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FARINHA DAS PARTES NÃO CONVENCIONAIS DE HIBISCUS:

CARACTERIZAÇÃO E ESTABILIDADE DE ARMAZENAMENTO

IMPERATRIZ – MA
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FARINHA DAS PARTES NÃO CONVENCIONAIS DE HIBISCUS: CARACTERIZAÇÃO E ESTABILIDADE DE ARMAZENAMENTO

Trabalho de Conclusão de Curso apresentado ao Curso de Engenharia de Alimentos da Universidade Federal do Maranhão/CCSST, para obtenção de grau de Bacharela em Engenharia de Alimentos.

Orientadora: Prof.ª Dra. Tatiana de Oliveira Lemos

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FARINHA DAS PARTES NÃO CONVENCIONAIS DE HIBISCUS: CARACTERIZAÇÃO E ESTABILIDADE DE ARMAZENAMENTO

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Resumo

A vinagreira (*Hibiscus sabdariffa L.*) é uma PANC com relevante potencial nutricional, porém suas folhas e caules são altamente perecíveis. Assim, a desidratação para produção de farinha a partir das folhas e caules desta é uma alternativa promissora. O objetivo da pesquisa foi avaliar as características de identidade e qualidade da farinha de vinagreira e verificar a influência do tipo de embalagem durante o armazenamento. Foram realizadas análises para composição nutricional da farinha: valor energético, carboidratos, proteínas, lipídios, cinzas, ferro, sódio, potássio e vitamina C. Para a estabilidade, a farinha foi acondicionada em garrafa PET (EMB1) e em saco laminado PET metalizado/PEBD sem vácuo (EMB2), armazenadas por 90 dias, com análises a cada 30 dias de: atividade de água (Aa), pH, acidez total titulável (ATT), contagem de coliformes totais e fecais, bolores e leveduras e pesquisa de Salmonella. A composição nutricional determinada foi: 333,73 kcal (valor energético); 60,50 g/100 g (carboidratos); 17,72 g/100 g (proteínas); 2,65 g/100 g (lipídios); 7,67 g/100 g (cinzas); 238,30 mg/100 g (sódio); 143,13 mg/100 g (ferro); 77,99 mg/100 g (vitamina C). Os resultados obtidos durante o armazenamento foram, respectivamente para EMB1 e EMB2: 0,52-0,56 e 0,35-0,48 (Aa); 2,61-2,66 e 2,53-2,69 (pH); 8,13-9,05 e 9,11-9,60 (ATT). Foram obtidas contagens de coliformes totais e fecais < 3 NMP/g e ausência de Salmonella. As contagens de bolores e leveduras atenderam ao limite microbiológico regulatório. Assim, a farinha obteve uma boa

qualidade nutricional e o tipo de embalagem não influenciou em sua segurança. Mas, nas características de identidade e qualidade do produto.

Palavras-chave: Vinagreira, Folhas, Caules, Proteínas, Ferro, Estabilidade.

Introdução

A vinagreira (*Hibiscus sabdariffa L.*) é uma planta alimentícia não convencional (PANC), pertencente à família Malvaceae, com potencial nutricional, contendo proteínas, carboidratos, vitamina C, β-caroteno e ferro [1]. A parte mais usada dessa PANC é o cálice, sendo as folhas e os caules subutilizados. Geralmente, as folhas e os caules são descartados, exceto na África, onde as folhas são utilizadas como ingredientes em sopas e molhos, e no Brasil, onde as folhas são utilizadas na preparação de um alimento típico da gastronomia do estado do Maranhão, chamado arroz de cuxá [2].

As folhas e os caules frescos da vinagreira são perecíveis, o que torna um desafio o armazenamento a longo prazo dessas partes não convencionais de *Hibiscus sabdariffa* para aproveitamento, devido a alta atividade de água dessas, a indisponibilidade de instalações de armazenamento a frio e a possibilidade de deterioração. Consequentemente, a aplicação de uma tecnologia de conservação para aumentar a vida útil desse alimento, como a desidratação, pode permitir seu consumo a longo prazo e facilitar o manuseio, transporte e armazenamento [3].

