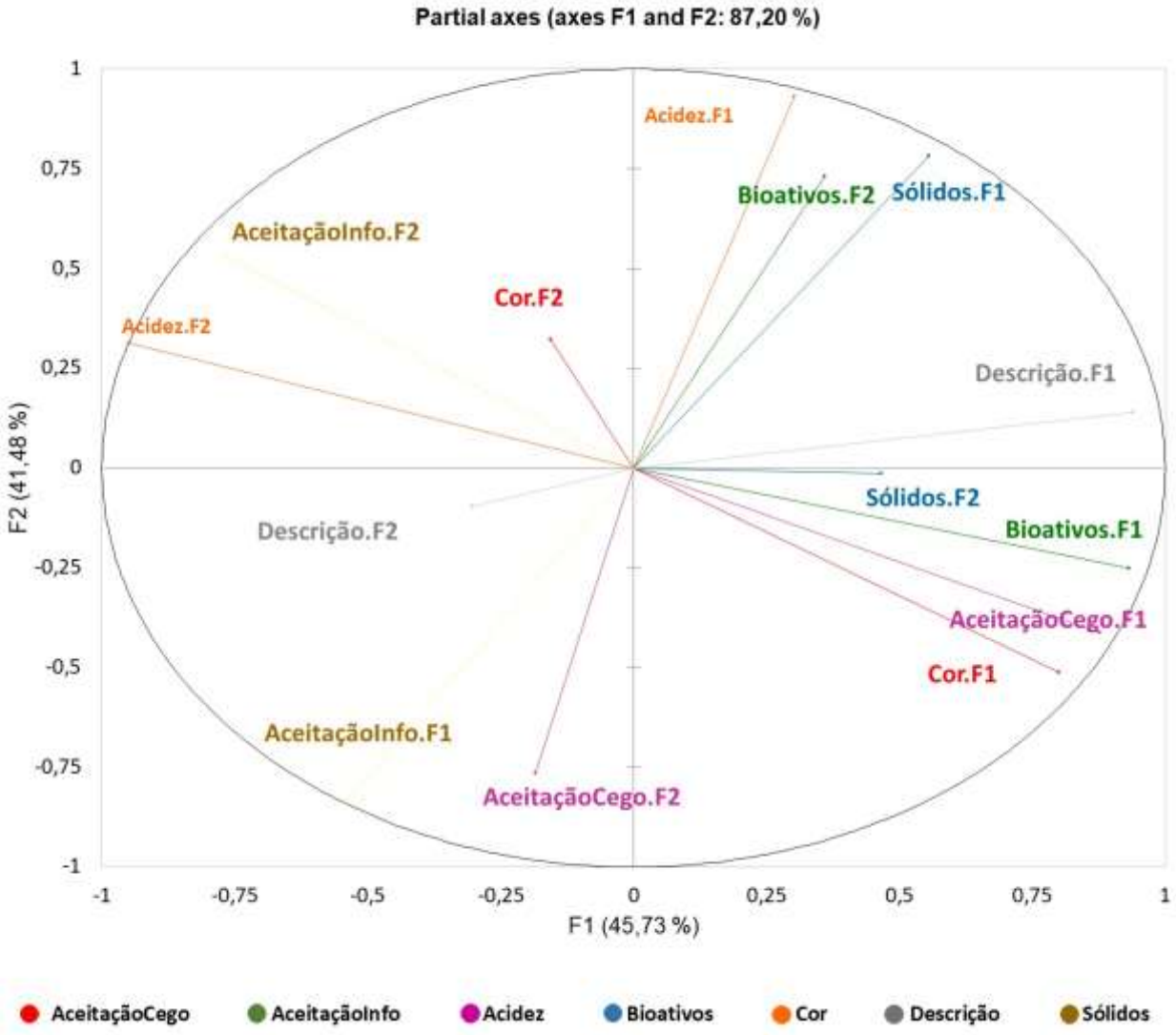

Figura 4. Eixos parciais dos grupos de variáveis. Onde: Aceitação representa as notas individuais para os grupos cego e informado; Acidez representa as medidas qualitativas de pH, acidez volátil, acidez fixa e acidez total; Bioativos representa as respostas da determinação de os compostos fenólicos e os compostos antioxidantes (DPPH e ABTS); Cor representa as coordenadas de cor obtidas para L, a*, b*, Croma e Hue; Descrição representa as soma das frequência dos termos descritores total e Sólidos representa as análises de Cinzas, proteína, densidade, Extrato seco e sólidos solúveis.

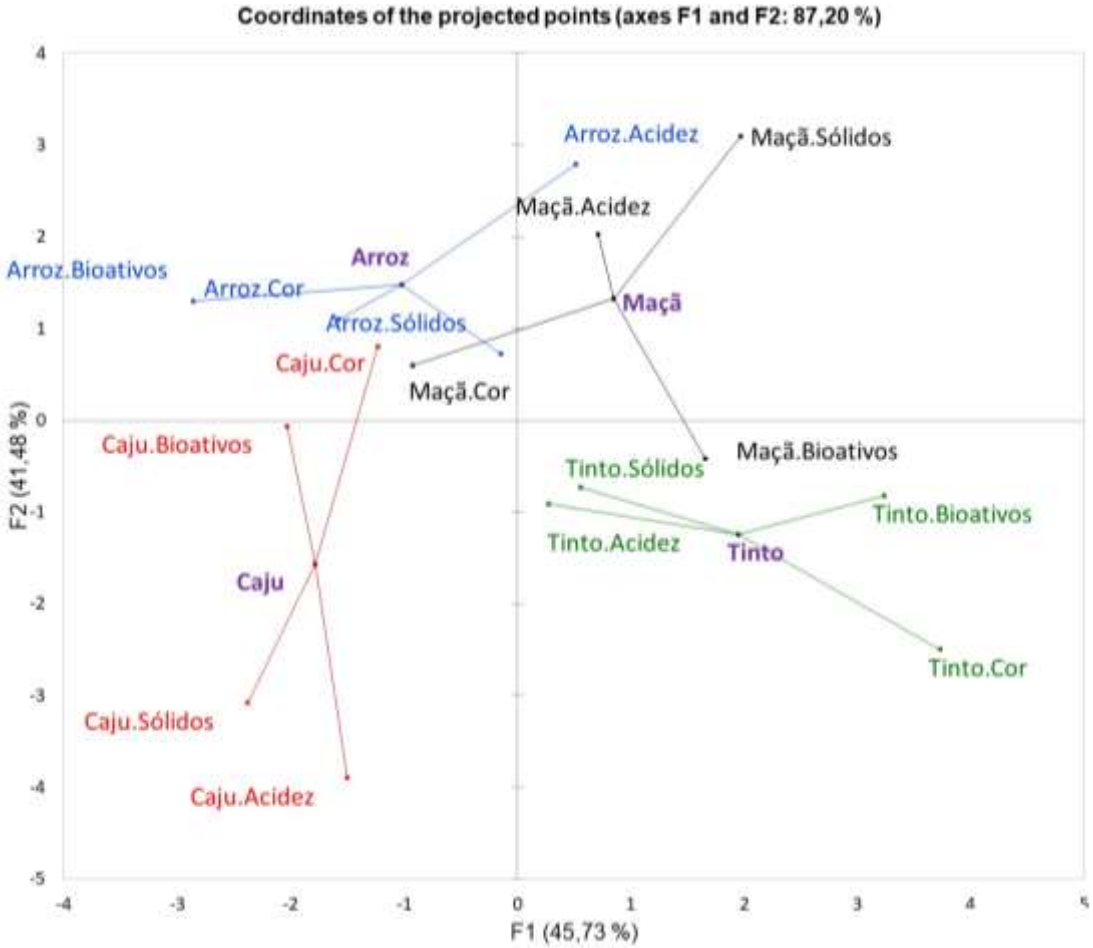

Figura 5. Coordenadas dos pontos projetados da análise de fatores múltiplos

ANEXO II- NORMAS DE PUBLICAÇÃO DA REVISTA LWT - FOOD SCIENCE AND TECHNOLOGY

LWT
Food Science and Technology

ELSEVIER

AUTHOR INFORMATION PACK

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ISSN: 0023-6438

DESCRIPTION

LWT - Food Science and Technology is an international journal that publishes innovative papers in the fields of **food chemistry**, **biochemistry**, **microbiology**, **technology** and **nutrition**. The work described should be innovative either in the approach or in the methods used. The significance of the results either for the science community or for the **food industry** must also be specified. Contributions written in English are welcomed in the form of review articles, short reviews, research papers, and research notes. Papers featuring animal trials and cell cultures are outside the scope of the journal and will not be considered for publication.

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CAPITULO IV

ARTIGO 3: CARACTERÍSTICAS FÍSICAS, QUÍMICAS E ACEITAÇÃO SENSORIAL DE BEBIDAS MISTAS DE FERMENTADO ACÉTICO DE CAJU-ÁRVORE-DO-CERRADO, ÁGUA DE COCO E SUCOS DE UVA E DE MAÇÃ

Artigo a ser submetido para revista LWT - Food Science and Technology

CARACTERÍSTICAS FÍSICAS, QUÍMICAS E ACEITAÇÃO SENSORIAL DE BEBIDAS MISTAS DE FERMENTADO ACÉTICO DE CAJU-ÁRVORE-DO-CERRADO COM VARIAÇÕES DE ÁGUA DE COCO E SUCOS DE UVA E DE MAÇÃ

RESUMO

Para usufruir dos benefícios do consumo do vinagre, fermentado acético (FA), na saúde e melhorar a palatabilidade, em algumas culturas é usual misturar o produto com sucos. Os sucos integrais de uva (SU) e de maçã (SM) são conhecidos por seus elevados teores de compostos antioxidantes, já a água de coco (AC) é um isotônico natural facilmente encontrado no Brasil. O aproveitamento tecnológico do cajuzinho-arvore-do-cerrado e seus subprodutos, como o FA, pode contribuir com o desenvolvimento regional do cerrado. O objetivo desta pesquisa foi avaliar as características físicas, químicas e a aceitação sensorial global de bebidas mistas (BM) de FA de cajuzinho-árvore-do-cerrado com variações de AC, SU e SM. Delineamento Simplex foi utilizado, e foram avaliados os sólidos solúveis (SS), pH, acidez total, densidade, composição proximal, sacarose, açúcares totais, perfil mineral, parâmetros instrumentais de cor e compostos bioativos. Análise sensorial de aceitação global e intenção de compra foram também realizadas para comparar seus resultados com a amostra de maior desejabilidade em função da maior saudabilidade. Os teores de AC, SU e SM afetaram significativamente os parâmetros: luminosidade, densidade, SS, pH, acidez total, umidade, proteína, potássio e compostos fenólicos. A AC provocou maior luminosidade e pH e menor acidez, já o SU elevou os SS, a acidez e as proteínas e o SM aumentou os SS, a luminosidade, a umidade e o potássio. Os resultados indicam que o desenvolvimento da BM é viável quanto aos aspectos nutricionais, sensoriais e saudabilidade, além de contribuir com a preservação do bioma Cerrado.

Palavras-chave: *Anacardium othonianum* Rizzini, *Cocos nucifera* L., *Vitis vinifera*, *Malus domestica*, perfil de minerais, atividade antioxidante.

HIGHLIGHTS

As bebidas mistas elaboradas são fonte de compostos antioxidantes e minerais

A bebida mista favorece o usufruto dos benefícios do vinagre na saúde

A bebida mista com maior saudabilidade foi aceita sensorialmente

1. INTRODUÇÃO

Suco é a bebida obtida diretamente de frutas, com características físicas, químicas e sensoriais do fruto utilizado. O consumo de suco integral de frutas pode contribuir para a saúde dos consumidores, principalmente pela presença de compostos fenólicos. Neste sentido, o consumo de suco de frutas é certamente uma alternativa considerada mais saudável às bebidas açucaradas (Mustafa & Suan, 2017).

O suco de uva integral é um produto bem aceito pelos brasileiros, sendo facilmente encontrados nos supermercados, ele possui polifenóis que tem efeitos positivos na saúde (Mota et al., 2018). O suco integral de maçã também é comumente encontrado nos supermercados brasileiros e seu consumo também é associado com redução de risco de doenças crônicas (Vieira et al., 2012).

No que se refere aos aspectos sensoriais, um estudo com suco de maçã industrializado indicou que o consumidor não está totalmente satisfeito com o sabor deste produto, sugerindo a necessidade de um balanço melhor entre os atributos sensoriais (Włodarska, Pawlak-Lemańska, & Sikorska, 2019a; Włodarska, Pawlak-Lemańska, Górecki, et al., 2019). Consumidores de suco de uva também estão atentos ao equilíbrio das intensidades nos atributos deste produto, e em um estudo de comparação com sucos de uva integral, reconstituído e néctar, os pesquisadores observaram valores significativamente maiores para atributos como adstringência e gosto amargo para o suco integral, mesmo este suco sendo o mais aceito (Pontes et al., 2010), indicando uma oportunidade para melhorar o *flavour* do produto.

Por sua vez, a água de coco é uma bebida natural, refrescante e considerada como isotônico por conter açucares, minerais, aminoácidos, enzimas, compostos aromáticos entre outros compostos bioquímicos. O produto é facilmente encontrado, tanto na sua forma natural como industrializada, e é consumido por pessoas de qualquer idade (Burns et al., 2020).

Produtos alimentícios com menor adição de ingredientes e com apelo saudável tem ganhado cada vez mais espaço no mercado e no gosto dos consumidores. O mercado de bebidas tem inovado com produtos para promoção da saúde e bem estar, alternativos a produtos derivados de leite, e produtos veganos com apelo também para dietas de alérgicos (Wilson & Temple, 2016). Geralmente, esses produtos são BMs, por exemplo misturas de chá com suco de frutas ou bebidas naturalmente fermentadas que tem difícil classificação, como o kombucha, que tem diferentes ácidos orgânicos presentes (Guergoletto et al., 2019).

Dentre os ácidos orgânicos, o acético tem sido bem estudado quanto ao seu efeito na saúde, com respostas positivas no controle glicêmico (Noh et al., 2020), na melhoria do sistema imune intestinal (Lee; Kim; Shin, 2015) e fadiga pós-treino (Inagaki et al., 2020).Além disso, o ácido acético já é consumido em algumas culturas em uma mistura com suco(Giudici et al., 2017), e pesquisas demonstraram que estas bebidas também apresentam efeitos positivos na saúde (Enkhsaikhan et al., 2018; Inagaki et al., 2020; Park et al., 2014; Wu et al., 2013).

O cajuzinho-árvore-do-cerrado demonstrou bom aproveitamento tecnológico para a produção de fermentado acético pelo método submerso (Rocha Neves et al., 2020), e o produto obtido apresentou 39,88 $mg.L^{-1}$; 38,42 e 37 μM Trolox 100 mL^{-1} de compostos fenólicos, DPPH e ABTS (dados não publicados). Os fermentados acéticos e vinagres, também consumidos como temperos, têm baixo valor agregado, e por isso faz-se importante seu aproveitamento no desenvolvimento de novos produtos, visando o fortalecimento deste ramo industrial.

