# BIOFILM DEVELOPMENT FROM WASTE FROM THE EXTRACTION PIE OF CUPUAÇU BUTTER (THEOBROMA GRANDIFLORUM)

Midsy Oliveira FERREIRA[1,] Leonardo Victor Gomes de MELO[2] & Nilton Akio MUTO[3]

[1] *Biotechnology/Faculty of Biotechnology/ Institute of Biological Sciences/ Federal University of Pará, Belém, Brazil.*
* *Corresponding author's email address: midsyferreira@icb.ufpa.br*

## ABSTRACT

Plastic pollution is one of today's main environmental problems, where the catastrophic effects are already noticeable, especially in the seas and oceans. Although the emergence of plastics has revolutionized the most diverse segments, opening up the opportunity to manufacture a huge variety of materials, its major drawback is the long time it takes to degrade. Depending on the nature of the plastic matrix, some can take up to centuries to degrade completely; given that most are made from petroleum derivatives, this time can be even longer. Thus, there is currently a great search for renewable matrices, where residual biomass is an excellent candidate, among which is the residue from the extraction of fat from the cupuaçu seed, which has several components such as long-chain fatty acids, which are commonly used in the manufacture of biofilms, but which still does not have a correct destination and in many cases is dumped in the environment. The aim of this work was therefore to develop a biofilm from the cupuaçu extraction cake residue, with a view to obtaining a biofilm that is environmentally sustainable, as well as adding value to the residue.

**Keywords:** Plastic. Biodegradable. Waste. Cupuaçu. Biofilm

## 1 INTRODUCTION

In recent years, the amount of plastic produced to meet the needs of the population has grown too much, which has caused enormous damage to the environment, so much so that this pollution is currently considered to be one of the world's biggest environmental problems. Despite its versatility in many different segments, plastic takes a long time to decompose, which results in enormous environmental damage, as it takes around 100 to 400 years for these materials to degrade in the environment through the action of ultraviolet rays, humidity and heat (Santos *et* al., 2012). The presence of plastic waste in the oceans was first reported in scientific literature in the early 1970s, and has come to the fore in recent years (Jambeck; Geyer; Wilcox, 2015). On the ground, these plastics cause various problems, such as visual pollution and also contribute to the accumulation of standing water, which consequently serves as a breeding ground for disease-transmitting mosquitoes.

In recent years, the search for biodegradable plastic alternatives such as biopolymers has increased. Some of these bioplastics, which are obtained from renewable sources, have great potential for replacing those produced from fossil sources in certain applications (Agrawal; Araújo; Brito, 2011). Thus, the use of biodegradable polymers and biomaterials appears to be a possible solution to the environmental consequences caused by the inappropriate disposal of conventional polymers and plastics (Enríquez *et al*., 2012; Rocha *et al.,* 2014). Among the renewable sources with the potential to produce biopolymers are residual biomasses, which not only have added value but are also discarded in the environment. Among these biomasses is the cupuaçu cake residue, which is the by-product of extracting butter from the fruit.

The cupuaçu tree (*Theobroma grandiflorum*) is a perennial fruit tree that belongs to the *Malvaceae* family and is typical of the Amazon region, where it is of great importance to Amazonians both as a food crop and economically. This species is found spontaneously in the forest areas of the south and northeast of the eastern Brazilian Amazon and northeastern Maranhão, and also in the Amazon region of neighboring countries (Schwan, 2000). According to Homma (2001) and Lopéz (2015), cupuaçu can be used in general, but the pulp is the most important part and stands out for its characteristics of acidity, active aroma and very pleasant flavor. The pulp of the fruit is consumed in a wide variety of forms such as juices, liqueurs, ice cream, creams, desserts, cakes, pies and other delicacies.

Over the years, the expansion of cupuaçu cultivation has allowed it to reach other markets such as cosmetics, where the product used is cupuaçu butter. Cupuaçu butter is a triglyceride that solidifies at temperatures below 30 °C because it has a balanced content of saturated and unsaturated fatty acids. The use of cupuaçu butter in cosmetics is due to the compound's anti-inflammatory, moisturizing, antioxidant, emollient and lubricating properties (Ramos, 2016). Because of all these properties, the amount of cupuaçu produced to supply the market has increased considerably, which consequently increases the volume of waste, which has no considerable added value and is therefore discarded by companies.

In this sense, given that there is an urgent search for biodegradable plastics and that the extraction of cupuaçu butter generates a considerable amount of waste, the aim of this work was to develop a biofilm from the residue of the cupuaçu butter extraction cake.