A partir da tecnologia convencional da desidratação é possível produzir farinha de vegetais como uma alternativa para o aproveitamento das partes não convencionais desses e para a agregação de valor comercial a essas matrizes alimentares [4]. Além disso, a produção de farinhas vegetais vem ganhando destaque na indústria brasileira, devido ao crescente interesse por produtos com melhora do perfil de nutrientes e por promover o aumento de vida útil a esses alimentos naturalmente perecíveis, sendo esta uma alternativa

para o aproveitamento integral dos vegetais [5]. Sendo a farinha, o produto resultante das partes comestíveis de uma ou mais espécies de cereais, leguminosas, frutos, sementes, tubérculos e rizomas por moagem e/ou outros processos tecnológicos que garantam a segurança no processamento de alimentos [6].

Todos os alimentos apresentam um tempo de vida útil que é caracterizado pela sua estabilidade nutricional, sensorial, química, física e microbiológica. Entende-se por estabilidade de um produto o período no qual ele pode ser consumido de forma que essas características estejam conservadas [7]. Para garantir a qualidade e segurança de um produto desidratado é importante armazená-lo em embalagem adequada, já que esta é a principal barreira de proteção entre o alimento e o ambiente externo. A embalagem tem como função evitar o processo de degradação que ocorre devido a interação do alimento com a luz, umidade, variações de temperatura e oxigênio, por exemplo. Além de proteger o alimento contra agentes deteriorantes, é uma barreira contra agentes infectantes e sujidades [8].

O uso de embalagens plásticas em alimentos vem crescendo cerca de 4 a 7% ao ano. Dentre os polímeros mais utilizados em embalagens plásticas temos o politereftalato de etileno – PET, polipropileno – PP, polietileno de baixa densidade – PEBD e o polietileno de baixa densidade – PEAD [9]. Para o armazenamento de farinhas, as embalagens utilizadas no presente estudo, garrafa PET e laminado PET metalizado/PEBD, foram baseadas em estudos prévios e nas embalagens já usadas comercialmente, para produtos similares. Como exemplo temos a farinha de mandioca envasada em garrafa PET abordada no trabalho de Junior e Cruz [10].

O objetivo da pesquisa foi avaliar as características de identidade e qualidade da farinha de vinagreira (*Hibiscus sabdariffa L.*) e verificar a influência do tipo de embalagem utilizada, nas características de identidade e qualidade da farinha durante o

armazenamento. O estudo tem uma patente depositada no INPI no Brasil com número de registro de BR 10 2019 011320 0.

Metodologia

Hortaliça não-convencional

A hortaliça não-convencional vinagreira (*Hibiscus sabdariffa L.*) (Fig. 1) utilizada no presente estudo foi cedida pela Associação dos Agricultores Familiares do Maranhão (AGRIMA) do município de Imperatriz – MA.

Produção da farinha de vinagreira

A farinha de vinagreira foi produzida conforme processo tecnológico descrito na patente de invenção BR 10 2019 011320 0. A formulação utilizada para a composição da farinha de vinagreira foi de 50% de farinha das folhas de vinagreira e 50% de farinha dos caules de vinagreira, visando o uso integral das partes não convencionais da planta.

Após a produção, a farinha (200 g) foi acondicionada nas seguintes embalagens: garrafa PET (Fig. 2) e saco laminado PET metalizado/PEBD sem vácuo (Fig. 3).

Caracterização da farinha de vinagreira

Antes do acondicionamento nas embalagens, a farinha de vinagreira foi submetida às análises a seguir.

pH, Acidez total titulável (ATT)

As análises foram realizadas conforme metodologias descritas pelo Instituto Adolf Lutz [11].

Atividade de água

A atividade de água foi medida por método direto, através de um higrômetro baseado em psicrometria de (Decagon – Aqualab), por ponto de orvalho com controle interno da temperatura da amostra, com resolução de 0,001Aa, sob temperatura de 24 ± 1ºC.

