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NATURAL COLOR FROM CAMU-CAMU (MYRCIARIA DUBIA) RESIDUE: EVALUATION OF STABILITY AND APPLICATION IN FOODS

CORANTE NATURAL DE RESÍDUO DE CAMU-CAMU (MYRCIARIA DUBIA): AVALIAÇÃO DA ESTABILIDADE E APLICAÇÃO EM ALIMENTOS

COLORANTE NATURAL A PARTIR DE RESIDUOS DE CAMU-CAMU (MYRCIARIA DUBIA): EVALUACIÓN DE LA ESTABILIDAD Y APLICACIÓN EN ALIMENTOS

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ABSTRACT

Color is a key attribute in food acceptance, directly influencing consumers' perception of quality. In this context, natural colors have attracted interest as an alternative to synthetic colors due to their safety and clean-label appeal. This study evaluated the potential of camu-camu bran (Myrciaria dubia) as a food colorant. The fruits were processed, pressed to obtain solid residue, and subjected to forced convection drying. The resulting bran was characterized for color stability, considering samples exposed and not exposed to light, and subsequently applied to yogurt, with colorimetric analyses performed over 32 days of storage. The results demonstrated that exposure to light did not significantly alter the colorant's stability. In the yogurt, an initial reduction in the parameters of luminosity (L*) and yellow intensity (b*) was observed, followed by stabilization over time, confirming the viability of using the bran as a natural colorant. It is concluded that camu-camu has potential for application in dairy foods, and additional studies with microencapsulation techniques are recommended to optimize the stability of the pigments and expand their industrial application.

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Keywords: Camu-Camu. Natural Color. Yogurt. Stability.

RESUMO

A cor é um atributo essencial na aceitação dos alimentos, influenciando diretamente a percepção de qualidade pelo consumidor. Nesse contexto, os corantes naturais têm despertado interesse como alternativa aos sintéticos, devido à segurança e ao apelo clean label. O presente estudo avaliou o potencial do farelo de camu-camu (Myrciaria dubia) como corante alimentício. Os frutos foram processados, prensados para obtenção do resíduo sólido e submetidos à secagem por convecção forçada. O farelo obtido foi caracterizado quanto à estabilidade de cor, considerando amostras expostas e não expostas à luz, e posteriormente aplicado em iogurte, com análises colorimétricas realizadas durante 32 dias de armazenamento. Os resultados demonstraram que a exposição à luz não promoveu alterações significativas na estabilidade do corante. No iogurte, verificou-se redução inicial nos parâmetros de luminosidade (L*) e intensidade de amarelo (b*), seguida de estabilização ao longo do tempo, confirmando a viabilidade do uso do farelo como corante natural. Conclui-se que o camu-camu apresenta potencial de aplicação em alimentos lácteos, sendo recomendados estudos adicionais com técnicas de microencapsulação para otimizar a estabilidade dos pigmentos e ampliar sua aplicação industrial.

Palavras-chave: Camu-Camu. Corante Natural. Iogurte. Estabilidade.

RESUMEN

El color es un atributo clave en la aceptación de los alimentos, influyendo directamente en la percepción de calidad de los consumidores. En este contexto, los colorantes naturales han atraído interés como una alternativa a los colorantes sintéticos debido a su seguridad y atractivo de etiqueta limpia. Este estudio evaluó el potencial del salvado de camu-camu (Myrciaria dubia) como colorante alimentario. Las frutas fueron procesadas, prensadas para obtener un residuo sólido y sometidas a secado por convección forzada. El salvado resultante se caracterizó por estabilidad de color, considerando muestras expuestas y no expuestas a la luz, y posteriormente se aplicó al yogur, con análisis colorimétricos realizados durante 32 días de almacenamiento. Los resultados demostraron que la exposición a la luz no alteró significativamente la estabilidad del colorante. En el yogur, se observó una reducción inicial en los parámetros de luminosidad (L*) e intensidad de amarillo (b*), seguida de una estabilización en el tiempo, confirmando la viabilidad de usar el salvado como colorante natural. Se concluye que el camu-camu tiene potencial de aplicación en alimentos lácteos y se recomiendan estudios adicionales con técnicas de microencapsulación para optimizar la estabilidad de los pigmentos y ampliar su aplicación industrial.

