Lip balm made from butter extracted from bacuri (*Platonia insignis* Mart.) Amazonian fruit seeds: Development and characterization

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ABSTRACT

With the growing demand in the cosmetic industry for plant-based ingredients, this article presents a novel approach to developing a lip balm from butter extracted from *bacuri* seeds (*Platonia insignis* Mart.). The physical-chemical characterization of the *bacuri* seed butter was conducted, including determining the melting point and fatty acid (AG) content by gas chromatography coupled with mass spectrometry (GC-MS). The lip balm formulation, obtained using the phase inversion method, was evaluated for its applicability through a rheological study. The melting point values found were 35 and 79 ºC for the formulation, aligning with values described in the literature. The AG composition of the butter sample revealed significant levels of palmitic acid (42,2%), oleic (28,8%), and palmitoleic (10,8%). In the rheological study, the lip balm exhibited the physical characteristics of a non-Newtonian fluid of the pseudoplastic thixotropic type, an ideal behavior for topical formulations. These results underscore the potential of the butter extracted from *bacuri* seeds as a promising alternative input for a unique and innovative lip balm product, instilling a sense of optimism in the reader.

Keywords:Oil seed Amazonian, Lip balm, *Bacuri*, Organic cosmetics, Raw material.

INTRODUCTION

The world's most remarkable plant genetic diversity is sheltered in the Amazon, one of the most important known biomes, which occupies more than 49% of the Brazilian territory, safeguarding about 1.5 million plant species (Dias et al. 2023). Currently, these species guide the research and development sector of the cosmetic industry in the innovative field of raw materials, becoming the alternative to synthetic ingredients that are often harmful to human health. For example, heavy metals such as cadmium, iron, and lead can be found in inorganic pigments, which cause serious, severe adverse reactions (Łodyga-Chruścińska et al. 2018; Mawazi et al. 2022).

Allied to the research of new inputs of natural origin, there is a change in the profile of cosmetics consumers. The search for products that contain more natural ingredients, provide nutrients, and contribute to the consumer's health has become a trend. In addition, products that have organic or natural matter certification seals, cruelty-free, and packaging that respects the recycling cycle are gaining more and more space in the market (Nakagami and Pinto 2020; Mawazi et al. 2022; Martins and Marto 2023).

In this scenario, oilseed plants gain prominence for their richness and versatility of application in the industry. They also offer the possibility of maintaining sustainability for communities through family farming, such as those in the Amazon that effectively participate in production. Fixed oils can be obtained from fruits or seeds and are rich in fatty acids that provide emollient properties

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and bioactive components such as carotenoids, sterols, and vitamin E (Serra et al. 2019; Assis et al. 2020).

We appropriate commodities, transform them into products for consumption, and discard them when they are no longer helpful. However, it's not too late to change. For many years, we have thought of our planet's resources as unlimited, living too much in the present without thinking about the well-being of future generations that will follow us. Waste is the final phase of a process known as the "linear economy." However, we can shift to a more sustainable model that considers the future as much as the present (Daly and Farley 2004; Mckinsey & Company 2016; FCC-Group 2020).

Therefore, there is an urgent need to transition from the linear take-make-use-dispose economy to a better organization and use of resources through the circular economy, a plausible solution to global sustainability challenges. However, the shift to a circular economy is a complex process. It requires substantial changes in the value chain, such as adapted design, better waste and water management, and increased product recycling and reuse (Velenturf et al. 2019).

Bacuri butter (*Platonia insignis* Mart.) is a vegetable residue obtained from pressing seeds discarded by the food industry. In traditional medicine, this residue is called "*bacuri lard*" and is popularly used to treat dermatological diseases. Thus, it presents itself as a natural, unrefined, biocompatible, and biodegradable lipid with potential application in the cosmetic and pharmaceutical industry (Serra et al. 2019; Lima et al. 2021; Yamaguchi et al. 2021).

Lip balms, the unsung heroes of lip health, are cosmetic formulations composed of butter, waxes, and oils. They play a vital role in maintaining the health of your lips, providing hydration and moisturizing, which are essential to combat external factors such as climate change (Tamura et al. 2016; Mawazi et al. 2022; Dahmer et al. 2023). Furthermore, the industry has harnessed the power of lip balm bases to incorporate antioxidant active ingredients and sun protection factor (SPF), further boosting your lip health by preventing aging and sun damage (Fonseca et al. 2020; Hendrawati et al. 2022; Portilho et al. 2022).