Valor energético

Determinou-se com base na composição da farinha de vinagreira utilizando os fatores de conversão de Atwater: 4 kcal. g-1 (carboidratos), 4 kcal.g-1 (proteínas) e 9 kcal.g-1 (lipídios) [12].

Composição nutricional

As análises de carboidratos, proteínas, lipídios, cinzas, ferro, sódio e potássio, conforme metodologias descritas pelo Instituto Adolf Lutz [11].

Vitamina C

O teor de vitamina C foi determinado pelo método 2,6 diclorofenol indofenol segundo [13]. A leitura foi realizada em espectrofotômetro a 520 nm. Os resultados foram expressos em $mg.100g^{-1}$.

Contagem de coliformes totais e fecais

A contagem de coliformes totais e fecais foi realizada de acordo com o método do NMP técnica de diluição múltipla [14].

Pesquisa de *Salmonella*

A pesquisa de *Salmonella* foi realizada com o kit analítico 3M Petrifilm Salmonella Express System [15].

Contagem de bolores e leveduras

A contagem de bolores e leveduras foi realizada com o kit analítico *3M Yeast and Mold Count Plate* [15].

Estabilidade da farinha de vinagreira

A estabilidade da farinha de vinagreira acondicionada em garrafa PET e em saco laminado PET metalizado/PEBD sem vácuo foi avaliada por um período de 90 dias. A cada tempo de armazenamento (0, 30, 60, 90) foram realizadas as análises de umidade, atividade de água, pH, ATT, cor, contagem de coliformes totais e fecais, pesquisa de Salmonella e contagem de bolores e leveduras. Avaliado de acordo com a análise estatística teste t de Student's ($p > 0,05$)

Resultados e Discussão

Caracterização da farinha de vinagreira

De acordo com a Tabela 1, o valor energético obtido para a farinha de vinagreira, foi de 336,73 kcal/100g, maior que o obtido por Almoraie [17] na farinha de trigo suplementada com farinha de noz, onde foi verificado que a adição melhorou em até 50% o valor nutricional dos pães. Considerando que a declaração de nutrientes obrigatórios no rótulo dos alimentos, deve ser feita também em % de valores diários (%VD), em uma dieta de 2.000 kcal, temos que 100 g da farinha de vinagreira possuem 17% do VD para o valor energético [18].

O conteúdo de carboidratos avaliado na farinha de *Hibiscus* foi de 60,50 g/100 g. Este valor é superior ao observado na farinha das folhas de mandioca que foi de 22,27 g/100 g e na farinha de okara que teve uma média de 32,10 g/100 g de carboidratos [19, 20]. Considerando que a declaração de nutrientes obrigatórios no rótulo dos alimentos,

deve ser feita também em % de valores diários (%VD) e o valor diário de referência de carboidratos para uma dieta adulta adequada, é de 300 g, temos que 100 g da farinha de vinagreira possuem 20 % do VD para carboidratos [18].

O teor de proteínas da farinha de vinagreira foi de 17,72 g/100 g, e merece atenção, já que nos últimos anos houve um crescente interesse sobre a inserção de proteínas vegetais em produtos alimentícios. Nas farinhas vegetais, a fração proteica pode ser explorada como ingrediente nutricional em produtos alimentícios processados, decorrente da atual tendência de alimentos associados à saúde e bem-estar [21]. Em comparação com outros estudos, temos 2,87 g/100 g de proteínas para farinha de jenipapo e 11,76 g/100 g de proteínas para a farinha de casca de maracujá, teores menores que o observado na farinha de vinagreira, [20,19,22]. Com base nos valores obtidos de proteínas para a farinha de vinagreira e o valor diário de referência de proteínas para fins de rotulagem nutricional dos alimentos em geral, que é de 50 g, temos que 100 g de farinha de vinagreira possuem 35% do VD para proteínas [18].