## 2 MATERIAL & METHODS

### 2.1 Biomass preparation

The waste from the cupuaçu pie was donated by the food engineering faculty. When it arrived at the laboratory, the residue was ground up in an industrial processor and then placed in packages which were stored in a refrigerator until the analyses were carried out.

### 2.2 Centesimal composition

The centesimal composition of the cupuaçu cake residue was carried out according to the official methods of AOAC (1997), the moisture content was determined in a drying oven with air circulation at 105ºC (AOAC method nº925.10), ash was determined by incineration in a muffle furnace at 550ºC (AOAC method no. 923.03), protein content was determined by total nitrogen analysis by Kjeldahl (NTK method) (AOAC method no. 920.87), the lipid fraction was determined by the Bligh & Dyer method (1959). The total fiber content was analyzed using the gravimetric-enzymatic method established by AOAC, adapted by Embrapa Agroindústria de Alimentos (AOAC method no. 985.29) (Freitas *et al.,* 2008).

2.3 Protein Extraction

The protein fraction present in the residue was obtained according to Santos *et al*., 2005, with adaptations. 50g of the cupuaçu residue sample was weighed and transferred to a 600 ml beaker along with 500g of water, and homogenized with a glass rod. It was then transferred to a jacketed beaker with hot water circulation, which was placed on a hot plate. During this time, the pH was adjusted to 7.00 using NaOH, and when this ideal pH was reached, 1.9 ml of Celluclast enzyme was added, the plate was allowed to reach 55º C and 250 rpm for 1 hour and then the contents of the beaker were distributed into 6 falcon tubes which were duly weighed to get the weight as close as possible to being inserted into the centrifuge (Nova Técnica - NT825, Campinas) at 4º C at 10,000x g for 30 minutes. At the end of the centrifugation stage, the supernatant was removed and transferred to a beaker and then distributed in silicone molds which were placed in an oven at 105ºC for 24 hours.

2.4 Bending strength and resistance analysis

An analysis was carried out to test the strength of the film, where a 0.2 mm strip was removed from the film and inserted into the texturometer, which was duly configured to carry out the analysis.

## 3 RESULTS & DISCUSSION

3.1 Centesimal analysis

With the biomass duly crushed, all the centesimal analyses were carried out, which showed excellent results. Table 1 shows the values found.

**Table 1** - Percentage of centesimal analyses

| | Composition | | | | |
|---|---|---|---|---|---|
| Biomass | Protein (%) | Lipids (%) | Ash (%) | Humidity (%) | Fibers + Carbohydrates (%) |
| Cupuaçu | 25.70 | 12.14 | 3,74 | 11.87 | 46.55 |

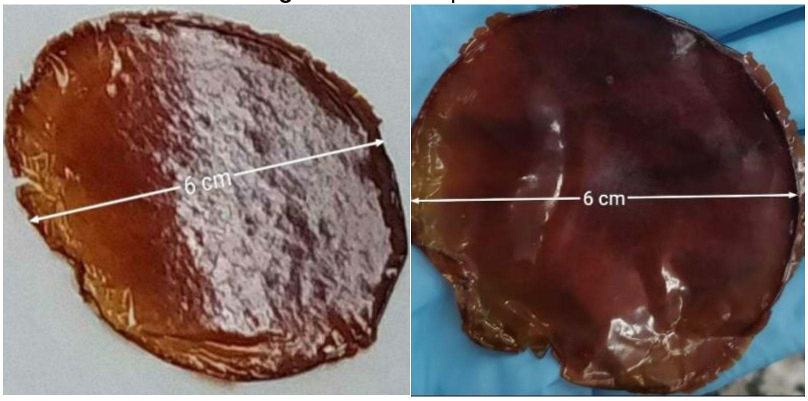
These results show that the residue is rich in fiber and protein, making it viable for formulating a biofilm. Based on the protein value found, protein extraction was carried out to obtain the desired fraction.

3.2 Biofilm production

The protein extraction was successful and a good yield was obtained. The high content of small particles favors the extraction process, since smaller particles increase the surface area of interaction with the solution, improving mass transfer from the plant matrix (Makanjuola, 2017).

The percentages of protein found showed that the cupuaçu press cake residue is viable for making biofilms. The extracted product was poured into silicone molds and placed in a drying oven for 24 hours. At the end of the incubation period in the oven, the films were duly disinfected. Figure 1 shows the biofilm obtained.

