TREVEALING INFLUENCES ON FOOD SELECTIONS AND INVESTIGATING SENSORY RESPONSES TO NATURALLY COLORED ICE CREAM

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ABSTRACT

To develop tasty and colorful products based on Spirulina and its ingredients, it is indispensable to investigate their sensory characteristics panoramic, considering beyond the direct aspects of acceptability. Among the components of Spirulina, C-phycocyanin (C-PC) is the most popular. This phycobiliprotein is widely used in food products as a natural blue dye and exhibits antioxidant and several other biological effects. Since color plays a vital role as a sensory attribute that influences consumer expectations and perceptions, this work's main aim was to unveil the drivers behind food choices and explore the sensory perception of naturally colored ice cream. To achieve the objective, four variations of ice cream were prepared: a control sample without added pigments, one with Spirulina, another with C-PC, and finally, one with residual biomass obtained from the blue pigment extraction process. A panel of untrained judges then evaluated these ice creams. The results indicated that the ice cream naturally colored with C-PC outperformed all other formulations regarding preference and overall acceptance, confirming the potential of C-PC to substitute artificial colorants.

Keywords: Spirulina. C-phycocyanin. Desserts. Sensorial preference. Food innovation.

1 INTRODUCTION

Consumer demand for natural foods rich in nutrition, bioactive compounds that combat free radicals, and other health benefits has been steadily increasing.[1] Microalgae, notably Spirulina, and their constituents offer promising prospects as sustainable and nutritious food ingredients, particularly due to the emphasis consumers place on health, flavor, and natural origins. To create appetizing and visually appealing products using Spirulina and its derivatives, a comprehensive examination of their sensory profiles is essential, extending beyond mere acceptability to encompass a panoramic view of their sensory characteristics.

In today's food industry, the most commonly used blue colorant is a synthetic organic molecule known as brilliant blue FCF (Blue 1).[2] This colorant exhibits a peak absorption around 628 nm and is not only prevalent in food products but also finds application in pharmaceuticals, cosmetics, and dietary supplements.[3] Approved by the FDA as one of the initial color additives, brilliant blue FCF is classified as a triarylmethane dye.[4] It is prominently found in a wide array of consumer goods ranging from cotton candy, ice cream, canned and processed peas, soups, bottled food coloring, icings, and ice pops to items flavored with blueberries, dairy products, soft drinks, and cocktails such as Blue Curaçao.

Despite the approval for the use of artificial blue colorants like Blue 1 and Blue V (E 131) in food by the Food and Drug Administration,[4] there is a growing necessity to improve the risk evaluation concerning their consumption and potential impacts on human health. This evaluation should take into account various factors such as regional food variations and specific cultural considerations. In response to these concerns, food producers are urged to seek alternatives and voluntarily remove artificial blue dyes from their products, particularly as consumer interest in clean-label foods continues to rise.[5] Therefore, the present work aims to investigate consumer preferences by exploring the sensory perception of naturally colored ice cream.

2 MATERIAL & METHODS

Spirulina biomass (gently donated from Fazenda Tamanduá®) was utilized not only as an ingredient but also as a source of C-PC, which was extracted and purified following the method described by Fratelli et al.[6] The formulations were adapted according to previous studies.[7]

A sensory evaluation was conducted, wherein 74 consumers participated by answering a comprehensive questionnaire and providing their ratings of overall preferences using a 9-point hedonic scale. The scale ranged from "dislike extremely" to "like extremely," with a neutral option "I don't like or dislike" at the center. In addition to the ratings, participants also responded to general inquiries regarding age, consumption habits, frequency of consumption, and the key factors influencing their purchase decisions regarding ice cream products.[7]

The study involved analyzing data from four ice cream formulations using descriptive and quantitative methods. A mixed model approach was used to compare the impact of these formulations on Global evaluation, Appearance, Aroma, Flavor scores, and Purchase Intention. The analysis indicated that individuals had a significant impact, with the Intraclass Correlation Coefficient

ranging from 29% to 53%. Although outliers were detected in the Aroma variable, their exclusion did not substantially alter results. Bonferroni correction was applied for pairwise comparisons, and Correspondence analysis evaluated the connection between ice cream formulations and emotional descriptors. The study maintained a 95% confidence level for statistical significance and utilized JAMOVI (2.3.26) for data analysis.

3 RESULTS & DISCUSSION

While many studies assessing food product acceptance through sensory analysis typically focus on individual attributes, this study introduces a novel approach aiming to evaluate sensory characteristics in a more holistic and integrated manner. The sensory analysis conducted evaluated group comparisons across Global, Appearance, Aroma, and Flavor domains. The mixed model analysis indicated a significant impact of ice cream formulations on global evaluation (Figure 1). Ice cream with Spirulina biomass (SB) had the lowest mean scores for Global evaluation, followed by Spirulina Residual biomass (RB). No significant differences were found between the C-PC and Control formulations in terms of Global evaluation scores.