Já o teor de lipídios para a farinha de vinagreira foi de 2,65 g/100 g. Menores teores de lipídios, quando comparado aos teores da farinha de vinagreira, foi verificado na farinha de jenipapo, 0,67 g/100 g, e na farinha de casca de maracujá, 1,64 g/100 g [16, 20]. Já a farinha de okara apresentou um teor de lipídios de 11,9 g/100 g, maior que o teor da farinha de vinagreira [22]. Considerando os valores obtidos para a farinha de vinagreira e o valor diário de referência de gorduras totais para fins de rotulagem nutricional dos alimentos em geral, que é de 65 g, temos que 100 g da farinha de vinagreira possuem 4% do VD para gorduras totais [18].

Para a farinha de vinagreira o teor de cinzas obtido foi de 7,67 g/100 g de cinzas. Teores de cinzas inferiores aos obtidos para a farinha de vinagreira, foram obtidos para a farinha de jenipapo (4,04 g/100 g) e para a farinha de okara (3,0 g/100 g) [16, 22].

Enquanto a farinha de casca de maracujá obteve teor de cinzas superior (8,13 g/100 g) ao da farinha de vinagreira [20]. O teor de cinzas máximo para a farinha de trigo é de 1,4 g/100 g, menor que o observado na farinha de vinagreira [8].

O teor de sódio obtido para a farinha de vinagreira foi de 238,30 mg/100 g. Este valor é superior ao da farinha de trigo que foi de 1,0 mg/100 g, e inferior ao teor de sódio da farinha de *Talinum paniculatum*, que foi de 891,67 mg/100 g [23,21]. Amplamente difundido na natureza, o sódio, no organismo humano, é o eletrólito responsável pela manutenção do volume e osmolaridade do fluido extracelular, contribuindo para a manutenção do equilíbrio ácido-básico, absorção de nutrientes, transmissão nervosa e contração muscular. Contudo, o alto consumo de sódio na dieta é considerado um fator de risco que favorece o desenvolvimento das doenças crônicas não transmissíveis [24]. Conforme os valores obtidos para a farinha de vinagreiras e o valor diário de referência de sódio para fins de rotulagem nutricional dos alimentos em geral, que é de 2.000 mg, temos que 100 g de farinha de vinagreira representam 12% do VD para sódio [18].

O teor de ferro obtido para a farinha de vinagreira foi de 143,13 mg/100 g. O ferro é indispensável para o desenvolvimento correto de diversas funções fisiológicas. Segundo a ANVISA [25], o recomendado é a ingestão de 14,0 mg desse mineral diariamente por adultos. Assim, a farinha de vinagreira apresenta valor consideravelmente, superior a esta recomendação. De acordo com os valores obtidos para a farinha de vinagreira e o valor diário de referência (VDR) de ferro para fins de rotulagem nutricional dos alimentos em geral, que é de 14 mg, temos que para atender VDR se faz necessário o consumo de 9,78 g de farinha de vinagreira [18]. No estudo de Schveitzer et al. [26] foram obtidos teores de ferro de 39,1 mg/100 g em farinha de inflorescência de brócolis, 64,0 mg/100 g em farinha de cenoura e 16,4 mg/100 g em farinha de repolho, teores menores que o obtido na farinha de vinagreira.

O teor de vitamina C obtido para a farinha de vinagreira de 77,99 mg/100 g, apresenta-se como um dado relevante, em comparação com outros tipos de farinhas vegetais, tais como, 18,99 mg/100 g obtidos na farinha de jenipapo e 56,6 mg/100 g obtidos na farinha de folhas de mandioca [16, 19]. A vitamina C possui função antioxidante e é encontrada naturalmente, em frutas e vegetais. Além disso, é muito sensível ao processamento e condições de armazenamento, podendo sofrer significativa degradação durante esses períodos. Assim, a sua retenção é considerada como um índice de conservação de alimentos e da qualidade nutricional do mesmo [27]. Conforme os valores obtidos para a farinha de vinagreiras e o valor diário de referência de vitamina C para fins de rotulagem nutricional dos alimentos em geral, que é de 100 mg, temos que 100 g de farinha de vinagreira representam 78% do VD para vitamina C [18].