Por outro lado, o delineamentos Simplex é uma ferramenta estatística utilizada na elaboração de BMs, visando encontrar um balanço dos aspectos físico-químicos e sensoriais (Akonor, 2020; Kieling et al., 2019; Minh, 2017). Hipótese, justificativa...

Neste contexto, o presente trabalho objetivou avaliar as características físicas, químicas e a aceitação sensorial de BMs de fermentado acético de cajuzinho-árvore-do-cerrado com misturas de água de coco e sucos de uva e maçã, para obter uma bebida com apelo saudável e características sensoriais adequadas ao paladar brasileiro.

2. MATERIAL E MÉTODOS

2.1 Processamento das bebidas mistas

Os sucos de maçã (Campo Largo, PR, Brasil) e de uva (Salton, Bento Gonçalves, RS, Brasil) e a água de coco (OQ bebidas saudáveis, Petrolina, PE, Brasil) foram adquiridos em comercio local (Rio Verde, GO, Brasil). Além das misturas (**Tabela 1**), adicionou-se fermentado acético, que foi produzido anteriormente (Rocha Neves et al., 2020) na proporção de 15 mL para 100 mL de bebida. A acidez do vinagre foi padronizada para 4%, diluindo-o com água filtrada, conforme os produtos comerciais no Brasil. As misturas foram adicionadas em recipientes de vidro, agitadas manualmente e armazenadas sob refrigeração até o momento das análises.

2.2 Características físicas e químicas

As matérias-primas e as misturas obtidas foram caracterizadas quanto aos parâmetros instrumentais de cor (L*, a* e b*), com colorímetro (Konica Minolta, CR-400, , São Paulo, Brasil), previamente calibrado com placa branca (Samborska et al., 2019); densidade com densímetro (Anton Paar DMA-45, Anton Paar, Ashland, VA, USA); pH com potenciômetro (Lucadema, Luca-210, São Paulo, Brasil), previamente calibrado com soluções 4,0 e 7,0; sólidos solúveis com refratômetro (Refractometer Reichert, Buffalo, USA) a 25°C; acidez total por titulação com NaOH 0.1 N, cinzas por combustão total em forno mufla; proteína pelo método microKjldhal, multiplicando o teor de N pelo fator 6,25, todos de acordo com a os métodos da AOAC (1980), Os teores de sacarose e açucares totais foram determinados pelo método ADNS (Vasconcelos et al., 2013). O perfil mineral foi obtido por leitura em

espectrofotômetro de chama (Varian, SpectrAA 50B, Agilent, Santa Clara, CA) após tratamento das amostras com ácido clorídrico (12,5M) e agitação orbital (170 rpm) por 3 h. Os teores de Zn, Cu, Mn, Fe, Mg, K, Ca, N e Na foram determinados.

A capacidade antioxidante por ABTS (2,2′-Azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)) foi determinada baseado na metodologia de Miller et al. (1993), modificada0(Rufino et al., 2010). Uma alíquota de 30 µM foi homogeneizada com 3.0 mL de solução do radical ABTS, após 6 min. a absorbância foi aferida a 734 nm em espectrofotômetro UV-Vis (UV-5100 Spectrophotometer, Metash, Shangai, China), observando os radicais cátions pela mudança de coloração. Já a capacidade antioxidante por DPPH (2,2-Diphenyl-1-picrylhydrazyl) foi determinada de acordo com Brand-Williams, Cuvelier e Berset (1995), com modificações. Homogeneizou-se 3.9 mL de solução de radical DPPH e 1 mL de amostra por 30 min, e então a absorbância foi aferida a 515 nm em espectrofotômetro UV-Vis. Em ambos métodos, os resultados foram expressos em µM Trolox 100 mL^{-1}. O conteúdo total de compostos fenólicos foi determinado de acordo com Li et al. (2009). Uma amostra de 200 µL foi adicionada de 1.9 mL de reagente Follin-Ciocalteau. Carbonato de cálcio (60 g L^{-1}) foi usado para neutralizar a solução. A absorbância foi obtida a 725 nm após 120 min. Os resultados foram expressos em equivalente grama de ácido ferúlico. A leitura da cor foi realizada em quintuplicata, o conteúdo mineral apenas uma leitura e as demais análises em triplicata.

2.3 Aceitação sensorial

A análise sensorial foi realizada para comparar os resultados da desejabilidade com as repostas obtidas de 144 provadores, que experimentaram 7 formulações de bebidas (uma das repetições do ponto central) avaliando quanto a intenção de compra (Della Torre et al., 2003) e índice de aceitação global (Bastos et al., 2014). Os provadores tinham entre 18 e 54 anos de idade (84.7% 18 a 29 anos, 15.3% 30 a 54 anos) e 36.1% eram do sexo masculino. Todos os participantes consumiram BM ou bebida que promove o bem estar, sendo que 64.58%

afirmaram consumir BM pelo menos 1-2 vezes na semana, (sendo 21.5% ocasionalmente, 11.1% 5 vezes ou mais e 2.78% diário) e 86.1% afirmaram consumir bebida que promove o bem-estar (sendo 13.89% ocasionalmente, 18.7% 5 vezes ou mais e 13.89% diário). Todos os participantes concordaram em participar assinando o termo de consentimento livre e esclarecido antes das análises. A análise sensorial foi realizada no laboratório de análise sensorial, em cabines individuais sob luz branca em sessão única. As amostras foram apresentadas de forma monádica e aleatória, onde solicitou-se aos provadores que entre uma amostra e outra, limpassem o palato com a água ofertada. O projeto foi aprovado no Comitê de Ética em Pesquisa (n° 26392219.7.0000.0036).

2.4 Análise dos resultados

O planejamento Simplex tipo lattice (Neto et al., 2010), foi utilizado para elaboração experimental das BMs com fermentado acético de cajuzinho-do-cerrado, e os resultados foram avaliados por análise de variância e regressão polonomial dos pseudocomponentes. Os modelos ajustados para cada variável resposta foram visualizados em gráficos obtidos com auxílio de um software Statistica 7.0 (Statosoft, Statistica 7.0, Tulsa, USA). A função desejabilidade foi aplicada visando a otimização da BM (Schiassi et al., 2018) para variáveis com respostas significativas escolhidas por relevância ao sabor (menores acidez e sólidos solúveis) e saudabilidade (maior teor de compostos fenólicos). A ordem dos experimentos foi casualisada.

3. RESULTADOS E DISCUSSÃO

3.1 Características físicas e físico-químicas

Os valores médios obtidos nas análises físicas e químicas das BM experimentais foram apresentados na Tabela 2. Os modelos polinomiais para luminosidade, compostos fenólicos, proteína, umidade, densidade, potássio, sólidos solúveis, acidez total e pH foram significativos ($p \geq 0,05$), explicando de 84 a 98% das respostas (Tabela 3). A falta de ajuste foi significativa apenas para a densidade. No entanto, quando o quadrado médio do erro experimental é baixo em relação ao quadrado médio da falta de ajuste é usual considerar o modelo preditivo (Soares et al., 2020; Waszczynskyj; Da Silva, CS, 1981), como ocorreu neste trabalho.

Não tem como discutir e trazer o tópico 3.3 aqui?

3.1.1 Parâmetros de cor, compostos fenólicos e atividade antioxidante

A cor de um alimento é considerada um dos primeiros parâmetros qualitativos avaliados pelos consumidores (Spence, 2019). A luminosidade refere-se à capacidade do produto refletir a luz, e variou nas BMs de 13,38 a 61,59 (Tabela 2). Os maiores valores foram associados as BMs com maiores quantidades de SM e menores de SU (Tabela 3 e Figura 1A). Em pesquisas com jambolão (J. C. Soares et al., 2020) e com cacto, morango e mosto (Embaby et al., 2016) para obtenção de bebidas, os autores também observaram a luminosidade como parâmetro significativo. Em produtos processados a cor é associada as matérias-primas utilizadas, e também com os processos para a obtenção do mesmo. O SM, tem maiores valores de luminosidade (Włodarska, Pawlak-Lemańska, & Sikorska, 2019b), o

que corrobora com nossos resultados, já que observamos a tendência de maior luminosidade para este produto.

Os ingredientes variáveis não afetaram a* e b*, apesar dos mesmos variarem de 16,95 (BM2) a 44,09 (BM6), e entre 5,03 (BM2) e 26,76 (BM6), respectivamente (Tabela 2), apresentando cores de roxo intenso a lilás. A cor também pode ser alterada pela concentração de compostos fenólicos CF), que podem influenciar na aparência, sabor, corpo, fragrância e propriedades antimicrobianas. Um grupo que pode impactar nas características dos produtos são as antocianinas, elas são as responsáveis pela tonalidade vermelha, dependendo do pH e também de outros compostos, por exemplo com os taninos, pode formar coloração laranja estável (Garde-Cerdán et al., 2017). Os compostos fenólicos também são parte majoritária de compostos antioxidantes em uvas e vinhos (Ivanova & Stefova, 2011) e em suco de maçã (Tokuşoğlu, 2011). Neste trabalho, os CF das BMs variaram de 54,36 a 110,11 $mg.L^{-1}$ (Tabela 2). As formulações com maiores teores de SM apresentaram as maiores concentrações de compostos fenólicos e as com maiores concentrações de SU concentrações intermediárias (Tabela 3 e Figura 1B).

O tipo de processamento (Włodarska et al., 2019), a variedade dos frutos, as condições de manejo, o estagio de maturação (Ivanova & Stefova, 2011), o tempo de armazenamento, e as mistura dos ingredientes (Embaby et al., 2016; Schiassi et al., 2018) podem favorecer a degradação dos compostos antioxidantes presentes em bebidas. Apesar dos ingredientes variáveis não terem afetado significativamente a atividade antioxidante, as BMs apresentaram valores consideráveis de atividade antioxidante (DPPH e ABTS), que oscilaram de 1.191,75 a 1320,00 μM Trolox.100 mL^{-1} e entre 1.674,78 e 2.297 μM Trolox.100 mL^{-1}, respectivamente (Tabela 2). A capacidade antioxidante aliada ao vinagre das BMs, podem regular a pressão arterial através da supressão da atividade da enzima conversora de angiotensina I, o mesmo mecanismo usado em drogas para controle da pressão arterial (Honsho et al., 2005).

3.3 Umidade, densidade e sólidos solúveis

A umidade das BMS variou entre 88,67 e 92,32% (Tabela 2), sendo maior quando os níveis de AC e de SM foram maiores e a quantidade de suco de uva foi menor na formulações (Tabela 3; Figura 1C). A umidade é a quantidade de água de um alimento, e em bebidas varia de acordo com o tipo da mesma, chegando a representar 99% em chá e café, e para sucos e bebidas energéticas 84,52 a 88,1%, respectivamente (Acaroz et al., 2019). Em BM vegetal de soja, água de coco e umbu, a água pode representar de 71,29 até 85,25%, dependendo dos componentes da mistura (Moura Neto et al., 2016). No presente trabalho, os valores encontrados foram ligeiramente superiores, o que pode ocorrer devido as fontes de matérias-primas utilizas, o que indicou que as BMs produzidas podem ser consideradas uma boa fonte de hidratação, de acordo com Mustafa e Suan, (2017).

A densidade é um parâmetro relacionado a medida sensorial de corpo em bebidas, sendo afetada pelo teor de sólidos solúveis (Giraldo et al., 2017). Apesar dos modelos para os teores de sacarose e de açúcares totais não terem sido influenciados pelas variáveis independentes (Tabela 3), observou-se que a BM6, com menor teor de AG e maior de SU apresentou a maior densidade e teores de sacarose e de açúcares totais (Tabela 2), uma vez que os açúcares são os principais responsáveis pelos sólidos solúveis em bebidas adocicadas.

Os açúcares são os principais componentes dos sólidos solúveis em bebidas.

Nas BMs a densidade variou de 1,028 a 1,050 g cm^{-3}, sendo maior naquelas com maiores concentrações de sucos e menor de água de coco (Figura 1D). Na literatura, a densidade de suco de maçã foi reportada próxima de 1,043 g cm^{-3}, dependendo da marca e do tipo de processamento (Halagarda & Suwała, 2018), enquanto a de sucos de uva integral comerciais entre 1,058 a 1,064 g cm^{-3}(Rodrigues et al., 2019), e 1,03 g cm^{-3} para água de coco *in natura* (L. S. Soares et al., 2016). Existem poucos trabalhos que correlacionam a densidade de sucos e BMs com aspectos químicos ou sensoriais. Um dos fatores que podem influenciar a pequena quantidade de estudos envolvendo a densidade é a metodologia para sua determinação, que utiliza o picnômetro, uma vidraria facilmente encontrada, porém de excessiva delicadeza, que faz com que o erro experimental aumente sensivelmente. Em um

estudo que correlacionou a densidade com aspectos sensoriais, os autores observaram que as bebidas com menores densidades eram as mais aceitas (Halagarda & Suwała, 2018). Na presente pesquisa o mesmo comportamento foi observado, o que sugere a necessidade de mais estudos correlacionando a densidade com a aceitação sensorial.

O teor de sólidos solúveis das BMs variaram de de 8,7 à 11,9 °Brix (Tabela 2), e foi afeitado significativamente pelos ingredientes variáveis, sendo maior quanto maiores a quantidade de sucos e menor de água de coco (Figura 1E). Sólidos solúveis é uma medida obtida pelo índice de refração de soluções, que pode variar com a concentração dos compostos, temperatura e comprimento de onda da luz. O °Brix é a relação de gramas de sacarose em 100 g de amostra obtidas pela leitura do índice de refração e é usado como indicador do teor de açúcar nos alimentos. No entanto, vale ressaltar que o método só tem acurácia para soluções puras de sacarose (Nielsen, 2010). Em BM de cajuína, néctar de maracujá e néctar de goiaba o teor de sólidos solúveis variou de 40 a 54° Brix, pois os produtos comerciais continham adição de açucares(Brito et al., 2010). Já em BM de mangaba, cagaita e marolo estes valores ficam entre 2,97 e 7° Brix (Schiassi et al., 2018). O que demonstra a variação dos sólidos solúveis em BMs depende das matérias-primas e ingredientes utilizados. O teor de sólidos solúveis também foi considerado como fator de predição da aceitação sensorial, sendo os menores valores associados a maiores aceitações, mesmo comportamento observado em pesquisa anterior (Halagarda & Suwała, 2018) com SM.