Palabras clave: Camu-Camu. Colorante Natural. Yogur. Estabilidad.

1 INTRODUCTION

Color is an essential attribute in food products, as it directly influences the consumer's perception and purchase intention. In this context, dyes are widely used by the industry to intensify or correct the natural color of foods, contributing to the enhancement of their sensory characteristics (Soutelino et al., 2024; Tereucan et al., 2021). In addition to the visual aspect, color plays a fundamental role in the acceptance of food, as it is often associated with its quality, freshness, and expected flavor, even influencing the consumer's sensory memory (Spence, 2018).

The dyes used in food can be of natural origin, being extracted from animal, mineral or vegetable sources, or they can be synthetic, obtained through chemical processes. The latter are widely used by the industry due to their greater color stability, low cost, and ability to generate more intense shades. However, some synthetic dyes pose potential risks to human health, especially when consumed in excess by children, and may be associated with adverse effects such as asthma attacks, changes in the immune system, and sleep disorders (Tereucan et al., 2021; Pereira et al., 2024; Palianskikh et al., 2022). In addition to the health risks, there is a growing rejection by consumers of artificial additives, driving the *clean label movement* and the search for ingredients of natural and sustainable origin

In this scenario, natural alternatives have been gaining prominence, especially pigments such as anthocyanins, betalains, carotenoids, and chlorophylls, which in addition to giving color to foods, can exert beneficial biological functions related to antioxidant activity and reducing the risk of chronic diseases (Rodriguez-Amaya, 2019). This dual functionality expands the possibilities of application of natural dyes, making them attractive not only from a technological point of view, but also from a nutritional and marketing point of view.

In this scenario, the camu-camu (*Myrciaria dubia*), a reddish Amazonian fruit, has attracted attention for its high levels of vitamin C, phenolic and bioactive compounds with antioxidant and antimicrobial properties. In addition to being considered a functional food, this fruit and its by-products have been explored as natural food colorants, which expands its potential for application in the industry (Rodrigues et al., 2020; Santos et al., 2022; García-Chacón et al., 2024). The use of residues of this fruit for the production of dyes also contributes to the valorization of the production chain and to the reduction of environmental impacts related to the disposal of by-products.

Thus, this study aimed to obtain and characterize a dye from camu-camu residue, as well as to evaluate its stability and the kinetics of color degradation in yogurt as a potential substitute for synthetic dyes.

2 MATERIALS AND METHODS

2.1 PLANT MATERIAL AND REACTANTS

The fruits of camu-camu (Myrciaria dubia) were obtained from the company Camu-camu Fruits of the Amazon (Vitória do Xingu, Brazil) and kept under freezing during transport and until the analysis was carried out. For processing, the fruits were selected according to the stage of maturation, and those that were still green or excessively ripe (softened) were discarded. Then, the fruits were washed, sanitized and crushed in an industrial grinder (Model JI Colombo, 700 W) for 2 minutes at 10 ± 1 °C. Subsequently, the mass was pressed to separate the solid and liquid fraction, in order to simulate the industrial waste. The solid material obtained was immediately packed in polyethylene packaging and stored at –18 °C in the absence of light.

2.2 DRYING EXPERIMENT

After preliminary tests, the plant material was thawed and evenly distributed on parchment paper arranged in stainless steel trays. Drying was conducted by forced convection of hot air, at a constant speed of 1 m/s, using a benchtop dryer (Solab, model SL-102). The drying process took place at 80 °C for 23 hours. Afterwards, the dry residue was macerated to obtain the bran.

2.3 STABILITY AND COLOR ANALYSIS

The camu-camu meal was divided into two samples that were stored in Petri dishes: one of them exposed to lighting from fluorescent lamps and the other protected with aluminum foil, in order to avoid contact with light. The stability assessment was carried out on days 1, 10, 20 and 30. Color analyses were conducted in a Minolta® CR400 portable colorimeter, equipped with an integration sphere and a 3° viewing angle (d/3 illumination, D65 illuminant). The colorimetric system adopted was the CIELab, considering the parameters of luminosity (L*), red intensity (a*) and yellow intensity (b*).*