Estudo da estabilidade da farinha de vinagreira

A Tabela 2 apresenta os resultados das análises das características de identidade e qualidade da farinha de vinagreira acondicionada em garrafa PET (EMB1) e saco laminado PET metalizado/PEBD sem vácuo (EMB2), durante o armazenamento por 90 dias a temperatura ambiente (25 °C). O parâmetro de atividade de água variou para EMB1 de 0,52 a 0,56 e para EMB2 de 0,35 a 0,48. No entanto, os valores obtidos foram menores que 0,60, o que pode garantir uma maior vida útil à farinha de vinagreira, devido à menor disponibilidade de água livre para o crescimento microbiano [28]. Considerando a atividade de água com o tipo de embalagem, foi observado que houve diferença significativa entre EMB1 e EMB2 e que EMB1 obteve uma menor atividade de água. A farinha foi obtida por metodologia padronizada, tendo como referência o valor de atividade de água abaixo de 0,60 para finalização da secagem. Seth e Sarkar [29] afirmaram que vários fatores podem afetar a difusividade efetiva do produto durante o

processo de secagem. Fatores esses que podem estar relacionados às etapas de obtenção da farinha, tais como, a geometria do material, onde a etapa de trituração influencia a geometria das folhas e caules triturados, podendo interferir na difusividade do material e consequentemente, na remoção da água desse [30]. Sendo assim, embora as folhas e caules da vinagreira desidratados atendam ao critério de finalização da secagem, não necessariamente apresentaram a mesma atividade de água, uma vez que cada processo pode ter um desempenho diferente devido ao fator mencionado. Além disso, cada embalagem possui uma taxa de permeabilidade ao vapor de água diferente, que também podem ter contribuído para a diferença no comportamento da atividade de água entre as embalagens. Hemery et al. [31] verificaram que a atividade de água da farinha de trigo fortificada embalada em saco PET/alumínio não mudou significativamente, durante 6 meses de armazenamento a temperatura de 25 ºC com umidade relativa do ar (UR) de 65% e 85% (0,64 ± 0,02). Já as amostras de farinha de trigo fortificada embaladas em sacos de papel, armazenadas durante 6 meses, apresentaram variações de atividade de água com a UR, onde as amostras de farinha de trigo fortificada armazenadas a temperatura de 25 ºC e 65% UR sofreram uma redução dos valores de atividade de água. Enquanto as amostras de farinha armazenadas a temperatura de 25 ºC e 85% UR apresentaram aumento significativo da atividade de água, comportamento esse similar ao observado no presente estudo [31].

Entre as embalagens, verificou-se que não houve diferença significativa, exceto em T30, para o parâmetro pH, sendo o menor valor encontrado para EMB2 (2,53). Alcântara et al [32] encontraram valores superiores ao descrito para a farinha de vinagreira, ao analisar o pH da farinha do pedúnculo do caju (4,15) e da casca do maracujá (3,77), o que pode ser justificado pela característica de cada matéria-prima. Naturalmente, a vinagreira possui em sua composição ácidos orgânicos, como os ácidos oxálico, málico,

shiquímico e fumárico, com destaque para o ácido málico encontrado em maior concentração (9,10 ± 0,09 g/100 g), que podem colaborar para o baixo valor de pH da farinha [33].

Quanto à acidez total titulável (ATT), observou-se que, comparando o parâmetro entre as embalagens, não houve diferença significativa, exceto para T90, com a maior média (9,60) para EMB2. Silva et al. [28] obtiveram valor de ATT em farinha de *Talinum paniculatum* inferior aos apresentados neste estudo. Sabe-se que a presença e a natureza dos ácidos nos alimentos influenciam o crescimento microbiano por colaborar na redução do pH [33].

A Tabela 3 apresenta os resultados da avaliação da segurança e qualidade microbiológica da farinha de vinagreira acondicionada em garrafa PET (EMB1) e em saco laminado PET metalizado/PEBD sem vácuo (EMB2), durante o armazenamento por 90 dias a temperatura de 25 ºC. As análises foram realizadas durante o período de 90 dias, em intervalos de 30 dias a partir do tempo T0, obtendo valores periódicos para contagem de coliformes totais, contagem de coliformes fecais, pesquisa de Salmonella e contagem de bolores e leveduras.