3.4 Proteínas e perfil mineral

Proteínas são fontes de aminoácidos essenciais, e sua importância fica evidenciada em suplementos alimentares, onde os valores podem varias de 3,0 a 11,2% (Wilson & Temple, 2016). A recomendação para este macronutriente e de 0,8 a 1 g kg^{-1} ao dia (Paula et al., 2012). Bebidas com proteína do soro do leite de vaca são comumente estudadas e associada com

aspectos fisiológicos e de comportamento de consumo (Carter et al., 2020), no entanto não encontramos muitas pesquisas que reportam o teor de proteínas em bebidas vegetais, provavelmente devido aos baixos percentuais esperados para este produto. Em suco misto de abobora, manga, morango, maçã verde e laranja, foi reportado 2,7% de proteína (AlJahani & Cheikhousman, 2017). Já em bebida de soja, alternativa ao leite, o valor de proteína chegou a 2,4 % (Wilson & Temple, 2016).Enquanto nesta pesquisa, os valores de proteína da BM variaram de 1,12 a 1,81% , sendo os maiores valores obtidos com quantidades mais elevadas de sucos na mistura e menos água de coco (Figura 1F). Apesar de a proteína ser um nutriente que é geralmente associado à saciedade, estudos demonstram que, mesmo bebidas fortificadas com proteína do soro de leite, não são capazes de saciar a fome da mesma forma que alimentos sólidos(Chambers et al., 2015; Wilson & Temple, 2016). No entanto, quando informado sobre os nutrientes na bebida o consumidor pode criar expectativa de saciedade para o consumo do alimento (McCrickerd et al., 2015).

Os minerais são indispensáveis para o metabolismo dos seres vivos (de la Guardia & Garrigues, 2015). Nesta pesquisa os teores de cinzas das BMs variaram de 0,26 a 0,30 g 100 mL^{-1}. Em BM de abobora, maçã verde, manga, laranja e morango o teor de cinzas foi de 0,77 g. 100 mL^{-1}(AlJahani & Cheikhousman, 2017), já em bebidas de kefir a base de soja esses valores variaram de 0,4 a 0,7 g 100 mL^{-1}(da SILVA et al., 2018). Os minerais podem ser classificados em elementos majoritários e elementos traços de acordo com a necessidade de ingestão humana. Os majoritários (Na, K, Ca, Mg, Cl e P) são essenciais em quantidades acima de 50 mg por dia, enquanto os traços, são essenciais em quantidades inferiores a 50 mg ao dia (Belitz et al., 2009). O potássio (K) contribui para a regulação da pressão arterial (de la Guardia & Garrigues, 2015), sendo o consumo de 782 mg ao dia é suficiente para uma dieta equilibrada com efeitos positivos na saúde (Belitz et al., 2009).

Nesta pesquisa apenas o K foi significativamente afetado pelas variáveis independentes (Tabela 3), e os valores mais altos foram verificados nas BMs mistas com maiores teores de água de coco (Figura 1G). No entanto, nas proporções médias da mistura, verificaram-se os menores valores de K, o que pode ter ocorrido devido as características de pH e redox das misturas, já que alguns elementos traços podem doar ou receber elétrons em

reações de oxidação ou redução, e mudanças químicas geralmente envolvem reações redox (de la Guardia & Garrigues, 2015).

A formulação BMC2 apresentou menores teores de sódio (55,0 ppm) e também menores teores de ferro (0,22 $\mu g.kg^{-1}$), já a formulação BM3 foi a a que apresentou maiores teores de sódio, potássio, cálcio e magnésio. O sódio é conhecido por sua propriedade osmótica no corpo humano. Outros elementos minerais como cálcio, ferro, magnésio e zinco, presentes nas BMs são relevantes para dietas equilibradas. O magnésio auxilia na absorção de cálcio, que por sua vez é essencial para a manutenção dos ossos e que com o passar do tempo o corpo humano precisa de reposição. Já o zinco é um mineral que é geralmente utilizado para fortificação em alimentos, assim como o ferro, que é responsável por transportar o oxigênio nas células (de la Guardia & Garrigues, 2015), todos presentes nas BMs experimentais.

3.5 Acidez e pH

A acidez titulável e o pH são medidas que determinam a acidez de um alimento. Os métodos e as respostas obtidas são diferentes, e cada uma tem um papel na qualidade do alimento. Enquanto que a acidez titulável impacta diretamente no sabor dos alimentos, o pH impacta nas propriedades químicas relacionadas aos H_3O^+(hidrônios), que são os íons de hidrogênio dissolvidos em solução aquosa (Nielsen, 2010). Neste sentido, o ácido em níveis de pH diferentes pode interferir na percepção do *flavour* dos alimentos (Hartwig & Mcdaniel, 1995). Nesta pesquisa o pH variou de 3,18 a 3,71(Tabela 2), e foi afetado pelos componentes variáveis da mistura (Tabela 3). Os valores de pH foram menores nas BMs com maior conteúdo de suco de uva (Figura 1H). Em bebidas ácidas, o pH seguro para o sistema digestivo é acima de 3 (Lončar et al., 2006). Portanto, todas as BMs apresentaram-se dentro deste limite. Já acidez apresentou valores de 8,16 e 13,41%. Os menores valores de acidez total foram observados em BMs com maior quantidade de água de coco na formulação

(Figura 1I). Bebidas acidificadas podem apresentar valores de acidez total até 15% (Lončar et al., 2006; Tran et al., 2020). Após a conversão das unidades de acidez (de 8,16 a 13,41%), verificou que todas BMs estão abaixo desse limite máximo. O equilíbrio do sabor doce e da acidez deixa a bebida mais palatável (Tran et al., 2020).

3.6 Teste de desejabilidade e análise sensorial

A função desejabilidade foi aplicada para otimizar as BMs de acordo com os seguintes critérios: menores valores de acidez e sólidos solúveis, e maiores de pH e compostos fenólicos, escolhidos devido a influência na aceitação sensorial e benefícios para a saúde. O resultado do teste de desejabilidade indicou uma formulação com 0,50:0,1:0,40 em pseudocomponentes, ou 0,38: 0,15: 0,32mL de água de coco: suco de uva: suco de maçã em 100 mL de bebida (Figura 2). Portanto, BM5 foi a formulação mais próxima.

Na análise sensorial (Figura 3A) observou-se que as BMs com menor índice de rejeição de intenção de compra foram BM1, seguida de BM5. Em valores relativos estas duas bebidas, BM1 tem 0,60: 0,10: 0,30 e BM5 tem 0,50: 0,10: 0,40, respectivamente para água de coco, suco de uva e suco de maçã. Portanto, a mistura dos ingredientes favoreceu a aceitação da BM, e o mesmo comportamento também foi observado em BM de cagaita, mangaba e marolo (Schiassi et al., 2018). A formulação BM1 obteve índice de aceitação global de 73% (Figura 3B), enquanto que a B5 69%. Em outras pesquisas com BMs os valores de índice aceitação global foram inferiores, e aquelas com os menores teores de SST também obtiveram maiores aceitações (Acham et al., 2020; Akonor, 2020). Os consumidores podem preferir sucos mais ácido do que doce, e a razão brix/acidez pode não ser preditiva para indicar o produto mais aceito (Halagarda & Suwała, 2018).

4. CONCLUSÕES

Os teores de água de coco e de sucos de uva e maçã afetam significativamente a luminosidade, o teor de compostos fenólicos, a umidade, a densidade, o teor de proteínas, potássio, acidez, o pH e os sólidos solúveis. O uso do delineamento de mistura favoreceu a obtenção de um balanço da acidez e açucares nas BMs. As BMs com maiores valores de intenção de compra e de índice de aceitação global apresentaram a proporção mais próxima aquela obtida na desejabilidade. É possível otimizar a elaboração da BM utilizando a desejabilidade para parâmetros com maior impacto na saúde e no paladar, no entanto, faz-se necessário a análise sensorial para comprovar a teoria.

A BM com maior desejabilidade apresentou menores teores de compostos antioxidantes, em virtude da menor concentração de .... Ainda assim, consumo das BMs pode auxiliar na ingestão diária de minerais essenciais. Os resultados demonstram que é viável o desenvolvimento de BM com fermentado acético de cajuzinho-árvore-do-cerrado, água de coco e sucos de uva e maçã, em relação aos aspectos nutricionais, sensoriais e de saudabilidade, além de contribuir com a preservação do bioma Cerrado.

A bebida mista com maior saudabilidade foi aceita sensorialmente ???

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Tabela 1. Formulações das bebidas mistas com base no delineamento Simplex, utilizado para avaliar o efeito de água de coco (AC), suco de uva (SU) e suco de maçã (SM) nas características físicas e químicas da bebida mista de fermentado acético de cajuzinho-árvore-do-cerrado. Os valores são apresentados em concentração real (mL de componente para 1000 mL de mistura) e pseudo-componentes.

Experimento	Proporção dos ingredientes variáveis nas misturas ternárias					
	Concentração real			Pseudo-componentes		
	AC(C1)	SU(C2)	SM(C3)	AC(X1)	SU(X2)	SM(X3)
BMC1	311,667	311,667	226,667	0,37	0,37	0,27
BMC2	311,667	311,667	226,667	0,37	0,37	0,27
BMC3	311,667	311,667	226,667	0,37	0,37	0,27
BM1	510	85	255	0,6	0,1	0,3
BM2	85	510	255	0,1	0,6	0,3
BM3	510	255	85	0,6	0,3	0,1
BM4	255	510	85	0,3	0,6	0,1
BM5	425	85	340	0,5	0,1	0,4
BM6	85	425	340	0,1	0,5	0,4

X1 + X2 + X3 =1, que equivale a 85%, pois todas as formulações tiveram acréscimo de 15% de vinagre de cajuzinho-árvore-do-cerrado.

Característica	BMC1	BMC2	BMC3	BM1	BM2	BM3	BM4	BM5	BM6

Tabela 2. Caracteristicas f e q Sólidos solúveis, pH, acidez total, densidade, cinzas, umidade, proteína, sacarose, açucares totais, minerais (N, Na, P, K, Ca, Mg, B, Cu, Fe, Mn e Zn), luminosidade(L*), a*, b*, croma e angulo de ângulo Hue, compostos fenólicos e capacidade antioxidante (DPPH e ABTS) das bebidas mistas experimentais

Luminosidade[1]	17,55±2,75	32,63±4,66	23,53±2,16	38,36±2,65	13,38±4,56	22,55±2,42	27,22±3,92	61,59±3,72	21,39±3,00
a*[1]	29,53±5,96	42,23±6,02	43,82±0,90	22,14±1,13	16,95±8,46	28,25±4,98	34,82±5,30	18,15±2,28	44,09±4,43
b*[1]	13,58±4,38	18,44±3,41	22,46±1,02	13,25±0,69	5,03±3,15	14,83±4,11	18,33±2,57	8,43±0,93	26,76±3,84
Compostos fenólicos[2]	88,39±0,26	92,13±0,61	102,24±0,46	59,31±0,91	95,28±0,26	54,36±0,38	86,78±0,88	88,05±0,10	110,11±0,88
DPPH[3]	1283,42±0,6	1260,92±0,39	1270,92±0,48	1191,75±0,72	1235,08±0,52	1281,75±0,30	1286,75±0,30	1320,08±0,24	1211,75±1,67
ABTS[3]	2245,89±0,03	2077±0,41	2279,22±0,46	1674,78±0,43	2295,89±0,08	1913,67±0,38	2297±0,14	2265,89±0,22	2284,78±0,16
Umidade[4]	89,89±0,08	90,09±0,09	89,79±0,18	91,6±0,22	88,67±0,07	91,76±0,06	90,41±0,4	92,32±0,33	88,4±0,4
Densidade[5]	1,039±0	1,039±0	1,039±0	1,033±0	1,047±0	1,028±0	1,037±0	1,032±0	1,05±0,07
Sólidos soluveis[6]	10,33±0,057	10,30±0	10,40±0	8,83±0,057	11,80±0	7,56±0,011	9,83±0,023	8,70±0	11,90±0
Sacarose[4]	25,41±0,002	26,77±0,003	23,89±0,002	19,84±0,00	21,01±0,004	7,44±0,012	17,83±0,015	20,12±0,002	29,49±0,025
Açúcares totais[4]	39,16±0,004	43,19±0,002	42,53±0,005	35,31±0,005	41,80±0,012	18,21±0,003	34,46±0,004	36,98±0,004	54,01±0,004
pH[1]	3,37±0,032	3,49±0,065	3,45±0,04	3,65±0,055	3,18±0,05	3,58±0,04	3,28±0,01	3,71±0,02	3,35±0,06
Acidez total[4]	12,14±0,07	12,03±0,07	12,08±0	8,16±0,14	12,67±0,22	10,86±0,07	11,71±0,07	9,12±0	13,41±0
Proteína[7]	1,32±0,01	1,37±0	1,37±0,01	1,12±0	1,81±0	1,5±0	1,62±0	1,12±0	1,687±0
Cinzas[7]	0,19±0,00	0,20±0,01	0,16±0,07	0,26±,01	0,22±0,11	0,30±0,04	0,22±0,02	0,26±0,01	0,20±0,01
Sódio[8]	63,00	55,00	56,00	74,00	74,00	88,00	73,00	65,00	60,00
Fósforo[8]	2,61	2,37	2,23	1,18	1,18	1,93	2,06	1,55	2,57
Potássio[8]	1140	1220	1210	1340	1340	1750	1500	1350	1280
Cálcio[8]	83,01	80,53	110,09	97,06	97,06	120,03	81,31	99,05	61,46
Magnésio[8]	49,08	48,09	55,01	48,02	48,02	67,05	52,19	24,38	55,75
Boro[9]	5,72	5,60	5,67	3,40	3,40	5,47	6,30	3,60	8,90
Cobre[9]	0,21	0,53	0,54	0,24	0,24	0,65	1,04	0,15	0,76
Ferro[9]	0,47	0,22	1,54	0,41	0,41	0,47	1,00	0,57	0,37
Manganês[9]	1,09	1,03	1,13	0,86	0,86	1,09	1,13	0,87	1,15
Zinco[9]	0,56	0,73	0,14	0,38	0,38	0,56	0,69	0,15	0,69

[1] Coordenadas de cor e pH (adimensional); [2] Compostos fenólicos (mg L^{-1}); [3] DPPH e ABTS (µM Trolox 100 mL^{-}); [4] Umidade, Sacarose, Açucares Totais e Acidez Total (g 100 mL^{-1}); [5] Densidade(g cm^{-3}); [6] Solídos Solúveis (° Brix); [7] Proteína e Cinzas (g 100 mL^{-1});[8]elementos majoritários (ppm); [9]Elementostraços (µg.kg^{-1}).

Tabela 3: Modelos estatísticos para os atributos significativos (p), com seus respectivos coeficientes de determinação (R^2) e falta de ajuste (FA).