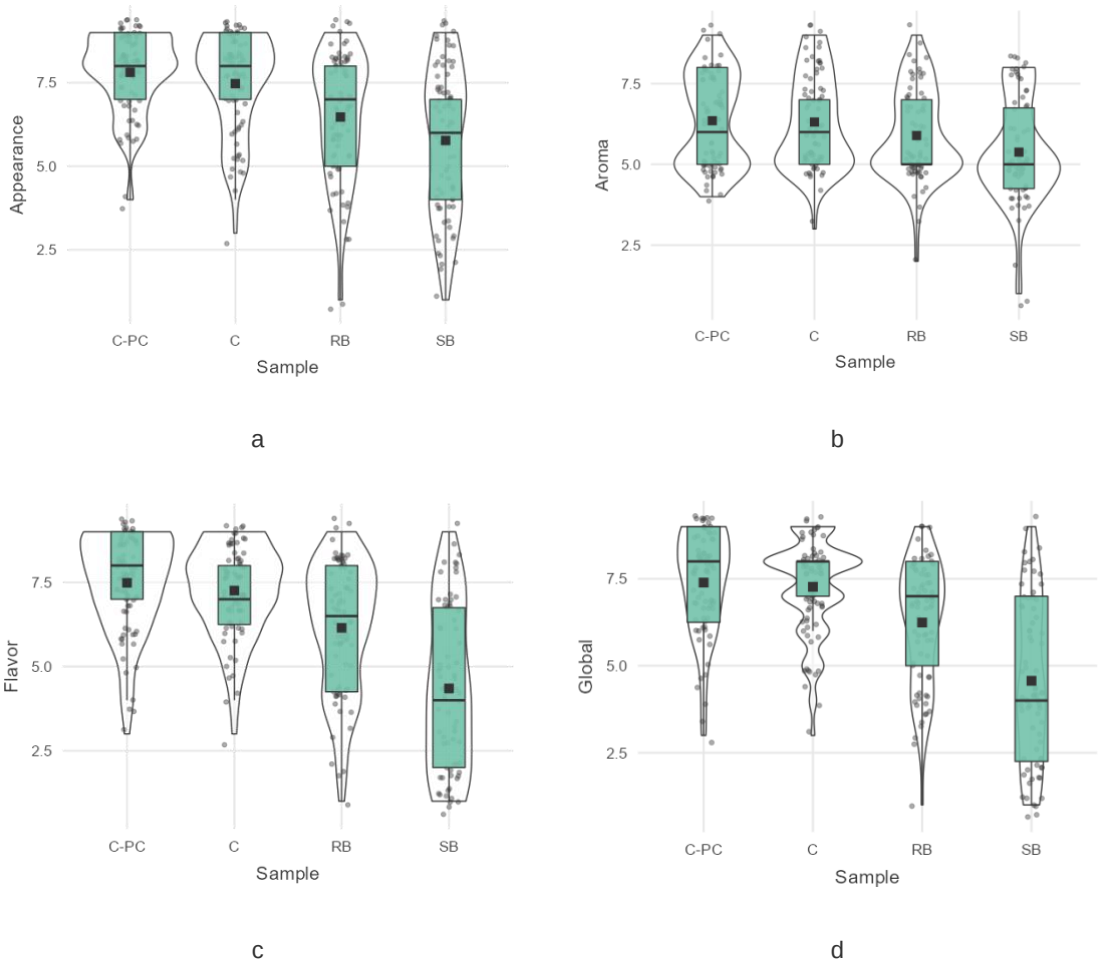

Figure 1 Comparison of Groups for Global (a), Appearance (b), Aroma (c), and Flavour (d): Boxplots, Violin Plots, and Density Plots. Note: "▪" indicates the mean.

The ice cream formulations significantly influenced the evaluations of Appearance, Aroma, Flavor, and Purchase Intention (PI). For Appearance, SB had lower scores compared to RB and the other two formulations (C-PC and Control). In terms of Aroma, SB received lower ratings compared to Control and C-PC, while RB was lower than C-PC. SB also had the lowest Flavor scores, significantly lower than the other formulations, and RB had lower scores than Control and C-PC. When it comes to Purchase Intention, SB had the lowest mean score, followed by RB, with significantly lower than the other formulations. No significant difference in PI was observed between C-PC and Control formulations.

Considering the literature, visual perception, including appearance and color plays a significant role in how food and its taste are perceived by consumers.[7] This affirmation can be reinforced by the present work since the highest rating was given to the appearance of C-PC ice cream with 70.26% of volunteers expressing "like much" and "like extremely," highlighting the blue ice cream's attractiveness, but these results did not impact the global parameter since no significant differences were detected

comparing to SC ice creams. One study by Lucas & Brunner[8] focused on consumer behavior regarding microalgae uptake, categorizing participants into segments to gauge their willingness to buy algae-based products based on previous knowledge. The findings revealed that the segment categorized as 'microalgae supporters and health eaters' exhibited the highest ratings across various microalgae-based scales, indicating a less neophobic profile with most females and non-omnivores. This group displayed a keen interest in environmental sustainability, quality food products, alternative protein sources, and prioritized food healthiness, illustrating a potential market segment for algae-based products like the ice creams in the study. On the other hand, consumers less familiar with microalgae-based foods often perceive fishy, earthy, or muddy odors and flavors as unpleasant, resulting in limited acceptance of such products.

4 CONCLUSION

These findings serve as essential foundations for the creation of innovative products integrating natural pigments known for their antioxidant qualities, with particular emphasis on sensory attributes. It is noteworthy that the visual appeal of C-PC ice creams even surpassed that of the control ice cream; however, despite this, no significant differences were observed in overall acceptance. This suggests the potential of these products to elevate consumer enjoyment and attractiveness while consuming fermented ice creams enriched with enhanced biological properties, natural coloring, and microalgae ingredients.

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ACKNOWLEDGEMENTS

The authors thank Fazenda Tamanduá for donating the organic Spirulina used in the present work. This work was supported by "Fundação de Amparo à Pesquisa do Estado de São Paulo - FAPESP" through the grants process n° 2020/06732-7, 2022/06293-9 and 2023/00857-0. The authors also acknowledge CAPES for financial support.