This work aimed to develop and characterize a lip balm based on butter extracted from bacuri seeds, a project that stands at the forefront of innovation. The goal is to reuse the residue of this fruit and generate a new value chain based on Amazonian sociobiodiversity. This initiative not only favors the generation of value chains and the creation of environments favorable to technological innovation and sustainability but also represents a promising opportunity for the growth and socio-economic development of traditional communities in the Amazon from the perspective of the standing forest.

MATERIAL AND METHODS

Material

Carnauba wax (*Copernicia prunifera* (Mill.) H.E. Moore), Castor oil (*Ricinus communis* L.), Isopropyl myristate, and Ethylenediamine tetra acetic acid (EDTA) were supplied by All Chemistry do Brasil Ltda (São Bernardo do Campo, Brazil). *Bacuri* seed butter (*Platonia insignis* Mart.) was provided by Amazon Oil Indústria e Comércio Ltda (Ananindeua, Brazil). This butter is cold extracted from wild species that grow naturally in the Amazon rainforest, sustainably extracted without pesticides and fertilizers. No preservatives, additives, or any other chemical substances are added.

Lipid profile of *bacuri* butter

The identification of fatty acids was performed by the method of Bannon et al. (1987) with modifications through an esterification process followed by the identification of chemical constituents by gas chromatography coupled to mass spectrometry (GC-MS) in the QP2010-Plus equipment (Shimadzu Corporation, Tokyo, Japan), with the aid of the MS Solution software and standard libraries. A silica capillary column (Rtx-5ms, 30 mx0.25 mmx0.25 µm) was used. The analysis conditions were injector temperature 250 ºC; furnace temperature programming 100 ºC (5 min), gradient from 4 ºC/min to 260 ºC (45 min); helium carrier gas (1.2 ml/min); 1.0 µl split injection of the sample; electronic impact ionization 70 eV; ion source temperature and transfer line of 200 ºC and 250 ºC, respectively. The compounds were identified by the retention time of the standards and by comparison of their respective mass spectra with those of the libraries mentioned above.

Melting point determination

To determine the melting point, the method described by the Adolf Lutz Institute (2008) was used by exposing the matter to heat, inserted in a capillary, under a gradual increase in temperature (Zenebon et al. 2008). The Analogue Melting Point Apparatus, model NFU 420, from Philip Harris, was used for this. The butter, *bacuri* seeds, and lip balm formulation samples were analyzed in triplicate. Warming occurred at 1 ºC/min until they became utterly liquid (Nunes et al. 2016).

Preparation of lip balm formulations

The lip balm formulation was obtained by the phase inversion method, employing a mixture of butter and oils of vegetable origin in appropriate

Table 1. Composition of lip balm based on butter from *bacuri* seeds (*Platonia insignis*).

COMPONENT	CONCENTRATION (%)	FUNCTION IN FORMULATION
Bacuri butter (*P. insignis*)	15-20	Emollient
Carnauba wax (*C. prunifera*)	20-30	Increased melting point and viscosity
Castor Oil (*R. communis*)	15-20	Surfactant, preserving agent
Isopropyl myristate	20-30	Emollient
EDTA	1-1,5	Preserving agent

proportions (Table 1). All excipients were previously weighed and divided into hot (phase A) and cold (phase B). Phase A was heated in a thermostatic bath at 40 – 45 ºC, and then phase B was poured over phase A. The mixture was manually homogenized with the aid of a glass stick and then spread over the stick molds for solidification at room temperature (25 ± 1 ºC).

Rheological measurements

Steady shear rate and dynamic frequency sweep tests were performed using stress controlled in an HR-1 Rheometer (Discovery Series Hybrid Rheometer - DHR) in the flow mode and equipped with the geometry of parallel steel plates (20 mm, separated by a fixed distance of 1.0 mm). The lip balm sample was carefully applied to the lower plate of the rheometer and analyzed at 32 ºC. Steady shear rate sweep tests (upward and downward) were carried out over a range of 0 to 100/s of shear rates (Nunes et al. 2016). The flow properties were determined at least in triplicate for each measurement, and the variation coefficient was calculated.