De acordo com os resultados obtidos, durante o armazenamento das farinhas acondicionadas em EMB1 e EMB2, as contagens de coliformes totais e fecais foram menores que 10 UFC/g e com ausência de *Salmonella*, o que garante a inocuidade do produto. Os resultados obtidos para as farinhas podem ser justificados pelos valores de pH inferiores a 4,5 aliados ao conteúdo de ácidos orgânicos, a Aw menor que 0,60 e a presença de antimicrobianos naturais da vinagreira que impedem o crescimento da maioria das bactérias patogênicas [34]. Sendo assim, temos que as farinhas acondicionadas em EMB1 e EMB2 atenderam ao limite microbiológico estabelecido pela

legislação brasileira para a categoria 2, hortaliças, raízes, tubérculos, fungos comestíveis e derivados, categoria específica d, secos, desidratados ou liofilizados [35].

Com relação à contagem de bolores e leveduras, os resultados obtidos para a farinha envasada em EMB1 e EMB2, foram menores que 10 UFC/g, exceto em T0 (EMB1 e EMB2) e T60 (EMB1). Os bolores e as leveduras são mais tolerantes a pH ácidos e baixa atividade de água do que as bactérias, por essa razão podem deteriorar a farinha. A vida útil da farinha é dependente da multiplicação da microbiota contaminante, quanto maior a carga microbiana inicial, menor a vida útil do produto, devido ao aumento da atividade microbiana. Sendo assim, com relação a carga microbiana necessária para a deterioração de alimentos, há um consenso na literatura de que em contagens microbianas acerca de aproximadamente 10^7 UFC/g ou mL de produto, os micro-organismos são capazes de produzir metabólitos e/ou alterarem o alimento de forma a tornar perceptível a deterioração [34, 36].

Santos et al. [37] produziram e analisaram farinha de banana verde armazenada por 90 dias e constataram que as contagens de coliformes totais, termotolerantes e bolores e leveduras, atenderam aos limites microbiológicos estabelecidos pela legislação brasileira, resultado este similar ao da presente pesquisa. Já Wanderley [9] em seu estudo realizou avaliação microbiológica da farinha de batata-doce cultivar Beauregard, durante 180 dias de armazenamento, e verificou ausência de Salmonella sp. nas amostras avaliadas, exceto na amostra acondicionada em embalagem de polietileno de alta densidade transparente, resultado este que difere do obtido no presente estudo. Além disso, Wanderley verificou em sua pesquisa que as amostras de farinha de batata doce obtiveram contagem de bolores e leveduras < 10 UFC/g em até 90 dias de armazenamento [9], resultado este que difere do obtido na avaliação microbiológica da farinha de vinagreira.

Os resultados da avaliação microbiológica da farinha de vinagreira armazenada por 90 dias a temperatura de 25 ºC demonstraram que as embalagens utilizadas para acondicionar o produto, não comprometeram a segurança e a qualidade microbiológica do produto durante o armazenamento.

Conclusão

Com base nas avaliações para a composição nutricional da farinha de vinagreira podemos afirmar que é uma ótima fonte de proteína, ferro e vitamina C, configurando assim, uma fonte alimentar alternativa para a inclusão de nutrientes na dieta.

A partir dos resultados obtidos para a avaliação da estabilidade da farinha de vinagreira, foi possível concluir que o parâmetro de atividade de água foi influenciado pelo tipo de embalagem utilizada no acondicionamento do produto durante o armazenamento. Já os parâmetros de pH e ATT sofreram influência do tipo de embalagem em T30 e T90, respectivamente. No entanto, o tipo de embalagem não influenciou de forma negativa a estabilidade da farinha.

Considerando os parâmetros analisados para EMB1 e EMB2, temos que os resultados obtidos atenderem as referências da literatura para o controle do desenvolvimento microbiano, destaque para atividade de água inferior a 0,60. No entanto, EMB2 obteve uma menor Aw durante o armazenamento, o que pode garantir uma melhor estabilidade para a farinha de vinagreira. As embalagens utilizadas no acondicionamento do produto não comprometeram a segurança e a qualidade microbiológica da farinha durante o armazenamento por 90 dias a temperatura de 25º C.