**Figure 1** - Biofilm produced




3.3 Bending strength and resistance analysis

At the end of the test, the film presented a strength resistance of 5 N, that is, this result shows that the possibility of including this item in the market is quite promising, such as insertion in the PVC film segment, given that it It has good resistance and adhesion, and is biodegradable, which directly contributes to the implementation of two of the 17 SDGs proposed by the UN (United Nations), with objectives 14 and 15 being strongly affected by the immense plastic pollution that takes centuries. to decompose (UN, 2015).

## 4 CONCLUSION

It is therefore concluded that the objective of the work was successfully achieved, demonstrating that the cupuaçu extraction cake residue is a viable biomass for use in the formulation of biodegradable films. In addition, the film produced showed good resistance, which is one of the requirements for good market acceptance. In addition, the fact that it is made from a renewable source also contributes to sustainable development, promoting great benefits for the planet.

## REFERENCES


[1] AGRAWAL, P.; ARAÚJO. E. M.; BRITO, G. F.; MÉLO, T. J. A. Biopolymers, biodegradable polymers and green polymers. **Electronic Journal of Materials and Processes**. v.6.2, p. 127-139, 2011

[2] AOAC - Association of Official Analytical Chemists. **Official Methods of Analysis of the Association of Official Analytical Chemists**. Washington: Ed. Washington, 1997.

[3] BLIGH, E.G.; DYER, W.J. A rapid method of total lipid extraction and purification. **Can. J. Biochem. Physiol**, v. 37, n. 8, p. 911-917, 1959.

[4] ENRÍQUEZ C, MARIO; VELASCO M, REINALDO; ORTIZ G, VICENTE. Composition and processing of almond-based biodegradable films. **Biotecnología en el sector Agropecuario y Agroindustrial**, v. 10, n. 1, 2012.

[5] FREITAS, C. S.; ANTONIASSI, R.; SILVA, T. S.; FELBERG, I. Collection of Analytical Methods for Fiber Determination. Rio de Janeiro: Embrapa Agroindústria de Alimentos. P. 37, 2008

[6] HOMMA, A. K. O. The development of agro-industry in the state of Pará. **Embrapa Amazônia Oriental-Article in an indexed journal (ALICE)**, 2001

[7] JAMBECK, J.R; GEYER, R.; WILCOX, C.; SIEGLER, T.R. et al. Plastic waste inputs from land into the ocean. **SCIENCE.** v. 347, p. 768-770, 2015.

[8] LOPÉZ, P. A. B. **Evaluation of the cupuaçu (theobroma grandiflorum (willd. ex spreng.) schum.) production chain in the municipalities of Itacoatiara, Presidente Figueiredo and Manaus**. [TCC] National Amazon Research Institute-INPA. Manaus, 2015.

[9] MAKANJUOLA SA. Influence of particle size and extraction solvent on antioxidant properties of extracts of tea, ginger, and tea-ginger blend. **Food Sci Nutr**, 5: 1179-1185, 2017.

[10] UN. 2030 Agenda for Sustainable Development. September 15, 2015. Available at: https://brasil.un.org/pt-br/91863-agenda-2030-para-o-desenvolvimento-sustent%C3%A1vel . Accessed on: 06/06/2024

[11] RAMOS, A.L. **Synthesis and characterization of solid lipid nanoparticles from cupuaçu butter - Theobroma grandiiflorum (Shum) with nanobiotechnological applications**. [Dissertation] Federal University of Acre. Rio Branco, 2016.

[12] ROCHA, Geisa Oliveira et al. Biodegradable composite films based on cassava starch and soy protein. **Embrapa Agroindústria de Alimentos-Article in indexed journal (ALICE),** 2014.

[13] SANTOS, A.S.F.; FREIRE, F.H. O.; COSTA, B.L.N.; MANRICH, S. Plastic bags: sustainable destinations and replacement alternatives. **Polímeros**, v. 22, n. 3, p. 228-237, 2012.

[14] SANTOS, R. D.; FERRARI, R. A. Aqueous enzymatic extraction of soybean oil. **Food Science and Technology**. Campinas, 25(1): p. 133-134, 2005.

[15] SCHWAN, R. F. et al. Cupuaçu [Theobroma grandiflorum (Willd Ex Spreng.)] . In: ALVES, R. E., FILGUEIRAS, H.A.C., MOURA, C.F.H. (coords.). Characterization of native fruits from Latin America. Jaboticabal: FUNEP, 2000. P.31-34 (Native Fruit Series, 9).


## ACKNOWLEDGEMENTS


I would first like to thank God for giving me the opportunity to carry out this work. To my colleagues in the laboratory who contributed in various ways to achieving the goal of this work. Sincere thanks to my advisor for all his partnership.