Atributo	Modelo	p	R^2	FA
Luminosidade	y = -10,320x1 + 62,685x2 + 184,972x3 - 430,226x2x3	0,0084	0,89	0,76
Compostos Fenólicos	y = 50,319x1 - 22,762x2 + 224,891x3 + 333,423x1x2	0,0025	0,93	0,7
Umidade	y = 91,91x1 + 91,24x2 + 94,22x3 - 20,98x2x3	0,0014	0,95	0,09
Densidade	y =1,012x1 + 1,039x2 + 0,978x3 +0,129x1x3 + 0,144x2x3	0,00058	0,86	0,02*
Sólidos Solúveis	y = 4,993x1 + 11,879x2 + 14,162x3	0,0005	0,92	0,008*
Proteína	y = 2,087x1 + 2,240x2 + 1,575x3 - 2,177x1x2 - 3,576x1x3	0,0013	0,98	0,27
Potássio	y = 3124x1 + 2246x2 + 4714x3 - 2759x1x2 - 9650x1x3 - 7379x2x3	0,037	0,95	0,15
Acidez titulável	y = 4,157 + 5,261x2 + 9,960x3 + 26,976x1x2 + 24,810x2x3	0,00012	0,99	0,04*
pH	y = 3,849x1 + 2,907x2 + 3,665x3	0,0004	0,93	0,69

Termos em negrito: não significativos ($p \leq 0,05$); *falta de ajuste significativa; X1: água de coco; X2: suco de uva; X3: suco de maçã

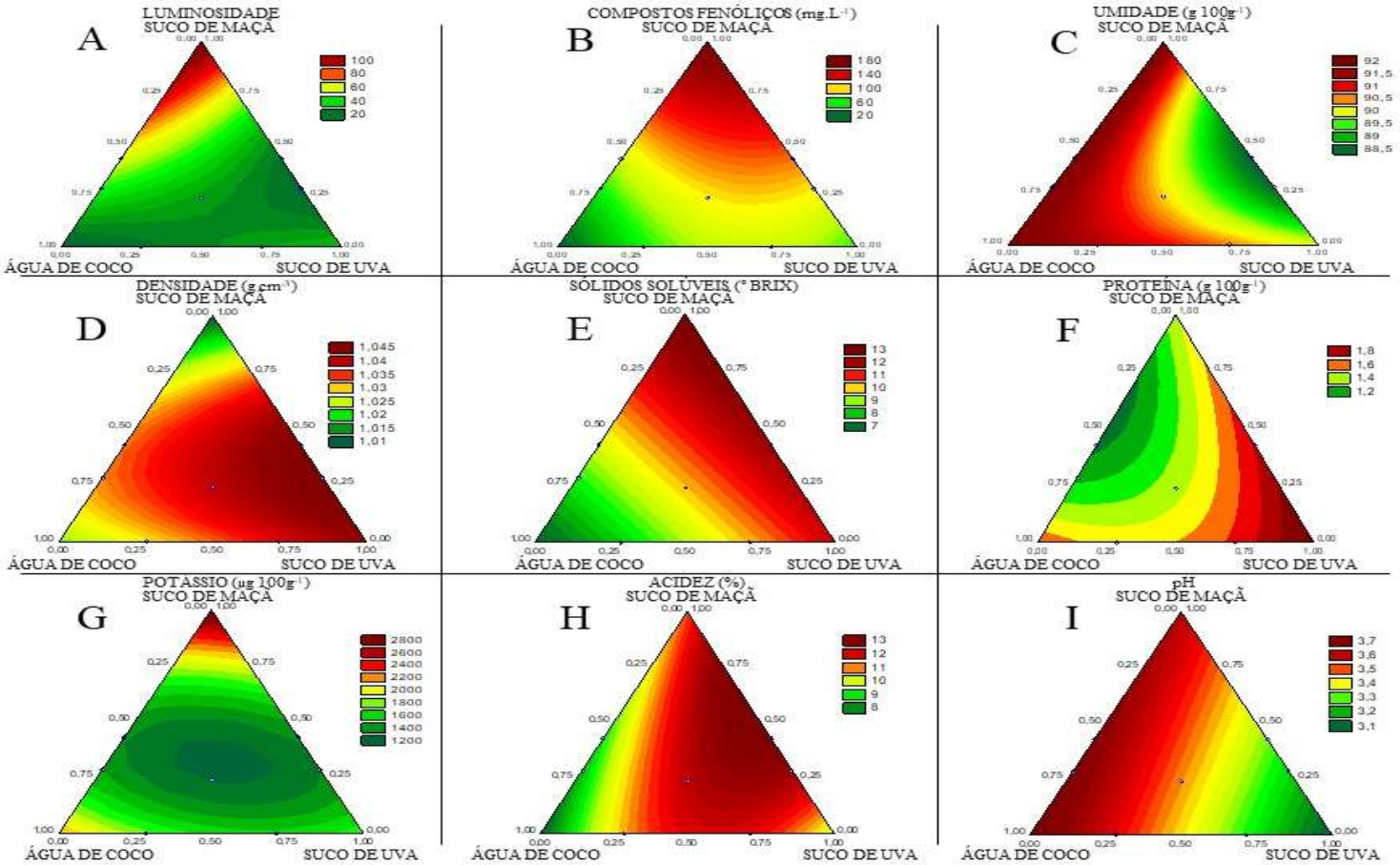
A
LUMINOSIDADE
SUCO DE MAÇÃ
100
80
60
40
20
ÁGUA DE COCO
SUCO DE UVA
B
COMPOSTOS FENÓLIÇOS (mg.L⁻¹)
SUCO DE MAÇÃ
180
140
100
60
20
ÁGUA DE COCO
SUCO DE UVA
C
UMIDADE (g 100g⁻¹)
SUCO DE MAÇÃ
92
91,5
91
90,5
90
89,5
89
88,5
ÁGUA DE COCO
SUCO DE UVA
D
DENSIDADE (g cm⁻³)
SUCO DE MAÇÃ
1,045
1,04
1,035
1,03
1,025
1,02
1,015
1,01
ÁGUA DE COCO
SUCO DE UVA
E
SÓLIDOS SOLÚVEIS (° BRIX)
SUCO DE MAÇÃ
13
12
11
10
9
8
7
ÁGUA DE COCO
SUCO DE UVA
F
PROTEÍNA (g 100g⁻¹)
SUCO DE MAÇÃ
1,8
1,6
1,4
1,2
ÁGUA DE COCO
SUCO DE UVA
G
POTÁSSIO (µg 100g⁻¹)
SUCO DE MAÇÃ
2800
2600
2400
2200
2000
1800
1600
1400
1200
ÁGUA DE COCO
SUCO DE UVA
H
ACIDEZ (%)
SUCO DE MAÇÃ
13
12
11
10
9
8
ÁGUA DE COCO
SUCO DE UVA
I
pH
SUCO DE MAÇÃ
3,7
3,6
3,5
3,4
3,3
3,2
3,1
ÁGUA DE COCO
SUCO DE UVA

Figura 1. (A) Luminosidade; (B) compostos fenólicos ($mg.L^{-1}$); (C) umidade ($g.100\ g^{-1}$); (D) densidade ($g.cm^{-3}$); (E) Acidez total titulável (%), pH, Sólidos solúveis (°Brix), , Proteína ($g.100\ g^{-1}$), , Potássio ($g.100\ g^{-1}$) e para suco de maça, suco de uva e água de coco em pseudocomponentes.

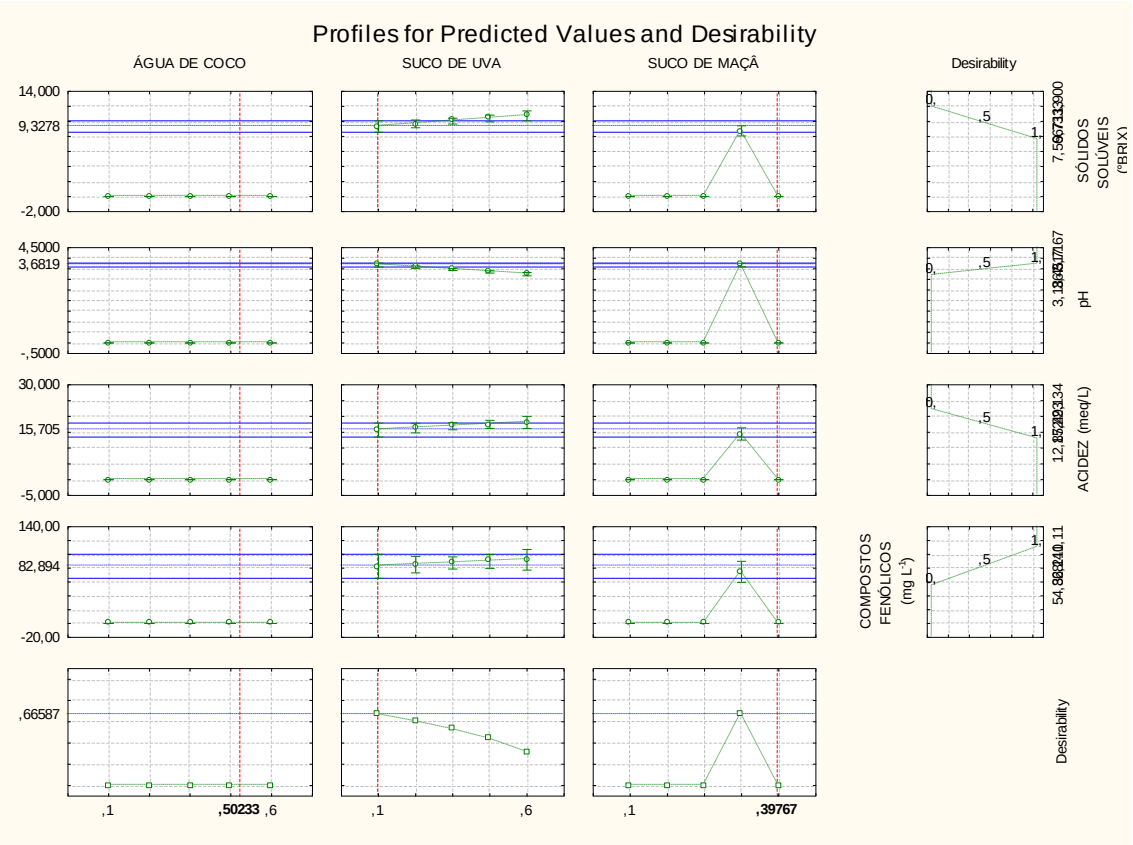

Figura 2. Diagrama de desejabilidade

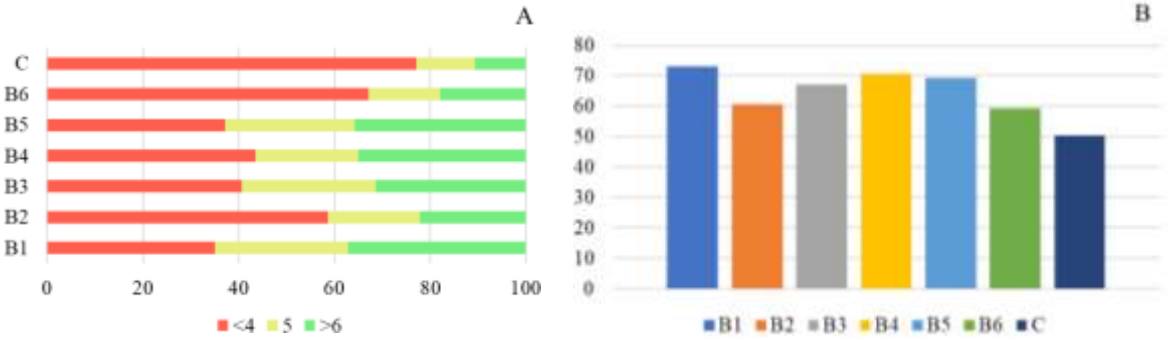

Figura 3. Representação gráfica para A: classificação da intenção de compra (%) e B: Índice de aceitação global das bebidas mistas elaboradas sem a repetição do ponto central do delineamento.

ANEXO III- NORMAS DE PUBLICAÇÃO DA REVISTA LWT - FOOD SCIENCE AND TECHNOLOGY

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CAPITULO V

ARTIGO 4: INFLUENCE OF HEALTH PROMOTION INFORMATION ON CONSUMERS' SENSORY AND EMOTIONAL PERCEPTIONS OF BEVERAGES CONTAINING VINEGAR

Artigo Submetido na revista Journal of the Science of Food and Agriculture

INFLUENCE OF HEALTH PROMOTION INFORMATION ON CONSUMERS' SENSORY AND EMOTIONAL PERCEPTIONS OF BEVERAGES CONTAINING VINEGAR

Running title

Health claims impact on consumers' sensory and emotional perceptions of beverages containing vinegar

ABSTRACT

BACKGROUND: Vinegar is a condiment related to health benefits, and the consumption could be affected by the acid flavor, in some cultures it is usual mixture the vinegar with a juice. However, sensory and emotional aspects of the beverages consumption still a lack in studies. This work aims to investigate the impact of information on consumers' emotional and sensory perceptions of seven formulations of coconut water, grape juice, and apple juice mixed with *Anacardium othonianum* Rizzini vinegar. The proportions were defined using a mixture design.

RESULTS: Sensory and emotional characteristics were obtained by a check-all-that-apply (CATA) questionnaire from 144 consumers. They were divided into two groups: a informed group that received information about the products' health claims, and a blind group. The overall acceptance of the beverages was also investigated using a 9-point hedonic scale. Acceptance data were assessed by ANOVA and Tukey's test (P> 0.05%), and logical regression was used for CATA responses.

RESULTS: The informed group was unable to differentiate the terms artificial, refreshing, and fresh flavor, and the emotions disappointed and sad, as occurred in the blind group. The

findings indicating that information affects the sensory and emotional perception of mixed beverages, with positive effects observed in response to increased content of grape juice. A broadly acceptable formulation was obtained that minimized negative emotions when information about the benefits of the product was provided to consumers.

Keywords: Check-all-that-apply, Healthy beverage, Emotional profile, Claims; Consumer behavior.

1. INTRODUCTION

The beverages acceptance can be directly related to perception of healthiness and sweetness. The consumption habits of these products are positively correlated to lifestyle, socioeconomic status, and health condition[1]. This behavior suggests a new trend of well-being termed holistic health. This trend is forcing the beverage industry to offer healthy products that contains fewer ingredients perceived as harmful to health[2]. In response to this trend, beverages containing vinegar have been studied and their benefits in improving prokinetic functions[3], ovulatory regulation[4], reduced risk of hypertension[5], visceral fat[6], and post-workout fatigue[7] have been described. However, little is known about the sensory acceptance of this type of beverage.

An investigation of acceptance of beverages containing orange, apple, peach, and pineapple juice using different concentrations of sherry vinegar revealed that in addition to the concentration of vinegar, the type of fruit used influenced the acceptance of the beverage[8]. This behavior is predictable, since the perception of taste changes individually when various taste stimuli are presented together in a beverage[9].

Grape juice [25] and apple juice [26] are rich in antioxidants and have a sweet taste and good stability after processing. Coconut water is a natural isotonic[27] with several positive health effects[28]. These products could be used to develop a mixed beverage containing vinegar that has a balanced formulation, positive effects on health, and good sensory acceptance.

The interactions of flavors may or may not favor the development of a new food product. Specifically, for vinegar-containing beverages, the acidity resulting from the major component of acetic acid can be detrimental[10] found that the acidic taste can generate aversion to a product. In contrast, sweet taste is widely accepted[11] and can suppress other basic tastes (salty, sour, bitter, and umami) at medium and high concentrations. Mutual suppression with acid flavor can occur at high concentrations. These interactions are known as binary flavor interactions[9].

