POLYMERIC MEMBRANES WITH AMAZONIAN VEGETABLE OILS FOR USE AS BIOMATERIALS

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ABSTRACT

Amazonian natural resources, especially oilseeds, carry great therapeutic potential in improving human health due to their high concentration of bioactive compounds and essential fatty acids. Considering the need to develop new dressings that meet the dynamic and complex process of wound healing, this study proposes the formulation of chitosan-based membranes associated with fixed Amazonian oils of babaçu, buriti, and pracaxi. The results presented in the analysis of the vegetable oils revealed positive points for therapeutic application, with the presence of essential fatty acids and adequate acidity index according to the ANVISA standard. Regarding the degree of deacetylation, chitosan obtained 77.28%, a value that certificate that the processing of commercial chitosan was efficient. However, it is essential to carry out further studies to optimize the process parameters to improve the uniformity of the membranes and to carry out in vitro tests to conclude the absence of toxicity of the cutaneous dressing.

Keywords: dressing. chitosan. oil. Amazon.

1 INTRODUCTION

Among the natural resources present in the Amazon rainforest, oilseed plants receive special attention because they have unique bioactive compounds and essential fatty acids that can promote improvements in human health[1]. Oilseed matrices originating from palm tree species commonly have high levels of essential fatty acids, such as oleic acid (C18:1) and linoleic acid (C18:2)[2]. Examples of Amazonian palm trees include the babaçu (*Orbignya oleífera*) and the buriti (*Mauritia flexuosa*), belonging to the *Arecaceae* family, which are known in traditional medicine in the treatment of wounds, where studies highlight the biological activities of these palms through the stimulation of fibroblasts and collagen, in addition to limiting the oxidative stress of wounds [3-4].

Another oleaginous matrix presents in the Amazon region that stands out for its topical use in traditional medicine is the *Pentaclethra macroloba* of the *Fabaceae* family, which is called pracaxi. Its oil extracted from the seeds is rich in oleic, linoleic, and behenic acids (C22:0). These compounds exhibit anti-inflammatory, healing, antimicrobial, antihemolytic, and antivenom properties[5]. Given this, Amazonian oilseeds can be investigated in the wound healing process.

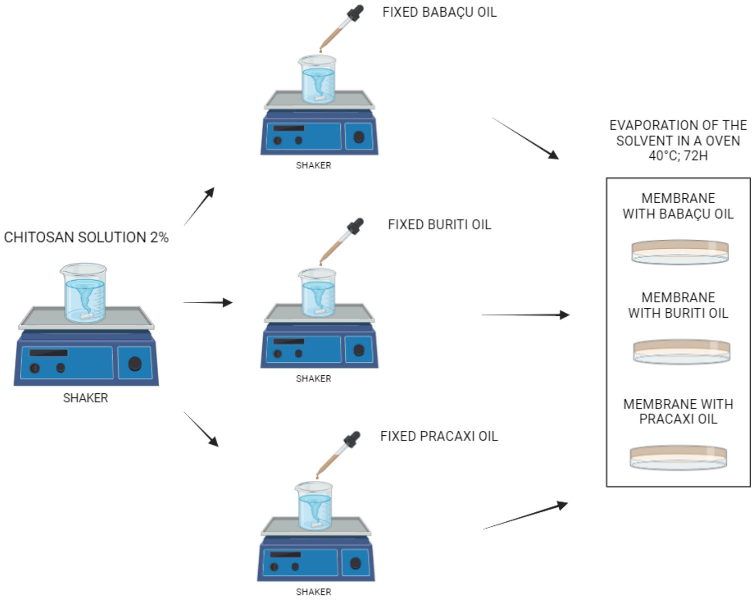
Natural, biodegradable, non-toxic, biocompatible materials that accelerate the healing process and have antimicrobial activity are strong candidates to act as dressings. In recent years, dressings made of natural polymers have shown positive results in this field, especially chitosan biomembranes, as they protect wounds from the external environment while allowing the entry of oxygen and water vapor, thus reducing the probability of bacterial infections[6]. Chitosan can also have its properties enhanced when associated with active compounds[7], in addition to being easy to process in different forms (gels, foams, membranes, and granules) enabling its application in different types of lesions and improvements in healing properties[8].

Therefore, this study aims to develop and evaluate membranes formed from chitosan and the Amazonian fixed vegetable oils of babaçu, buriti, and pracaxi, for potential use as cutaneous dressing.

2 MATERIAL & METHODS

Commercial chitosan powder (CAS: 9012–76–4), average molecular weight 190,000–310,000, obtained from Êxodo Científica (São Paulo, Brazil), was solubilized in a solution of 1% v/v acetic acid, at a concentration of 2% m/v, and kept in agitation for 24 hours. After that, Tween 80 1% by volume was added, concerning the polymer mass, and kept in agitation for 30 minutes. The babaçu, buriti, and pracaxi oils were obtained from Amazon Oil (Pará, Brazil) and used for the preparation of emulsions at concentrations of 0.1%, 0.2%, and 0.3% w/v. In polystyrene Petri dishes, 20mL of each emulsion was distributed and taken to an oven (Odontobras, MOD-EL-1.2) at 40°C for 72 hours for solvent evaporation. In the same way, we proceeded to the control film containing only the chitosan solution. Figure 1 shows the process illustration.