2.4 APPLICATION OF THE COLORING IN YOGURT

To prepare the yogurts, UHT whole milk (Parmalat®, 85%) was used, heated to approximately 45 °C. Then, sugar (10% w/v) was added and 0.04% commercial yeast (Christian Hansen®) was inoculated, containing the cultures of *Lactobacillus acidophilus*, *Bifidobacterium animalis* subsp. *lactis* and *Streptococcus thermophilus*. Fermentation was conducted in BOD for about 4.5 hours, until the milk reached pH 4.6. After this period, the dough was cooled to approximately 4 °C and subjected to breaking, with the subsequent

addition of 5% camu-camu meal. The yogurt obtained was stored at 4 °C for 32 days, and its color stability was evaluated (according to the methodology described above) on days 1, 4, 8, 15, 22 and 32.

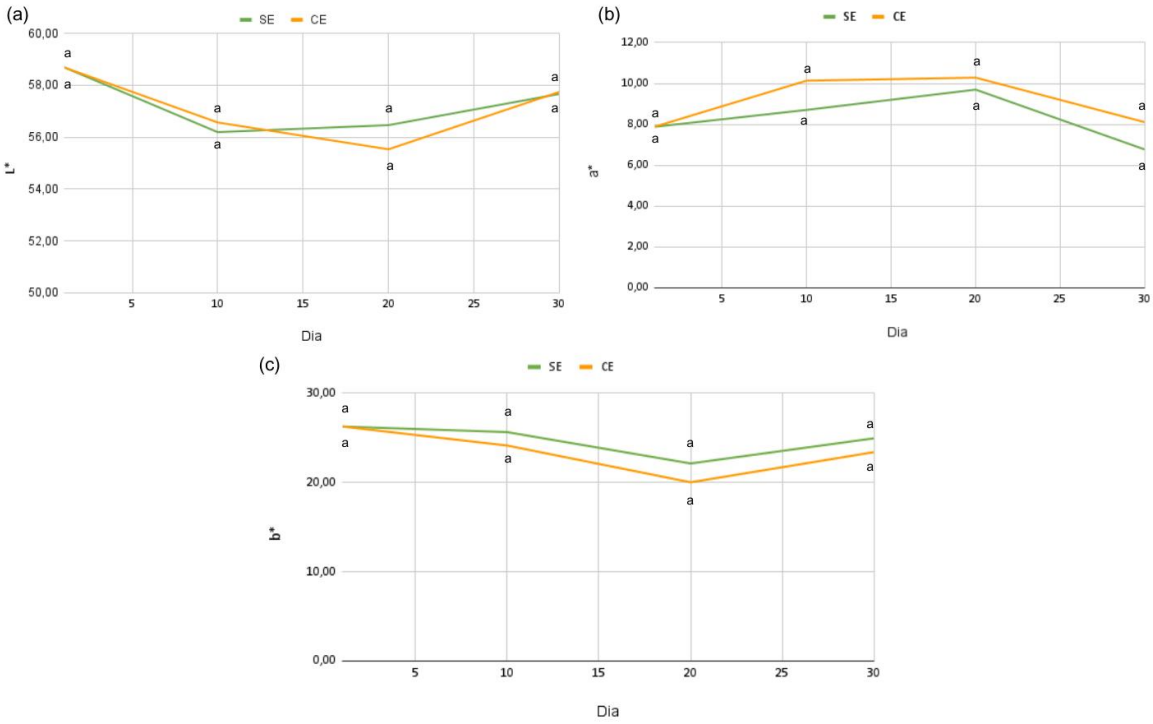
3 RESULTS AND DISCUSSIONS

3.1 COLOR STABILITY OF CAMU-CAMU DYE

Figure 1 presents the results of the evaluation of the dye stability with treatments of the sample exposed to fluorescent light and the sample stored in the dark, over a period of 30 days.

Figure 1

Colorimetry of samples with and without exposure to light for 30 days



SE: treatment without light exposure; CE: treatment with light exposure. (a): Luminosity; (b): Chroma a* (green-red); (c): Chroma b* (blue-yellow).
*Values with equal letters indicate that there is no significant difference between the samples, with a significance level of 95% ($p < 0.05$).