Acidic and sweet flavors can activate olfactory receptors, which increases the perception of flavors[12]. This behavioral interaction can contribute to the healthy appeal of foods by reducing the use of sugar[13] and salt[14]. In addition to the balance between flavors, density and color are characteristics considered by consumers of apple juice, for instance. However, in the commercial samples that were evaluated, these parameters were not balanced[15]. Although acidity can produce an unpleasant initial taste, it also ultimately provides a refreshing feeling and can lead to an "I want more" desire[16]. Therefore, adequate acidity balance in a beverage can increase its acceptance.

Besides to the intrinsic characteristics (physical-chemical and sensory), the quality of a product involves extrinsic characteristics that include packaging, price, and brand[17,18]. Extrinsic characteristics can influence consumers' perceptions of the intrinsic characteristics of a product[19-21], mainly due to the expectations generated[22]. Moreover, health or hedonic claims on labels can raise juice consumers' expectations and taste perception[19]. Emotional perception also could be used to understand consumer behavior. Emotional scales help differentiate the evaluation of foods with similar tastes[23]. The scales have also been used to predict the influence of health label information on consumers' taste expectations[21,24].

Due to… the preparation of this mixed beverage was motivated by the increased search for healthy products. It was hypothesized that information on the health-promoting benefits of the beverage would influence consumers' perception of a mixed beverage containing vinegar.

Incluir uma justificativa sucinta… In this study, the consumers' perception of a vinegar-based beverages has been assessed and the impact of health information on its acceptance was investigated using a sensory and emotional scale.

2. MATERIALS AND METHODS

2.1 Study design

A central location test was performed to evaluate the influence of health promotion information on consumers' perception of the vinegar-containing mixed beverage. The participants evaluated the beverages under two conditions. In the blind condition, they only evaluated the samples received. In the informed condition, they received information before trying the mixed beverage[29]. This project was approved by the Ethics and Research Committee (N°. 26392219.7.0000.0036).

2.2 Participants

In total,144 consumers were recruited at the Instituto Federal Goiano de Rio Verde (Brazil). Participants were most (84.7%) 18 to 29 years old, with 15.3% being 30 to 54 years old. Males comprised 36.1% of the participants. Most participants (86.1%) reported consuming beverages that promotes well-being (13.89% occasionally, 18.7% five times or more, and 13.89% daily). All participants agreed to participate by signing the informed consent form.

2.3 Motivation for study

The preparation of this mixed beverage was motivated by the increased search for healthy products. It was hypothesized that information on the health-promoting benefits of the beverage would influence consumers' perception of a mixed beverage containing vinegar.

2.4 Raw materials used in mixed beverage formulations

The juices used to prepare the beverages were purchased in local stores. Products with the fewest added ingredients were chosen. Apple juice contained only ascorbic acid (Campo Largo, PR, Brazil). Grape juice (Salton, Bento Gonçalves, RS, Brazil) and coconut water (OQ Bebidas Saudáveis, Petrolina, PE, Brazil) did not contain other ingredients. Vinegar from *Anacardium othonianum* Rizzini was produced by submerged fermentation using a Frings pilot-scale acetator in the food biotechnology laboratory of IF-Goiano, Rio Verde. Vinegar has an alcohol content of <1% and a triple acidity of 13%[30]. Acidity was standardized to 4% and the vinegar was diluted with filtered water as is done with commercial vinegar brands in Brazil.

2.5 Preliminary test

A preliminary sensory test was performed to find the most accepted vinegar concentration for the formulation design. Samples with different concentrations, 150[4] and 200 mL and 250[31], of vinegar completed with 100 mL juice, were coded and randomized for each of the 60 judges and presented with the collection instrument. The judges evaluated only the overall acceptance of the product using a structured 9-point hedonic scale, ranging from extremely disliked to extremely liked, and they rinsed their palates with water between samples[29]. The addition of 150/1000 mL of vinegar to juice was the most accepted proportion.

After the preliminary determination of the best vinegar concentration, a mixture design was used to determine the best juice mixture to use with the vinegar. We opted for a mixture design with seven formulations and used Statistica 7.0 software (StatSoft, Tulsa, OK, USA). The simplex experimental design used is shown in Table 1. All beverages were characterized in terms of pH (Luca-210; Lucadema, São Paulo, Brazil), soluble solids, and color (Colorimeter CR-400; Konica Minolta, São Paulo, Brazil) by direct reading and recording of titratable acidity using NaOH 0.1 N[32].

2.6 Experimental procedures

The sensory evaluation involved 144 participants. The last 70 participants received information about the possible benefits of the beverage for health promotion (informed group). These participants were told "The samples you will analyze are mixtures of different proportions of grape juice, apple, and water coconut. All of them contain 15 mL of *Anacardium othonianum* Rizzini vinegar in 100 mL of beverage. This could be an health-promoting beverage since the juices used are natural antioxidants, coconut water is isotonic, and vinegar helps in glycemic control, reducing liver damage, improving the intestinal immune system, inhibiting proliferation of carcinogenic cells, and promoting menstrual cycles in women." The first 74 participants did not receive any information on the possible effects of the beverage on their health (the blind group). This group order was necessary so that later participants were not made aware of the information by participants they knew in the institution.

The beverages were prepared according to the mixture design on the same day of the analysis, stored in glass containers, and refrigerated until serving (18°C). The judges monadically and randomly received seven samples whose quantity was sufficient to allow three sips. Participants were asked to try each sample three times, once before the overall acceptance question (structured 9-point hedonic scale), once before describing the sensory profile using the CATA questionnaire, and once before the emotional profile[33].

The 18 terms used in the sensory analysis (watery, pleasant aroma, wine aroma, apple aroma, vinegar aroma, fruity aroma, delicious, sweet, fresh, refreshing, acid taste, artificial taste, sour taste, fruity taste, natural taste, residual taste, smooth) were obtained from literature[34-36], only adapting the terms referring to the flavors used. As the 12 terms of the emotional profile[21](well, guilty, disappointed, energized, enthusiastic, happy, dissatisfied, irritated, neutral, concerned, satisfied, sad).

Participants were instructed to rinse their palates with water after tasting each sample. The terms were used randomly, but at similar frequencies, by the participants. At the end of the analysis, the participants completed the socio-demographic questionnaire. Separate

questions solicited information on the frequency of consumption of mixed beverages and beverages that promote well-being.

2.7 Data analyses

The perception of the influence of information (health benefits of the product) was evaluated by the analysis of variance (ANOVA) of overall acceptance. When the differences were significant ($p<0.05$), Tukey's test was performed for post-hoc comparison of means. The mixed beverage samples were characterized by the frequency of responses to CATA using logical regression. The groups (blind and informed) were analyzed separately. The selection of each of the terms (0/1) was considered a dependent variable, while the juice proportion variables were considered independent in the experiment[33]. The analyses of pH, soluble solids, color, and acidity were evaluated using Tukey's test at 95% confidence level. The analyses were performed using the statistical software R3.6.3 (R Core Team. R:A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria, https://www.R-project.org/).

3. RESULTS

3.1 Physicochemical characterization

The results of the physicochemical analysis were compared with responses indicated by the evaluators. The different formulations resulted in significant differences in the physicochemical analysis (Table 2).

3.2 Overall acceptance

Samples with higher concentrations of coconut water and lower concentrations of grape juice displayed lower average scores of overall acceptances in the informed group and the blind group (B2, B6, B7), B2 was equal to B6, differing from B5 and B7, which were the two samples with extreme grade averages in the evaluation. Lower amounts of grape juice negatively influenced the overall acceptance of samples by consumers' awareness of the health benefits of the product, as B7 and B6 differed from the other samples (Table 3).

In the blind group, sample B7 differed from all other samples and also displayed a lower average overall acceptance. This sample was composed of smaller amounts of grape juice and an average value of apple juice. B6 and B2 also differed from the other samples, indicating that higher amounts of coconut water influenced the acceptance of the product, probably due to the lower perception of sweet taste. The highest average (6.58) was observed for sample B1, which contained 25, 51, and 8 mL of grape juice, apple juice, and coconut water, respectively, in 100 mL of mixed beverage with 15 mL of vinegar.

The comparison of samples between consumer groups revealed that information did not affect the overall acceptance of the prepared beverages.

3.3 Sensory Terms

Blind group

The terms watery, pleasant aroma, apple aroma, vinegar aroma, delicious, sweet, fresh, refreshing, artificial flavor, fruity flavor, and natural flavor differed statistically in the blind group (Table 4). The main differences in the sensory characteristics of mixed beverages with vinegar were related to the increase in the amount of coconut water or grape juice.

The results of the blind group indicated that increased coconut water significantly increased the frequency in which the terms watery ($p=0.013^{-17}$) and apple aroma ($p=0.031^{-12}$) were used. Increase grape juice significantly increased the frequency in which the terms pleasant aroma ($p=0.006$), vinegar aroma ($p=0.010$), delicious ($p=0.011^{-3}$), fresh ($p=0.009^{-1}$), and natural flavor ($p=0.002$) were used, which consequently decreased the frequency in which these terms were used when more coconut water was added.

The frequency in which the terms sweet ($p=0.030$), refreshing ($p=0.006$), and fruity flavor ($p=0.006^{-1}$) were different between the highest concentration of grape juice and the lowest concentration of coconut water, with these terms being used less often when higher amounts of coconut water were added. The term artificial flavor was statistically significant for sample B2, being more frequently used in B2 (17) than in B1, B3, and B4.

In the corresponding analysis (Figure 1), samples B1, B3, B4, and B5 were positioned close to the positive terms (upper left quadrant) and sample B2 positioned closer to the terms for acidic, artificial, and residual flavor.

Informed group

The terms that differed statistically in the informed group were watery, pleasant aroma, apple aroma, vinegar aroma, delicious, sweet, natural flavor, fruity flavor, and residual flavor (Table 5). In this group, the main differences in the sensory characteristics of mixed

beverages with vinegar were also related to the increased amount of coconut water or grape juice in the mixture. The term watery ($p=0155^{-14}$) and apple aroma were more frequently used in samples with higher amounts of coconut water. However, the terms used most often in mixtures containing higher amounts of grape juice were apple aroma ($p=0.001$), sweet ($p=0.004$), delicious ($p=0.013^{-5}$), and fruity flavor ($p=0.01$). In the corresponding analysis (Figure 2), samples B2, B6, and B7 also positioned closer to the negative terms (watery, residual flavor, and artificial flavor).

3.4 Emotional profile

The description of the emotional profile after sampling and selecting the applicable words from the list[21] revealed significance in both groups for the terms happy, dissatisfied, pleasant, and unpleasant (Figure 3). The term energized ($p=0.002$) differed only in the informed group. The blind group also differed in the terms good ($p=0.028^{-3}$), disappointed ($p=0.004$), and sad ($p=0.009$).

The corresponding factor analysis, represented in the confidence ellipses (Figure 4-5), was applied according to the frequency of the terms mentioned in each sample. The predominant negative emotions (disappointed, guilty, dissatisfied, unpleasant, and worried) positioned close to samples B6, B7, and B2 in both groups. Samples B1, B4, and B5 were closer to positive emotional terms.

4. DISCUSSION AND CONCLUSIONS

The evaluation of intrinsic and extrinsic characteristics can help in predicting the success of a new product in the marketplace[37]. Although vinegar-based beverages are not popular in the Brazilian market, studies performed worldwide to evaluate their effects on health have described positive results[3-7,31]. Furthermore, consumers are increasingly looking for products with health appeal[38]. Given this scenario, the results of this study indicate the overall acceptance and descriptive sensory and emotional profile of vinegar-based beverages in consumers who were aware and unaware of their benefits.

Among the formulations evaluated, the increase in the amount of grape juice was positively correlated with positive emotions and a better overall acceptance of the products, regardless of whether the consumer was aware of the health benefits of the beverage (Table 2). However, informed consumers evaluated beverages with higher amounts of coconut water more positively, suggesting that consumers are interested in products with greater health appeal. This behavior was also observed in other research[39] for passion fruit and orange nectar with reduced sugar.

Even though sweeteners were not added in this study, beverages showed statistical differences for the term sweet. The Brix/Acidity ratio can be used as a quality measure to predict fruit acceptability[40]. Higher values indicate increasing acceptance of the product. In this study, Brix values ranged from 7.5 to 12, and the ratio of Brix and titratable acidity ranged from 9.22 to 10.25. Lower Brix values were related to lower rates of acceptance (observed in beverages B2 and B7), and higher Brix values were related to higher rates of acceptance (B4 and B5). However, the Brix/acidity ratio did not correlate with the responses.

The olfactory mechanism is overly sensitive and complex, reflecting its importance in primitive survival. The recognition of odors can lead humans to reject or accept a given food based on their previous experiences[41]. Apparently, vinegar aroma (AF between 9 and 14) was reduced with the increase in coconut water, which was observed in samples B6 and B7 in both groups. This behavior can be related to the pH, as it can change the flavor of acetic acid[42]. The pH of the beverages ranged from 3.19 to 3.72, which is considered an acceptable pH of acid

beverages for the digestive tract[43]. In this study, despite the reduced perception of vinegar aroma, we did not observe an increase in the overall acceptance of the samples.

The perception of acidic taste is complex, and it cannot be evaluated only by the acidity, pH, or the physical and chemical structures in food. Receptor proteins in saliva play a fundamental role in perception in humans[44]. Therefore, sensory responses may have been impacted by the complexity of beverage flavors and human biological factors.

The best effect on the perception of aroma seemed to be the increase in which the FA of the term pleasant aroma in the blind group, where higher values were observed in samples with higher amounts of grape juice (B1, B4, B5) and in sample B3, where the components of the mixed beverage were found in similar proportions. Although acid odor negatively influences the evaluation of a product[45,46], the taste and intensity of acetic acid do not differ from other acids[47]. Therefore, our results suggest that the use of grape juice, apple juice, and coconut water can reduce the odor of vinegar, thus increasing the acceptance of the product. The acceptance may also be related to the association of the acid flavor with surprised and exciting terms by the judges (something difficult, but desirable, to consume)[16].

Color can be associated with the flavors present in a food, with the shades of red being associated with the sweet taste[48], and may also reduce the perception of acid taste[49]. The color coordinate a* is related to red[41]. In this study, the lowest values of a* were in samples with the lowest amount of grape juice, and the highest luminosities (L*) and lowest values of saturation (Cr) were also in these samples (B6 and B7). Therefore, the perception of the acid flavor may also have been influenced by the color of the beverages, since beverages B6 and B7 had lower FA for the term vinegar aroma. However, they also had lower values of titratable acidity (8.47 and 9.32 mg/100 g of acetic acid, respectively).

An indication that the information may have influenced the evaluation of beverages is the term artificial flavor, which was statistically different for sample B2 in the blind group, and in the informed group, this term did not show statistical difference. Coherent responses were previously observed[19,29] that demonstrate better acceptance of products when consumers are aware of what they are consuming. This flexibility in the evaluation may be related to the feeling of confidence that the information provides[50].