RESULTS AND DISCUSSION

Fatty acid profile of *bacuri* butter

The fatty acid composition of *bacuri* butter accounted for 96.1% of its mass. The major fatty acids identified were palmitic acid (42.2%), followed by oleic acid (28.8%) and palmitoleic acid (10.7%) (Table 2).

Rocha et al. (2024) report that the *bacuri* seed corresponds to the fattest portion of the fruit. The predominance of palmitoleic acid makes *bacuri* butter a versatile ingredient for detergents, soaps, and cleaning products. In the cosmetic industry, applications such as surfactants, fragrance ingredients, opacifying agents, cleaning agents, emulsifying agents, and emollients are also known.

Saturated fatty acids in butter give greater consistency and hardness to lip formulations, contributing to their structuring. Among the saturated fatty acids in bacuri seed butter, palmitic acid stands out for its high concentration and ability to resist rancidification (Kelm and Wickett 2017; Aragão and Maximo 2024).

Table 2. Fatty acid composition of butter from *bacuri* seeds (*Platonia insignis*).

FATTY ACID	CONCENTRATION (%)
Palmitic acid (C16:0)	42.2
Oleic acid (C18:1)	28.8
Palmitoleic acid (C16:1)	10.8
Linoneic acid (C18:2)	3.9
Stearic acid (C18:0)	2.5
Lauric acid (C12:0)	1.5
Eicosanoic acid (C20:0)	1.3
Myristic acid (C14:0)	1.2
Montanic acid (C28:0)	0.1
Derived palmitic acid (C36:0)	3.81

Long-chain saturated fatty acids, such as eicosanoic (C20:0) and montane (C28:0), also stand out for their protective effect despite the low indices. When applied to the skin and mucous membranes, they act beneficially by reinforcing the structure of the cell membrane and protecting it from water loss, aiding in the hydration process (Goik et al. 2015).

Unsaturated fatty acids, in turn, have a high nutritional value and contribute to the skin healing process (Goik et al. 2019). The presence of double and triple bonds promotes greater flexibility and less interaction between its molecules, conferring a lower melting point value. The presence of polyunsaturated fatty acids, such as oleic acid (C18:1), contributes to greater spreadability of the formulation; in addition to the various benefits offered to human health since they are precursors of eicosanoids that regulate intracellular signaling, they have anti-inflammatory and antioxidant action (Serra et al. 2019).

Júnior et al. (2010) presented studies proving that the oleic, linoleic, and palmitoleic acids present in bacuri seed oil favor the healing process. In this way, the fatty acid profile present in the butter of *bacuri* seeds gives this raw material functionalities of paramount importance in the development of lip cosmetics, such as wetting, protection, and consistency.

Melting point determination

The hardness and structuring of lip cosmetics depend on the melting temperature of the waxes and kinds of butter and the proportion of each item used in their formulation. These items directly influence the product's final characteristics, such as texture and spreadability (Kelm and Wickett 2017; Frigerio et al. 2024).

According to a report by the Amazon Oil supplier, the butter's melting point in the *bacuri* seeds is around 35 ºC. The data was confirmed after a triplicate determination of the melting point, obtaining an average of 35 ºC ± 0,1 for the melting point of pure butter. The temperature at which butter melts is related to the proportions of saturated (75%) and unsaturated (25%) fatty acids found in its fatty acid profile since the arrangement of the fatty acid molecules defines the physical form of the material (Aragão and Maximo 2024).

The melting point of the lip balm, a crucial factor in its formulation, was 79 °C ± 0,3, close to the recommended value (65-75 °C) for wax- and oil-based lip balm formulations. This required property is partly due to carnauba wax, a raw material commonly used in semi-solid formulations that require a higher hardness factor for adequate resistance to application and storage, such as lipsticks and lip balms (Tinto et al. 2017). The high melting point of the lip balm contributes to the fact that the product shows enough hardness to avoid destructuring during application and storage (Frigerio et al., 2024).

Abidh et al. (2019) demonstrate that the melting point of the ingredients used to produce lipsticks influences the product's viscosity. The ratio of kinds of butter, waxes, and oils set at the design time should predict the lip balm's texture as the ingredients interact.

Rheological measurements

Lip cosmetic formulations must have specific physical characteristics that allow good spreadability and easy application, such as pseudoplastic-like flow properties with adequate viscosity (Kelm and Wickett 2017). Lipids are protagonists in the sensory modifications of lip products, a required characteristic for consumers directly influenced by the sensation when applying lipstick (Abidh et al. 2019). Therefore, knowledge about rheological flow parameters is indispensable for developing lipsticks, balms, and other formulations for topical application.