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Tabela 1 Composição nutricional da farinha de vinagreira (Hibiscus sabdariffa)

Parâmetros	Farinha de vinagreira
Valor energético	336,73 ± 0,10
Carboidratos (g/100 g)	60,50 ± 0,23
Proteínas (g/100 g)	17,72 ± 0,06
Lipídios (g/100 g)	2,65 ± 0,10
Cinzas (g/100 g)	7,67 ± 0,10
Sódio (mg/100 g)	238,30 ± 7,48
Ferro (mg/100 g)	143,13 ± 8,18
Vitamina C	77,99 ± 0,32

Todos os valores são representados como Média ± Desvio padrão n = 3.

Tabela 2 Caracterização da farinha de vinagreira acondicionada em garrafa PET (EMB1) e em saco laminado PET metalizado/PEBD sem vácuo (EMB2), durante o armazenamento por 90 dias a temperatura de 25ºC.

Tempo	Aw		pH		ATT (g.100 g^{-1})	
	EMB1	**EMB2**	**EMB1**	**EMB2**	**EMB1**	**EMB2**
T0	$0,52 \pm 0,00^{a}$	$0,35 \pm 0,02^{b}$	$2,61 \pm 0,01^{a}$	$2,56 \pm 0,05^{a}$	$8,76 \pm 0,31^{a}$	$9,18 \pm 0,25^{a}$
T30	$0,54 \pm 0,00^{c}$	$0,43 \pm 0,00^{d}$	$2,62 \pm 0,03^{b}$	$2,53 \pm 0,04^{c}$	$8,66 \pm 0,40^{b}$	$9,56 \pm 0,54^{b}$
T60	$0,53 \pm 0,00^{e}$	$0,46 \pm 0,01^{f}$	$2,66 \pm 0,07^{d}$	$2,69 \pm 0,04^{d}$	$8,13 \pm 0,04^{c}$	$9,11 \pm 0,60^{c}$
T90	$0,56 \pm 0,00^{g}$	$0,48 \pm 0,00^{h}$	$2,60 \pm 0,06^{e}$	$2,69 \pm 0,09^{e}$	$9,05 \pm 0,08^{e}$	$9,60 \pm 0,00^{d}$

T0: farinha de vinagreira no dia do envase. T30: farinha de vinagreira após 30 dias de envase. T60: farinha de vinagreira após 60 dias de envase. T90: farinha de vinagreira após 90 dias de envase.

Médias seguidas por letras minúsculas diferentes nas colunas diferem entre si pelo teste t de Student's ($p < 0,05$).

Tabela 3 Avaliação da segurança e qualidade microbiológicas da farinha de vinagreira acondicionada em garrafa PET (EMB1) e em saco laminado PET metalizado/PEBD sem vácuo (EMB2), durante o armazenamento por 90 dias a temperatura de 25 ºC

Tempo	Coliformes totais (NMP/g)		Coliformes fecais (NMP/g)		Salmonella/25 g		Bolores e leveduras (UFC/g)	
	EMB1	**EMB2**	**EMB1**	**EMB2**	**EMB1**	**EMB2**	**EMB1**	**EMB2**
T0	< 3	< 3	< 3	< 3	AUS	AUS	$7,4 \times 10^2$	$5,1 \times 10^3$
T30	< 3	< 3	< 3	< 3	AUS	AUS	< 10	< 10
T60	< 3	< 3	< 3	< 3	AUS	AUS	$1,2 \times 10^3$	< 10
T90	< 3	< 3	< 3	< 3	AUS	AUS	< 10	<10

EMB1-T0: farinha de vinagreira no dia do envase em garrafa PET. EMB1-T30: farinha de vinagreira após 30 dias de envase em garrafa PET. EMB1-T60: farinha de vinagreira após 60 dias de envase em garrafa PET. EMB1-T90: farinha de vinagreira após 90 dias de envase em garrafa PET. EMB2-T0: farinha de vinagreira no dia do envase em embalagem laminada PET metalizada/PEBD sem vácuo. EMB2-T30: farinha de vinagreira após 30 dias de envase em embalagem laminada PET metalizada/PEBD sem vácuo. EMB2-T60: farinha de vinagreira após 60 dias de envase em embalagem laminada PET metalizada/PEBD sem vácuo. EMB2-T90: farinha de vinagreira após 90 dias de envase em embalagem laminada PET metalizada/PEBD sem vácuo. AUS: Ausência.