The consumption of sweet beverages is cultural, and this habit cannot be changed quickly[51]. Public health and market strategies are necessary for a gradual change, as shown by previous research[39]. One of these strategies may be to substitute sweeteners with naturally sweetened products such as grape juice and apple juice. Another advantage of this type of beverage is that it can be easily standardized in the industry. Therefore, technological use and acceptance can be good, unlike, for example, kombucha[38]. Meeting consumers' expectations with healthy alternative products may be a more important strategy than reducing sugar, as consumers, even though aware of the benefits of the products, may prefer those with which they have more affinity[52]. Thus, this study demonstrates that formulating a mixed beverage that meets the demand for a healthy and palatable product is possible even without adding sugar.

All samples had an acidity between 7.6 and 13.56 g mL of acetic acid in 100 mL. We did not observe a correlation between the suppression of acid/sweet or sour/sweet flavors and the frequency in which the terms were used. However, when correlating the highest frequencies for the term delicious (21/B1 - blind group and 24/B5 - informed group), an increase in the frequency of fruity flavor was also observed (29 and 25 respectively). On the contrary[21] described that information decreased the capability of differentiating the samples, since the informed group had nine statistically significant terms ($p<0.5$) while the blind group had 11. This same behavior was observed in the emotional profile, where the informed group differed in five terms, while the blind group differed in seven terms.

No information led to the perception of two more negative emotional terms in the blind group (disappointed and sad). Although the influencing behavior of information on emotional perception is observed in previous studies[21], the present study shows that information about the benefits of an acid product has reduced the perception of negative emotions. This is because, according to the results obtained by[16], acidity is naturally correlated with negative emotions.

Future studies should evaluate the influence of the beverage consumption on the perceived well-being of consumers over time, proving the empirical hypothesis that this type of beverage is energetic and confirming the results of studies that demonstrate that beverages

with vinegar may bring health benefits. This study can elevate the status of vinegar and enable a new way to consume and enjoy its benefits.

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Table 1

Table 2. Physicochemical parameters of mixed beverage formulations with *Anacardium othonianum* Rizzini vinegar

Sample	pH	Brix	Acidity		Ratio	Color coordinates				
			Acetic acid	Citric acid	ss/AT	L	a	b	Cr	Hue
B1	3.28^{de}	9.8^{c}	9.32^{b}	29.84	10.19^{a}	28.21^{c}	36.5^{ab}	18.95^{bc}	41.13^{ab}	27.37^{b}
B2	3.59^{ab}	7.6^{e}	7.62^{c}	24.42	9.95^{ab}	24.11^{cd}	31.48^{bc}	17.50^{bc}	36.02^{bc}	29.01^{ab}
B3	3.45^{bc}	10^{b}	10.17^{b}	32.55	9.82^{a}	23.61^{cd}	44.26^{a}	22.83^{ab}	49.81^{a}	27.28^{bc}
B4	3.36^{cd}	12^{a}	12.71^{a}	40.69	9.87^{ab}	20.12^{de}	42.71^{a}	26.06^{a}	50.05^{a}	31.20^{a}
B5	3.19^{e}	12^{a}	13.56	43.40	9.22^{b}	15.80^{e}	13.48^{e}	3.48^{e}	13.93^{e}	14.52^{d}
B6	3.72	8.7^{d}	8.47^{cd}	27.13	10.25^{a}	63.88^{a}	18.94^{de}	8.39^{de}	20.72^{de}	23.79^{c}
B7	3.66^{a}	8.8^{d}	9.32^{bc}	29.84	9.43^{ab}	39.05^{b}	22.58^{cd}	13.56^{cd}	26.34^{cd}	30.99^{a}

*Different letters indicate significant differences at 5% significance level in the Tukey's test.

Table 3. Hedonic scale values for the informed and blind groups

Sample	Informed	Blind
B1	6.28^{abAB}	6.58^{aA}
B2	5.81^{bcBC}	5.47^{bCD}
B3	6.06^{abAB}	6.04^{aAB}
B4	6.34^{abAB}	6.37^{aAB}
B5	6.48^{aA}	6.25^{aAB}
B6	5.21^{cdDE}	5.33^{bCD}
B7	4.63^{dEF}	4.53^{cF}

Average values for the overall acceptance of mixed vinegar beverages with different proportions of grape juice, apple juice, and coconut water in different experimental conditions: informed (consumers received information about the benefits of the beverage) and blind. Overall acceptance averages with different lowercase letters (blind and informed) are statistically different between groups ($p<0.05$), uppercase letters indicate differences within the same group ($p<0.05$).

Table 4. Frequency of attributes chosen for the CATA questionnaire of the group of blind consumers by sample and result of the Cochran Q test

	B1	B2	B3	B4	B5	B6	B7
Watery*	2	20^{b}	5	5	5	24^{b}	37^{a}
Pleasant aroma*	28^{a}	16^{b}	28^{a}	28^{a}	23	16^{b}	15^{b}
Wine aroma	5	7	11	7	8	13	11
Apple aroma*	14	23	20	20	14	41^{a}	45^{a}
Vinegar aroma*	22^{ab}	20	17	22^{ab}	26^{a}	11^{c}	14^{bc}
Fruity aroma	16	10	15	13	18	12	7
Delicious*	21^{a}	7^{d}	14	16^{abc}	16^{ab}	5^{bcd}	4^{cd}
Sweet*	19	14^{b}	20	19	27^{a}	20	12^{b}
Fresh *	27^{a}	18	15^{bc}	21^{ab}	15^{bc}	10^{c}	10^{c}
Refreshing *	15	11	15	17^{a}	18^{a}	7^{b}	7^{b}
Acid taste	26	30	27	35	32	31	35
Artificial taste*	6^{b}	17^{a}	8^{b}	7^{b}	9	11	13
Sour taste	26	34	30	28	29	26	30
Fruity taste *	29^{a}	17^{bc}	28^{a}	24^{ab}	25^{ab}	12^{c}	13^{c}
Natural taste*	24^{a}	13^{b}	20	19	27^{a}	12^{b}	13^{b}
Residual taste	9	12	6	10	8	12	12
Smooth	25	25	23	19	21	21	14

Average values with different letters on the same row indicate statistical difference ($p \leq 0.05$) in the Cochran test.

Table 5: Frequency of attributes chosen for the CATA questionnaire of the group of informed consumers by sample and result of the Cochran Q test

	B1i	B2i	B3i	B4i	B5i	B6i	B7i
Watery*	1	14^{b}	3	2	1	21^{ab}	27^{a}
Pleasant aroma*	21	27^{a}	23^{a}	22^{a}	24^{a}	12^{b}	12^{b}
Wine aroma	6	4	3	5	4	5	3
Apple aroma*	18^{c}	20^{bc}	16^{c}	16^{c}	17^{c}	31^{a}	30^{ab}
Vinegar aroma*	17^{abc}	8^{d}	18^{ab}	22^{a}	18^{ab}	$10b^{cd}$	9^{cd}
Fruity aroma	12	11	11	14	16	9	8
Delicious*	13^{b}	10^{bc}	12^{b}	13^{b}	24^{a}	5^{cd}	1^{d}
Sweet*	19^{ab}	6^{c}	19^{ab}	23^{a}	12^{bc}	14^{ab}	16^{ab}
Fresh	14	12	10	11	12	8	8
Refreshing	9	9	14	17	11	12	10
Acid taste	26	31	31	28	33	22	29
Artificial taste	6	10	8	6	8	12	8
Sour taste	21	28	18	18	24	23	17
Fruity taste *	22^{ab}	15	21^{ab}	22^{ab}	25^{a}	10^{c}	14^{cb}
Natural taste*	19^{a}	8^{bc}	17^{a}	16^{ab}	14^{ab}	10	6^{c}
Residual taste*	8	13^{ab}	16^{a}	7^{bc}	11	11	5^{c}
Smooth	21	23	19	13	21	23	20

Average values with different letters on the same row indicate statistical difference ($p \leq 0.05$) in the Cochran test.

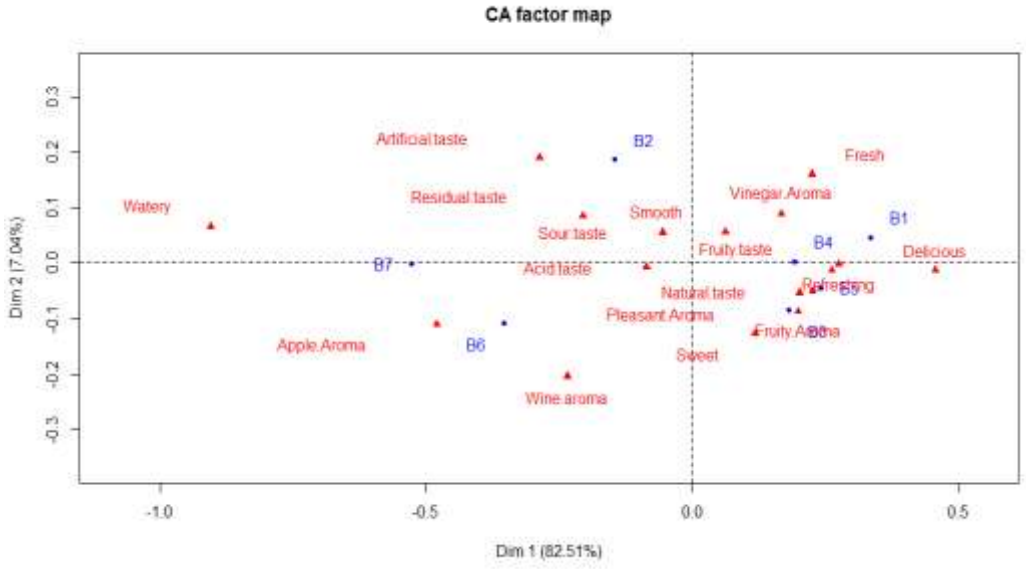

Figure 1: Corresponding analysis for mixed beverage samples (circles) and descriptive terms (triangles) in the blind group.

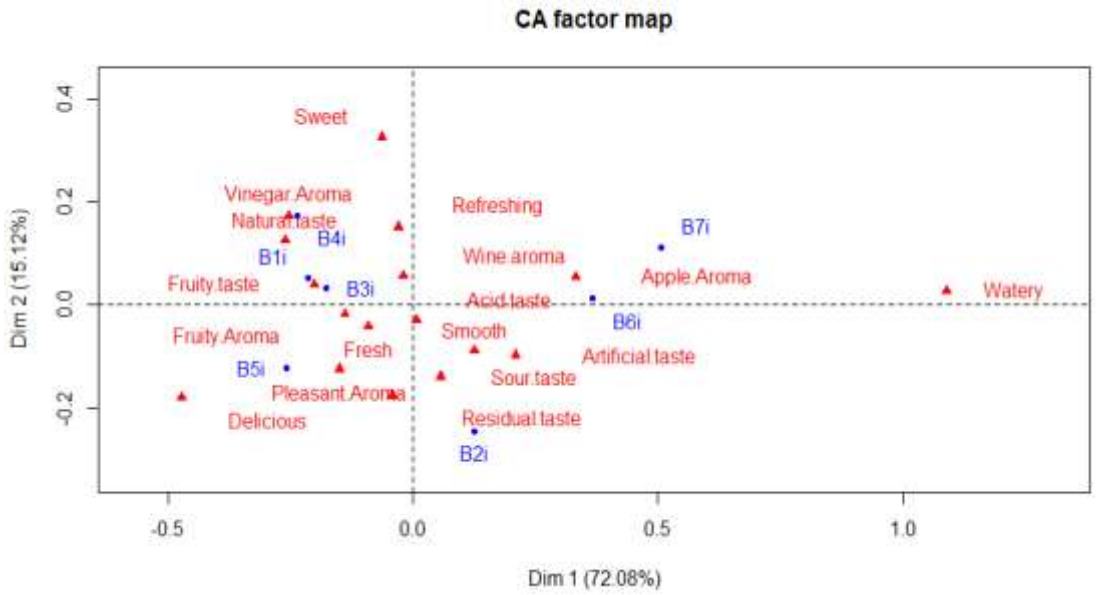

Figure 2: Corresponding analysis for mixed beverage samples (circles) and descriptive terms (triangles) in the informed group.

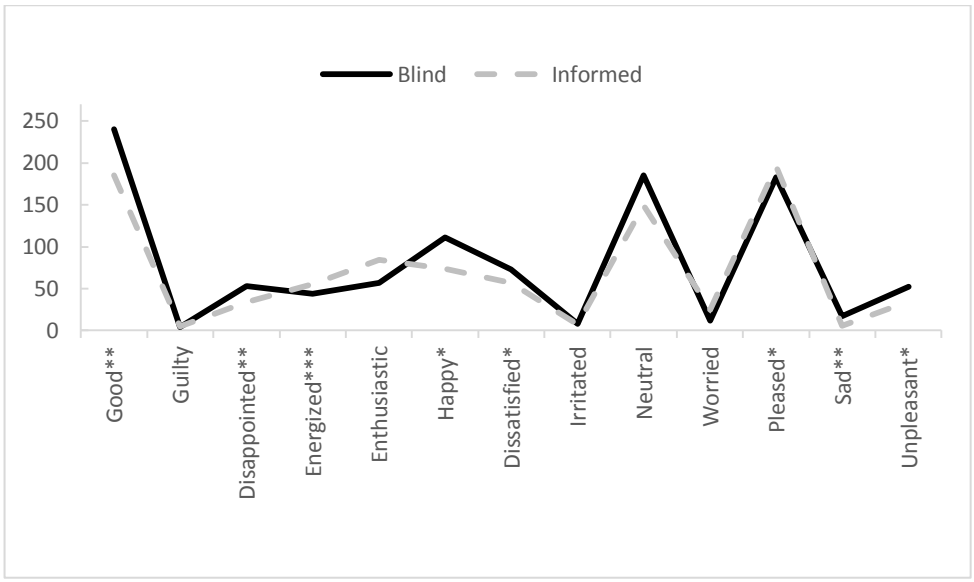

Figure 3: Emotional profile (absolute frequency) in the blind and informed groups, considering the seven samples for the groups. *blind and informed; **blind; ***informed

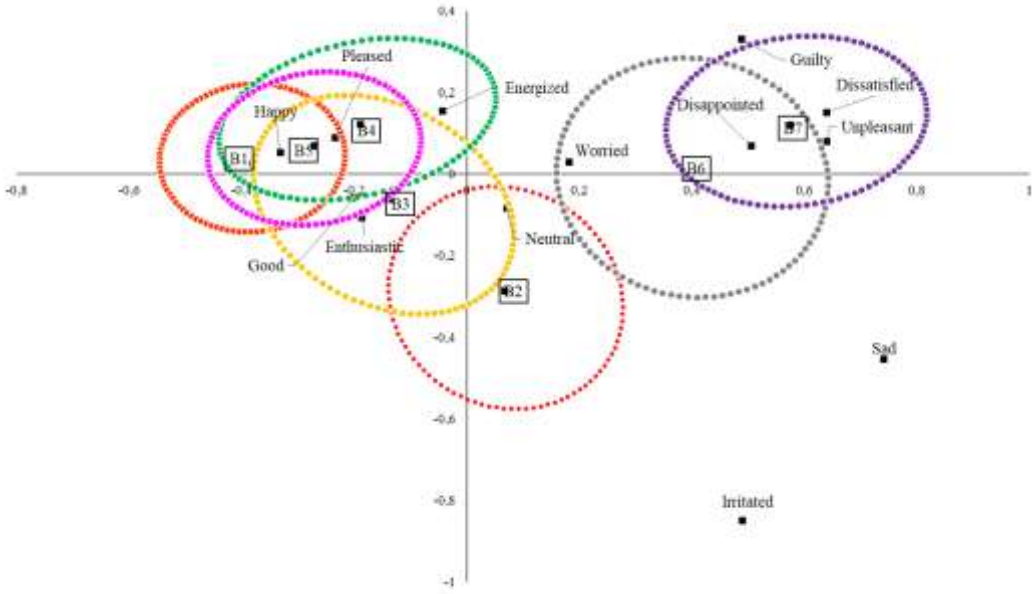

Figure 4: Confidence ellipses for mixed beverage samples and emotional terms in the blind group.