Figure 1 shows the rheological behavior of lip balm. The experiment was performed at 32 ºC, simulating the skin temperature. The flow curves showed a nonlinear relationship between shear stress and shear gradient, characterizing them as non-Newtonian behavior; that is, at constant pressure and temperature, the viscosity is dependent on the shear rate.

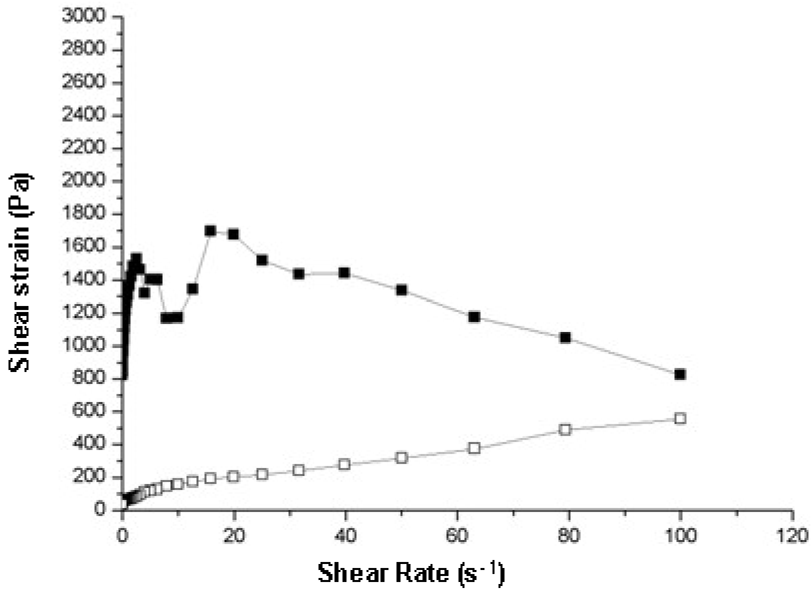

Figure 1. Rheological behavior for lip balm based on *bacuri* butter (*Platonia insiginis*). The outward curve is represented by the closed symbol, and the back curve by the open symbol at 32 ºC. Each value is the average of three replicates with a coefficient of variation less than 10%.

The lip balm based on *bacuri* butter decreases apparent viscosity as a function of shear stress, which characterizes a pseudoplastic fluid with moderate thixotropy, ideal for topical formulations (Lee et al. 2009). Partial destructuring of the formulation is required to apply the cosmetic effectively. In addition, the recovery of apparent viscosity after removal of the shear gradient was time-dependent (with thixotropy), as demonstrated by the expressive area of hysteresis formed between the flow curves, which ensures easy application of the lip product (Barnes 1997; Andrew and Jones 2006; Nunes et al. 2016)designed as platforms for improved drug delivery to mucosal sites. Binary interactive systems were manufactured containing hydroxyethylcellulose (HEC; 1-5% w/w.

In conclusion, this work presented the development of a lip balm based on Amazon butter extracted from *bacuri* fruit seeds, with adequate physicochemical properties and rheological behavior. The identified fatty acid profile makes this butter an excellent alternative input for cosmetic applications, meeting the industrial demand for increasingly natural and safe raw materials from Amazonian biodiversity.

This research highlights the potential benefits of using bacuri Amazonian butter, extracted from discarded seeds in the food industry, to create lip balm. The butter's favorable fatty acid profile gives it excellent physicochemical properties and rheological behavior, making it a promising ingredient for developing natural ointments in cosmetics. This addresses the increasing demand for secure and natural raw materials sourced from the Amazonian biodiversity in the beauty industry.

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AUTHORS' CONTRIBUTION

Conceptualization: KMN, GBS, and LCB; Methodology: KMN and BCCS; Validation: KMN, BCCS, and WSR; Formal analysis: BCCS, WSR, and RHVM; Investigation and resources: BCCS and WSR; Data curation: BCCS and JAA; Writing-original draft preparation: BCCS; Writing-review and editing: BCCS, WSR, and JAA; Visualization: BCCS and KMN; Supervision: KMN, GBS, and LCB; Project administration and funding acquisition: KMN. All authors read and approved the final manuscript.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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