Fig 1 Vinagreira (*Hibiscus sabdariffa*)

Fig 2 Farinha de vinagreira acondicionada em garrafa PET

Fig 3 Farinha de vinagreira acondicionada em saco laminado PET metalizado/PEBD sem vácuo

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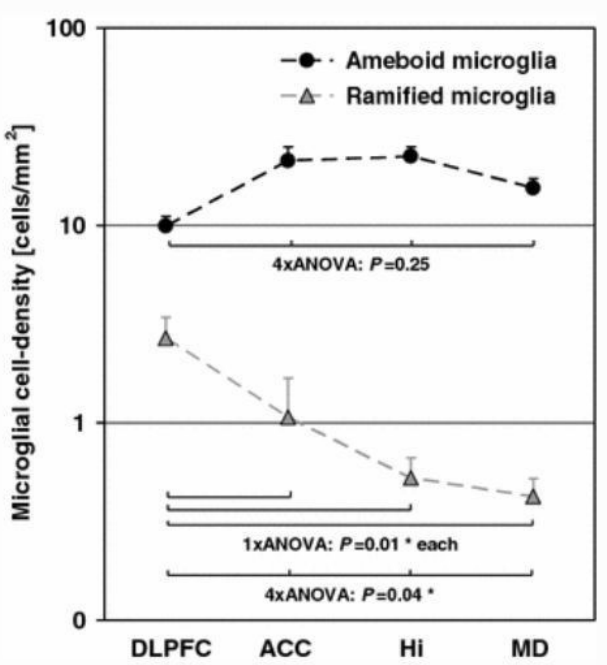

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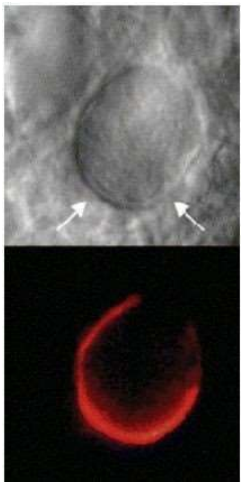

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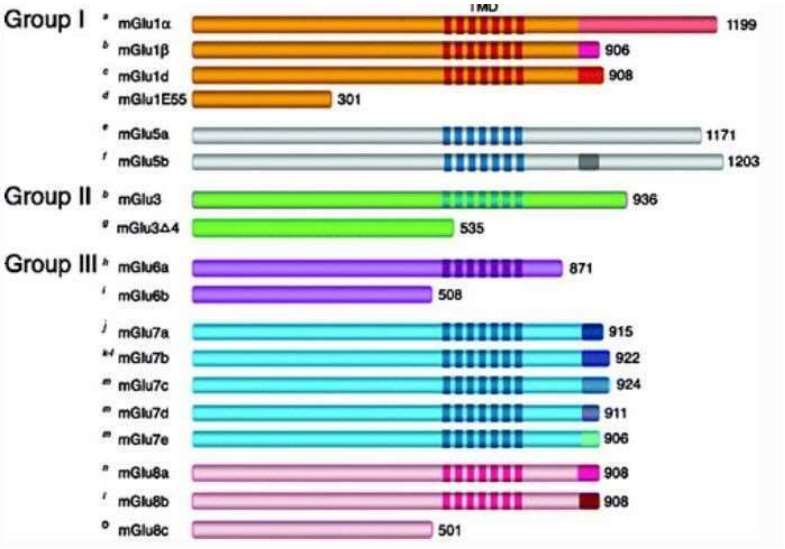
- 

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It is possible to collect multiple files in a .zip or .gz file.

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Informed consent was obtained from legal guardians.

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