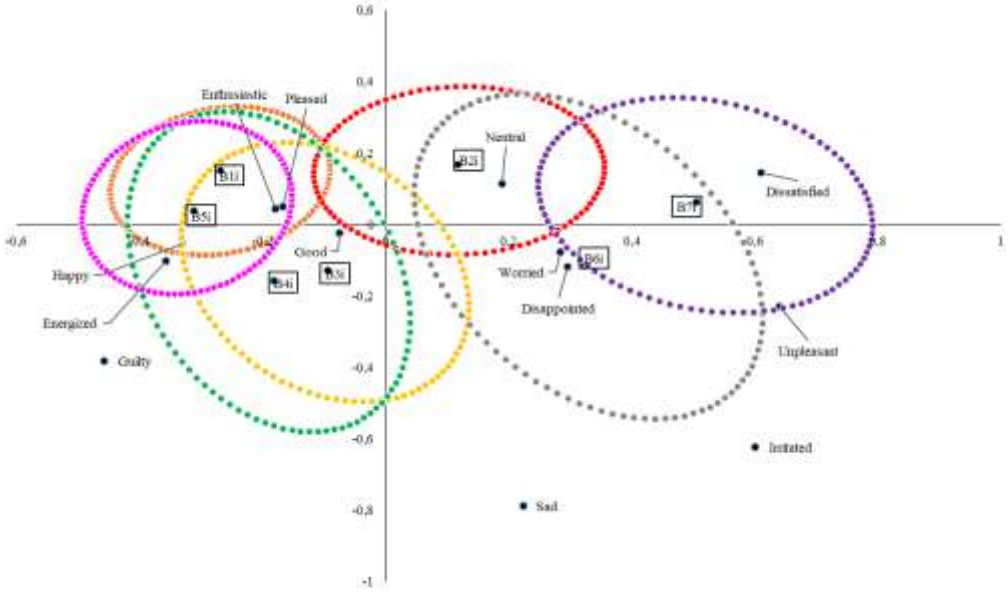

Figure 5: Confidence ellipses for mixed beverage samples and emotional terms in the informed group.

ANEXO II- NORMAS DE PUBLICAÇÃO DA REVISTA JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE

Journal of the Science of Food and Agriculture

Contents

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- Food Materials and Food Engineering
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- **Perspective:** A lightly referenced scholarly opinion piece, focusing on current or future

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Paper Type	Maximum Length (including tables and figures)
Research Article	6000 words
Short Communication	4000 words
Review	6000 words
Mini-Review	4000 words
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Spotlight	3000 words

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iv. The **authors' institutional affiliations at which the work was carried out**, (footnote for author's present address if different to where the work was carried out)
v. **Abstract** and **keywords**
vi. **Main text**
vii. **Acknowledgments**
viii. **References**
ix. **Figure Legends**
x. **Appendices**

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2. **Materials and Methods** section stating clearly, in sufficient detail to permit the work to be repeated, the methods and materials used. Give the statistical design (including replication) of each experiment where appropriate, and include the details of the supplier or manufacturer of any chemical or apparatus not in common use.
3. **Results** presented concisely, using tables or illustrations for clarity.
4. **Discussion** and interpretation of the results.
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References follow the Vancouver style, i.e. numbered sequentially as they occur in the text and ordered numerically in the reference list.

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- Avoid listing more references than necessary.
- Authors are responsible for the accuracy of the references.

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2. Williams K, Galerneau F. Maternal transcranial Doppler in pre-eclampsia and eclampsia. Ultrasound Obstet Gynecol 2003. https://doi.org/10.1002/uog.83

Book

3. Kaufmann HE, Baron BA, McDonald MB, Waltman SR (eds). *The Cornea*, 2nd edn. Churchill Livingstone, New York (1998).

Chapter in a Book

4. Barros MRA, Oliveira AC and Cabral JMS, Integration of enzyme catalysis in an extractive

fermentation process, in *Biocatalysis in Organic Media*, ed. by Laane C, Tramper J and Lilly MD. Elsevier Science Publishers, Amsterdam, pp. 185–196 (1987).

Electronic Material

5. Strunk W, Jr, *The Elements of Style*. [Online]. Columbia University, Academic Information Services (1995). Available: http://www.columbia.edu/acis/bartleby/strunk/ [17 November 1998]

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Legends should be concise but comprehensive – the figure and its legend must be understandable without reference to the text. Include definitions of any symbols used and define/explain all abbreviations and units of measurement.

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- STARD and TRIPOD
- CHEERS
- The EQUATOR Network
- Future of Research Communications and e-Scholarship (FORCE11)
- ARRIVE guidelines
- National Research Council's Institute for Laboratory Animal Research guidelines: the Gold Standard Publication Checklist from Hooijmans and colleagues
- Minimum Information Guidelines from Diverse Bioscience Communities (MIBBI) website; Biosharing website
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- EMBL Nucleotide Sequence Submissions

- GenBank

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ANEXO III-COMPROVANTE DE SUBMISSÃO

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Thank you for your submission

Submitted to	Journal of the Science of Food and Agriculture
Manuscript ID	JSFA-20-4186
Title	Influence of health promotion information on consumers' sensory and emotional perceptions of beverages containing vinegar
Authors	da Rocha Neves, Glenda Antonia Oliveira, Denize Machado, Adriana Braga, Bruna Maria Machado, Ana Luiza Viana, Letícia

Santos, Leonardo
Silva, Fabiano
Soares Junior, Manoel
Caliari, Márcio

Date Submitted 21-Oct-2020

Author Dashboard

CONSIDERAÇÕES FINAIS

O caju-árvore-do-cerrado apresentou potencial tecnológico para produção de vinagre pelo método de fermentação submersa, e o vinagre produzido nesta pesquisa obteve boa aceitação sensorial quando apresentado em um veículo. Neste sentido, o vinagre de caju-árvore-do-cerrado constitui um potencial substituto para o vinagre de maçã, pois estes dois produtos apresentaram desempenho similar (citar aqui o "desempenho"). No entanto, o vinagre produto deste trabalho, apresentou menores percentuais de compostos antioxidantes, quando comparado aos demais vinagres comerciais avaliados. Assim, para pesquisas futuras sugere-se que o processo de obtenção do vinagre seja investigado quanto ao melhor aproveitamento dos compostos bioativos dos pseudofrutos de caju-árvore-do-cerrado.

Neste estudo, observou-se que as alegações de saúde apresentaram impacto na avaliação sensorial dos vinagres e principalmente para as bebidas mistas elaboradas. Estas bebidas favorecem o consumo do vinagre, possibilitando o usufruto dos benefícios desse produto na saúde, além de agregar valor ao produto vinagre.

As bebidas mistas com maiores percentuais de suco de uva demonstram boa aceitação sensorial e intenção de compra, sendo que os consumidores não informados, sobre os possíveis benefícios da bebida na saúde, apresentaram maior número de associações negativas das emoções.

Com relação a análise sensorial, os resultados desta pesquisa sugerem que a forma de apresentar o vinagre, seja em veículo como o vinagrete, ou em uma bebida, melhora a aceitação global deste produto. No entanto, ressalta-se a importância da realização de mais pesquisas para encontrar um método mais adequado, definindo assim um padrão para apresentação do produto de acordo com o objetivo do estudo. E benefícios para a indústria? Investigação de cunho cientifico e TECNOLÓGICO.

O presente estudo abre novas perspectivas para o aproveitamento e agregação de valor tanto do fruto estudado, quanto do vinagre produzido por este, diminuindo a limitação de sazonalidade, regionalidade, o desperdício, além de incentivar à valorização dos frutos e consequente preservação da planta no bioma Cerrado.

contribuir com o desenvolvimento regional do cerrado

*Alternativa para a indústria de vinagres, bebidas, garantindo assim uma maior aplicabilidade da fruta e gerando alternativas para o consumo e comercialização.

APÊNDICES

APÊNDICE I- TERMO DE CONSENTIMENTO LIVRE ESCLARECIDO USADO PARA O VINAGRETE

Você está sendo convidado(a) como voluntário(a) a participar da pesquisa: intitulada "ACEITAÇÃO SENSORIAL DE VINAGRE PRODUZIDO A PARTIR DE CAJU-ÁRVORE-DO-CERRADO". Após receber os esclarecimentos e as informações a seguir, no caso de aceitar fazer parte do estudo, este documento deverá ser assinado em duas vias, sendo a primeira de guarda e confidencialidade do Pesquisador (a) responsável e a segunda ficará sob sua responsabilidade para quaisquer fins.

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1. Justificativa, os objetivos e procedimentos

A presente pesquisa é motivada a partir da necessidade de conhecer melhor o entendimento dos consumidores de vinagre, quanto a aceitação sensorial e sua relação com as características físicas do produto. Ela se justifica pois este é um produto novo.

O objetivo desse projeto é avaliar a aceitação sensorial de vinagre de caju-arvore-do-cerrado. Para a coleta de dados será utilizado formulário onde você deverá preencher as informações solicitadas, após avaliar os produtos fornecidos, conforme protocolo apresentado.

Você será apresentado ao produto a ser avaliado (vinagre de caju) e analisará o mesmo em um veículo (vinagrete de tomate), preenchendo a seguir sua aceitação em uma ficha de avaliação com escala hedônica não estruturada, onde você indicará uma nota entre gostou extremamente ou desgostou extremamente. Logo em seguida responderá sua intenção de

compra do produto, marcando uma das opções entre certamente compraria a certamente não compraria.

2. Desconfortos, riscos e benefícios

Para os participantes da pesquisa existe um risco de desconforto relacionado ao consumo de tomate, vinagre, caju e sal. E os riscos inerentes a você, participante, são: desconfortos e reações alérgicas, como náuseas e fadiga.

Orienta-se que após a participação o indivíduo permaneça no local de aplicação da análise pelo período de 30 minutos decorridos a partir da exposição ao produto, (caso não saiba se tem alergia) e não realize atividades como dirigir, para que em caso de reações adversas possa ser seguido o procedimento de socorro.

Os benefícios oriundos de sua participação serão de colaboração para melhor conhecimento dos atributos sensoriais para este produto.

3. Forma de acompanhamento e assistência:

Aos participantes será assegurada a garantia de assistência integral em qualquer etapa do estudo. Você terá acesso aos profissionais responsáveis pela pesquisa para esclarecimento de eventuais dúvidas. Caso você apresente algum problema a interrupção da análise do produto poderá ser realizada a qualquer momento e você poderá será encaminhado para tratamento adequado da seguinte maneira: o pesquisador responsável assumirá todos os danos provocados à saúde do indivíduo e tomará as providências necessárias, inclusive encaminhamento para atendimento médico e este será feito através do acionamento da equipe de primeiros socorros especializada, o SAMU pelo telefone 192.

E o participante poderá ser encaminhado para o ambulatório do IF goiano campus Rio Verde que conta com profissionais da área da saúde (médico, enfermeiros e auxiliar de enfermagem).

4. Garantia de esclarecimento, liberdade de recusa e garantia de sigilo

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Você é livre para recusar-se a participar, retirar seu consentimento ou interromper a participação a qualquer momento, sendo sua participação voluntária e a recusa em participar não irá acarretar qualquer penalidade.

O(s) pesquisador(es) irá(ão) tratar a sua identidade com padrões profissionais de sigilo e todos os coletados servirão apenas para fins de pesquisa. Seu nome ou o material que indique a sua participação não será liberado sem a sua permissão. Você não será identificado(a) em nenhuma publicação que possa resultar deste estudo.

5. Custos da participação, ressarcimento e indenização por eventuais danos

Para participar deste estudo você não terá nenhum custo nem receberá qualquer vantagem financeira.

Caso você, participante, sofra algum dano decorrente dessa pesquisa, os pesquisadores garantem indenizá-lo por todo e qualquer gasto ou prejuízo.

Ciente e de acordo com o que foi anteriormente exposto, eu _____ _____ estou de acordo em participar da pesquisa intitulada "ACEITAÇÃO SENSORIAL DE VINAGRE PRODUZIDO A PARTIR DE CAJU-ÁRVORE-DO-CERRADO", de forma livre e espontânea, podendo retirar a qualquer meu consentimento.

_____, de _____ de 20___

_____ _____

Assinatura do responsável pela pesquisa Assinatura do participante

APÊNDICE II- Termo de consentimento livre esclarecido usado para Bebida mista

Você está sendo convidado(a) como voluntário(a) a participar da pesquisa: intitulada "DESENVOLVIMENTO DE BEBIDA MISTA DE SUCO DE UVA E MAÇÃ COM ÁGUA DE COCO E VINAGRE DE CAJU-DE-ÁRVORE-DO-CERRADO". Após receber os esclarecimentos e as informações a seguir, no caso de aceitar fazer parte do estudo, este documento deverá ser assinado em duas vias, sendo a primeira de guarda e confidencialidade do Pesquisador (a) responsável e a segunda ficará sob sua responsabilidade para quaisquer fins.

Em caso de recusa, você não será penalizado (a) de forma alguma. Em caso de dúvida sobre a pesquisa, você poderá entrar em contato com os (as) pesquisadores (as) responsável através do telefone: (64) 98136-xxxx ou através do e-mail xxxxx@xx.com.br. Em caso de dúvida sobre a ética aplicada a pesquisa, você poderá entrar em contato com o Comitê de

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6. Justificativa, os objetivos e procedimentos

A presente pesquisa é motivada pelo desenvolvimento de um produto novo no mercado. O intuito e conhecer a aceitação sensorial e sua relação com as características físicas do produto. Ela se justifica pois este é um produto novo no mercado nacional.

O objetivo desta pesquisa é desenvolver uma bebida mista de suco de uva, maçã, água de coco e vinagre utilizando análise descritiva CATA.

Para a coleta de dados será utilizado formulário onde você deverá preencher as informações solicitadas, após avaliar os produtos fornecidos, conforme protocolo apresentado.