The samples showed a predominance of red (a+) and yellow (b+) pigments. The staining of the EC samples did not present statistical differences from the SE sample, which indicates that the incidence of light was not able to significantly alter the staining in the dyes. Similarly, Modesto Júnior et al. (2022), in fruit extracts (grumixama), anthocyanins were relatively stable against incandescent/fluorescent light, but UV light quickly degraded the pigments, so controlled visible light causes less damage than intense UV radiation

Similar results were also described by Antigo et al. (2020) when evaluating the stability of dye obtained from beet under light incidence for 40 days, reinforcing that certain pigments have relative resistance to induced light degradation.

This stability may be associated with the high levels of ascorbic acid from the fruit, since vitamin C acts as an electron donor and can regenerate other antioxidants, influencing the stability of oxidizable compounds in the matrix (Agwu, Ezihe & Kaigama, 2022; Yin et al., 2022; Santos et al., 2022).

On the other hand, Bianchini et al. (2025), when evaluating the stability of the coloration of dye extracted from freshwater microalgae for 90 days, observed a significant reduction in parameters a* and b* from the 45th day onwards, attributed to the oxidation and degradation reactions of carotenoids, resulting in the progressive loss of color intensity.

3.2 YOGURT COLOR STABILITY WITH CAMU-CAMU DYE

Table 1 presents the results obtained from the stability of the stain during the 32 days.

Table 1

Variation in the color of yogurt with camu-camu over 32 days

	Yogurt with camu-camu		
Day	**L***	**the***	**b***
1	98.45a ± 2.50	-71.61b ± 1.60	39.91a ± 1.76
4	86.28b ± 1.34	-0.13a ± 0.26	11.18b ± 0.96
8	74.24c ± 1.70	0.69a ± 0.24	9.93b ± 0.71
15	86.54b ± 2.74	-0.13a ± 0.21	11.03b ± 0.57
22	80.89b ± 0.66	-0.55a ± 0.44	11.29b ± 2.72
32	84.74b ± 3.92	0.07a ± 0.06	11.36b ± 0.58

*Values with equal letters in the same column indicate that there is no significant difference between the samples with a significance level of 95% ($p < 0.05$).

In the first days of storage, a significant reduction in luminosity (L*) was observed, which went from 98.45 on day 1 to 74.24 on the eighth day, indicating darkening of the product. This behavior may be associated with the initial instability of camu-camu pigments in the dairy matrix, possibly due to the low solubilization of the colorant granules and the interaction with yogurt proteins. From the eighth day on, there was an increase and subsequent stabilization of luminosity, a behavior also reported by Barreto et al. (2019) in yogurt added with anthocyanins from eggplant peel, suggesting that after the initial degradation, there is greater homogeneity and color stability in the product.

For parameter a*, there was a significant variation between the first and fourth days, followed by stabilization in the subsequent values. However, results close to zero indicate the absence of a predominance of the red hue, suggesting degradation of anthocyanins or low color expression in this matrix, a common phenomenon in dairy systems, as discussed by Calderón-Oliver & Ponce-Alquicira (2022).

Regarding b*, a marked reduction was observed in the first four days (39.91 to 11.18), an effect also reported by Haas et al. (2019). The loss of yellow hue can be attributed to the degradation of pigments such as carotenoids and flavonoids (Bianchinni et al., 2025). After the eighth day, the values remained stable, indicating greater resistance of the residual compounds during storage.

In general, the results show that the application of camu-camu colorant in yogurt has limitations regarding color stability, especially in the initial storage period. However, after stabilization of the parameters L*, a* and b*, there was relative maintenance of the color until the 32nd day, suggesting the feasibility of using the dye in dairy products. Strategies such as microencapsulation or association with stabilizers can be promising alternatives to increase color stability throughout the product's shelf life, as well as its application for processed and clean label foods (Lima et al., 2019; Calderón-Oliver & Ponce-Alquicira, 2022).

4 CONCLUSION

Camu-camu meal showed color stability during storage, even under exposure to light, and when applied to yogurt it promoted initial changes in the L* and b* parameters, followed by stabilization. These results demonstrate the potential of bran as a natural dye and clean label ingredient for the food industry. However, considering the sensitivity of pigments to processing and storage conditions, future studies involving microencapsulation techniques are recommended, aiming to increase stability and expand the possibilities of technological application.

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