Você analisará 7 amostras de bebida mista de forma individual, preenchendo a ficha com sua aceitação em escala hedônica de 9 pontos estruturada, onde você indicará uma nota entre gostou extremamente ou desgostou extremamente. Logo após deverá experimentar novamente a amostra e marcar todos os termos descritivos compatíveis com sua avaliação, e em seguida os termos que descrevem suas emoções durante provar a amostra. Logo em seguida responderá sua intenção de compra do produto, marcando uma das opções entre certamente compraria a certamente não compraria.

7. Desconfortos, riscos e benefícios

Para os participantes da pesquisa existe um risco de desconforto relacionado ao consumo de suco de uva, maçã, água de coco e vinagre de caju-de-árvore-do-cerrado. E os riscos inerentes a você, participante, são: desconfortos e reações alérgicas, como náuseas, fadiga e dores no estomago.

Orienta-se que após a participação o indivíduo permaneça no local de aplicação da análise pelo período de 30 minutos decorridos a partir da exposição ao produto, (caso não saiba se tem alergia) e não realize atividades como dirigir, para que em caso de reações adversas possa ser seguido o procedimento de socorro.

Os benefícios oriundos de sua participação serão de colaboração para melhor conhecimento dos atributos sensoriais para este produto.

8. Forma de acompanhamento e assistência:

Aos participantes será assegurada a garantia de assistência integral em qualquer etapa do estudo. Você terá acesso aos profissionais responsáveis pela pesquisa para esclarecimento

de eventuais dúvidas. Caso você apresente algum problema a interrupção da análise do produto poderá ser realizada a qualquer momento e você poderá será encaminhado para tratamento adequado da seguinte maneira: o pesquisador responsável assumirá todos os danos provocados à saúde do indivíduo e tomará as providências necessárias, inclusive encaminhamento para atendimento médico e este será feito através do acionamento da equipe de primeiros socorros especializada, o SAMU pelo telefone 192.

E o participante poderá ser encaminhado para o ambulatório do IF goiano campus Rio Verde que conta com profissionais da área da saúde (médico, enfermeiros e auxiliar de enfermagem).

9. Garantia de esclarecimento, liberdade de recusa e garantia de sigilo

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O(s) pesquisador(es) irá(ão) tratar a sua identidade com padrões profissionais de sigilo e todos os coletados servirão apenas para fins de pesquisa. Seu nome ou o material que indique a sua participação não será liberado sem a sua permissão. Você não será identificado(a) em nenhuma publicação que possa resultar deste estudo.

10. Custos da participação, ressarcimento e indenização por eventuais danos

Para participar deste estudo você não terá nenhum custo nem receberá qualquer vantagem financeira.

Caso você, participante, sofra algum dano decorrente dessa pesquisa, os pesquisadores garantem indenizá-lo por todo e qualquer gasto ou prejuízo.

Ciente e de acordo com o que foi anteriormente exposto, eu _____ _____ estou de acordo em participar da pesquisa intitulada “DESENVOLVIMENTO DE BEBIDA MISTA DE SUCO DE UVA E MAÇÃ COM ÁGUA DE COCO E VINAGRE DE CAJU-DE-ÁRVORE-DO-CERRADO”, de forma livre e espontânea, podendo retirar a qualquer meu consentimento.

_____, de _____ de 20___

Assinatura do responsável pela pesquisa	Assinatura do participante

APÊNDICE III- TERMO DE CONSENTIMENTO LIVRE ESCLARECIDO USADO PARA VINAGRES COMERCIAIS

Você está sendo convidado (a) como voluntário (a) a participar da pesquisa: intitulada "COMPARAÇÃO DAS CARACTERISTÍCAS SENSORIAIS DE VINAGRE DE CAJU-ÁRVORE-DO-CERRADO COM VINAGRES COMERCIAIS". Após receber os esclarecimentos e as informações a seguir, no caso de aceitar fazer parte do estudo, este documento deverá ser assinado em duas vias, sendo a primeira de guarda e confidencialidade do Pesquisador (a) responsável e a segunda ficará sob sua responsabilidade para quaisquer fins.

Em caso de recusa, você não será penalizado (a) de forma alguma. Em caso de dúvida sobre a pesquisa, você poderá entrar em contato com os (as) pesquisadores (as) responsável através do telefone: (64) 98136-xxxx ou através do e-mail xxxxx @xxx.com.br. Em caso de dúvida sobre a ética aplicada a pesquisa, você poderá entrar em contato com o Comitê de Ética em Pesquisa do Instituto Federal Goiano (situado na Rua 88, nº280, Setor Sul, CEP 74085-010, Goiânia, Goiás. Caixa Postal 50) pelo telefone: (62) 3605 3600 ou pelo e-mail: cep@ifgoiano.edu.br.

Justificativa, os objetivos e procedimentos

A presente pesquisa é motivada a partir da necessidade de conhecer melhor o entendimento dos consumidores de vinagre, quanto a aceitação sensorial e sua relação com as características físicas de produtos comerciais e um não comercial. Ela se justifica pois elaboramos um produto novo e ainda não existem estudos para este produto comparado com os produtos do mercado.

O objetivo desse projeto é avaliar a aceitação sensorial de vinagre de caju-arvore-do-cerrado e de vinagres comerciais de arroz, maçã e vinho tinto. Para a coleta de dados será utilizado formulário onde você deverá preencher as informações solicitadas, após avaliar os produtos fornecidos, conforme protocolo apresentado.

Você será apresentado aos produtos, individualmente, a serem avaliados: vinagres comerciais de maçã, vinho e arroz e um vinagre de cajuzinho-do-cerrado não comercial. Você deverá sentir o odor característico, o sabor e observar a aparência de forma individual para cada um deles, experimentando como um tempero e a seguir deverá preencher sua aceitação em uma ficha de avaliação com escala hedônica não estruturada, indicando uma nota entre

gostou extremamente ou desgostou extremamente. Também correlacionará 40 termos descritivos que correspondam a amostra que está avaliando. Logo em seguida responderá sua intenção de compra do produto, marcando uma das 7 opções entre certamente compraria a certamente não compraria.

Desconfortos, riscos e benefícios

Para os participantes da pesquisa existe um risco de desconforto relacionado ao consumo de vinagre. E os riscos inerentes a você, participante, são: desconforto gástrico e reações alérgicas como náusea, dores, fadiga, entre outros sintomas alérgicos.

Orienta-se que após a participação o indivíduo permaneça no local de aplicação da análise pelo período de 30 minutos decorridos a partir da exposição ao produto, (caso não saiba se tem alergia) e não realize atividades como dirigir, para que em caso de reações adversas possa ser seguido o procedimento de socorro.

Os benefícios oriundos de sua participação serão de colaboração para melhor conhecimento dos atributos sensoriais para o vinagre de cajuzinho e sua relação com os vinagres comerciais.

Forma de acompanhamento e assistência:

Aos participantes será assegurada a garantia de assistência integral em qualquer etapa do estudo. Você terá acesso aos profissionais responsáveis pela pesquisa para esclarecimento de eventuais dúvidas. Caso você apresente algum problema a interrupção da análise do produto poderá ser realizada a qualquer momento e você poderá será encaminhado para tratamento adequado da seguinte maneira: o pesquisador responsável assumirá todos os danos provocados à saúde do indivíduo e tomará as providências necessárias, inclusive encaminhamento para atendimento médico e este será feito através do acionamento da equipe de primeiros socorros especializada, o SAMU pelo telefone 192.

E o participante poderá ser encaminhado para o ambulatório do IF goiano campus Rio Verde que conta com profissionais da área da saúde (médico, enfermeiros e auxiliar de enfermagem).

Garantia de esclarecimento, liberdade de recusa e garantia de sigilo

Você será esclarecido (a) sobre a pesquisa em qualquer tempo e aspecto que desejar, através de telefone, e-mail ou contato pessoal (64)98136-xxxx, xxxxxx@xxx.com.br ou rua Sul Goiana, km1-IF Goiano.

Você é livre para recusar-se a participar, retirar seu consentimento ou interromper a participação a qualquer momento, sendo sua participação voluntária e a recusa em participar não irá acarretar qualquer penalidade.

O(s) pesquisador (es) irá(ão) tratar a sua identidade com padrões profissionais de sigilo e todos os dados coletados servirão apenas para fins de pesquisa. Seu nome ou o material que indique a sua participação não será liberado sem a sua permissão. Você não será identificado (a) em nenhuma publicação que possa resultar deste estudo.

Custos da participação, ressarcimento e indenização por eventuais danos

Para participar deste estudo você não terá nenhum custo nem receberá qualquer vantagem financeira.

Caso você, participante, sofra algum dano decorrente dessa pesquisa, os pesquisadores garantem indenizá-lo por todo e qualquer gasto ou prejuízo.

Ciente e de acordo com o que foi anteriormente exposto, eu _____ _____ estou de acordo em participar da pesquisa intitulada "COMPARAÇÃO DAS CARACTERISTÍCAS SENSORIAIS DE VINAGRE DE CAJU-ÁRVORE-DO-CERRADO COM VINAGRES COMERCIAIS", de forma livre e espontânea, podendo retirar a qualquer meu consentimento.

_____, de _____ de 20___

_____	_____
Assinatura do responsável pela pesquisa	Assinatura do participante

APÊNDICE IV- INSTRUMENTO DE COLETA DE INFORMAÇÕES A SER USADO PARA A ANÁLISE SENSORIAL DOS VINAGRES COMERCIAIS E DE CAJU-ÁRVORE DO CERRADO

Consumidor:3 - Nome:_____Data____/____/____ Amostra:182 Q:0

Idade: □ 18-29 □30-54 □55 ou mais Sexo: □Masc. □Fem.

Você está recebendo uma amostra de **vinagre**. Por favor, use a escala abaixo para indicar o quanto você gostou ou desgostou de cada amostra.

desgostei extremamente	desgostei muito	desgostei moderadamente	desgostei ligeiramente	não gostei e nem desgostei	gostei ligeiramente	gostei moderamente	gostei muito	gostei extremamente
□	□	□	□	□	□	□	□	□

Marque todas as palavras às quais você considera que são adequadas para descrever esse vinagre:

□ Sabor de limão	□ Gostoso	□ Aroma de uva	□ Sabor de Ácido Acético
□ Visual desagradável	□ Ruim	□ Odor desagradável	□ Visual agradável
□ Gosto Adstringente	□ Aroma picante	□ Aroma Cítrico	□ Sabor herbáceo
□ Aroma de limão	□ Aroma Frutado	□ Sabor de uva	□ Prazeroso
□ Sabor Azedo	□ Sabor de cajuzinho	□ Sabor Amargo	□ Aroma Adocicado
□ Aroma de cereal	□ Viscoso	□ Aroma Alcóolico	□ Sabor Alcóolico
□ Aroma suave	□ Aroma pungente	□ Sabor picante	□ Aroma de vinho
□ Aroma herbáceo	□ Sabor de cereal	□ Límpido	□ Sabor pungente
□ Sabor de Vinho	□ Aroma de madeira	□ Sabor de maçã	□ Aroma de maçã
□ Sabor de madeira	□ Odor agradável	□ Aroma de cajuzinho	□ Aroma Ácido

Com base em sua opinião, por favor, indique sua intenção de compra em relação ao produto que você acabou de avaliar, usando a escala abaixo.

Certamente não compraria	Possivelmente não compraria	Provavelmente não compraria	Talvez comprasse/ talvez não comprasse	Provavelmente compraria	Possivelmente compraria	Certamente compraria
□	□	□	□	□	□	□

APÊNDICE V- QUESTIONÁRIO DAS INFORMAÇÕES DE FAIXA ETÁRIA E DE CONSUMO PARA BEBIDA MISTA.

Agora responda algumas informações sobre você: **Consumidor: 31**

-Idade: □ 18-29 □30-54 □55 ou mais **Sexo:** □Masc. □Fem.

-Indique sua frequência de consumo para BEBIDA MISTA:

□	□	□	□	□
nunca	1-2 vezes por semana	5 vezes ou mais	todos os dias	mais de uma vez/dia

-Indique sua frequência de consumo para BEBIDA que promova a saúde ou bem-estar:

□	□	□	□	□
nunca	1-2 vezes por semana	5 vezes ou mais	todos os dias	mais de uma vez/dia

-Com base em sua opinião, por favor, indique o quanto você concorda com o uso dos nomes caso esse produto fosse comercializado.

	Discordo Totalmente						Concordo Totalmente
+Saúde	□	□	□	□	□	□	□
HealthyDrink	□	□	□	□	□	□	□
DrinkPower	□	□	□	□	□	□	□
Bem Saudável	□	□	□	□	□	□	□
ProBem	□	□	□	□	□	□	□

Comentários:

APÊNDICE VI- INSTRUMENTO DE COLETA DE INFORMAÇÕES A SER UTILIZADO PARA A ETAPA 2 DA ANÁLISE SENSORIAL DA BEBIDA MISTA

Consumidor:31 Nome:_____Data____/____/____ **Amostra:** 740

Por favor, beba um pouco de água para limpar seu paladar

1-Você está recebendo uma amostra de **bebida mista de uva, maçã e água de coco**. Por favor, beba um pequeno gole da bebida e depois use a escala abaixo para indicar o quanto você gostou ou da amostra.

◻	◻	◻	◻	◻	◻	◻	◻	◻
Desgostei extremamente	Desgostei muito	Desgostei moderadamente	Desgostei ligeiramente	Nem gostei nem desgostei	Gostei ligeiramente	Gostei moderadamente	Gostei muito	Gostei extremamente

Por favor, beba novamente um pouco da amostra, deixando uma pequena quantidade para a última questão:

A seguir, você encontra uma lista contendo atributos emocionais e sensoriais.

2-Por favor, selecione todos os atributos os quais você considera aplicáveis para a amostra

☐ Sabor Artificial	☐ Fresco	☐ Ruim	☐ Sabor frutado
☐ Doce	☐ Desagradável	☐ Aroma frutado	☐ Delicioso
☐ Aroma de vinagre	☐ Sabor Natural	☐ Bebida saudável	☐ Aroma agradável
☐ Aroma de vinho	☐ Aguado	☐ Sabor Azedo	☐ Sabor residual
☐ Refrescante	☐ Aroma de maçã	☐ Sabor ácido	☐ Suave

3-Por favor, selecione também todas as emoções que você achar aplicáveis para descrever como você se sente na hora que está consumindo a amostra.

☐ Triste	☐ Bem	☐ Energizado	☐ Neutro
☐ Entusiasmado	☐ Insatisfeito	☐ Feliz	☐ Preocupado
☐ Culpado	☐ Desapontado	☐ Irritado	☐ Satisfeito

3-Com base em sua opinião, por favor, indique sua intenção de compra em relação ao produto que você acabou de avaliar, usando a escala abaixo.

◻	◻	◻	◻	◻	◻	◻
Certamente não compraria	Possivelmente não compraria	Provavelmente não compraria	Talvez comprasse/ talvez não comprasse	Provavelmente compraria	Possivelmente compraria	Certamente compraria

Comentários:_____