Figure 1 process illustration of production of chitosan membranes with fixed oils of babaçu, buriti and pracaxi.



Fatty acid profile studies and acidity index analysis of oils were carried out according to the American Oil Chemists' Society (AOCS) method Ca 5a-40, 2009[9]. An analysis was also applied to determine the degree of chitosan deacetylation, based on the Broussignac method (10), and to determine the thickness of the membranes produced using a digital micrometer and three points to determine the mean thickness value.

3 RESULTS & DISCUSSION

From the literature review and the data provided by the company Amazon Oil, the fatty acid composition of babaçu, buriti and pracaxi oils was obtained, as well as chain size and percentage of unsaturation (Table 1).

Table 1 Fatty acid composition of babaçu, buriti and pracaxi oils, by Amazon Oil.

Fatty acid	Babaçu	Buriti	Pracaxi
Valeric acid (C 5:0)	-	0,6 – 1,00 (%)	-
Caprylic acid (C 6:0)	4,0 – 6,0 (%)	-	-
Capric acid (C 10:0)	6,0 – 8,0 (%)	-	< 15 (%)
Lauric acid (C 12:0)	43,0 – 47,0 (%)	-	-
Myristic acid (C 14:0)	15,0 – 19,0 (%)	-	-
Palmitic acid (C 16:0)	5,0 – 9,0 (%)	14,0 – 19,0 (%)	1,0 – 3,5 (%)
Stearic acid (C 18:0)	2,5 – 5,5 (%)	1,5 – 6,0 (%)	1,5 – 3,0 (%)
Oleic acid (C 18:1)	12,0 – 16,0 (%)	55,0 – 75,0 (%)	45,0 – 55,0 (%)
Linoleic acid (C 18:2)	1,0 – 3,0 (%)	10,0 – 15,0 (%)	10,0 – 15,0 (%)
Linolenic acid (C 18:3)	-	0,5 – 1,5 (%)	-
Arachidic acid (C 20:0)	-	-	1,0 – 3,0 (%)
Behenic acid (C 22:0)	-	-	14,0 – 20,0 (%)
Lignoceric acid (C 24:0)			8,0 – 14,0 (%)
Unsaturation	15 (%)	75 (%)	65 (%)

Buriti and pracaxi oils have a high concentration of oleic acid, a component known for its important role in modulating skin inflammatory responses, since it induces the release of cytokines, helping to reduce the inflammatory process in up to 5 days[4-11]. On the other hand, babaçu oil has lauric acid in its highest composition, which has antimicrobial properties responsible for reducing infections during the wound healing process[4]. Thus, the application of fixed vegetable oils suggests their therapeutic importance in the treatment of wounds, and their use in the development of cutaneous biomaterials.

To evaluate the quality of the oils, the analysis was carried out to determine the acidity Index, which reflects the state of conservation of the oil. Table 2 shows the results obtained.

Table 2 Acidity index of fixed vegetable oils from babaçu, buriti and pracaxi.

Oil	Acidity index (mg KOH/g)
Babaçu	0,27±0,12
Buriti	8,08±0,11
Pracaxi	2,27±0,51

Babaçu oil was acid value below the minimum value of 0.6 mg KOH/g delimited for refined oils by Resolution No. 481, March 15, 2021, of the National Health Surveillance Agency (ANVISA). In addition, this value is also lower than that of Serra et al. (2), who obtained 1.06 ± 0.03 mg KOH/g, concluding that the babaçu oil used in our study is in perfect condition. For buriti and pracaxi oils, the results were higher than those delimited by the Resolution for refined oils but did not exceed the established limit of 10 mg KOH/g. According to Pereira et al., the value obtained for pracaxi oil was 2.63 ± 0.01 mg KOH/g (1). On the other hand, the acidity of 8.08±0.11 mg KOH/g obtained for buriti oil is within the acidity range (1.82 ± 0.01 to 17.44 ± 0.21 mg KOH/g) presented in the literature for its oil in nature (12). Therefore, pracaxi and buriti oils are also of good quality.

Although commercial chitosan has a degree of deacetylation between 70 and 95%, it is crucial to know this exact value to ensure the quality of the chitosan used and to identify any chemical modifications in the polymer. After data analysis, the result of the degree of deacetylation was 77.28%. Since this degree of deacetylation is greater than 50%, it is concluded that the deacetylation of commercial chitosan was efficient[13].

Table 3 shows the results of the membrane thicknesses produced. The membrane thickness values ranged from 0.10 to 0.18 mm.

Table 3 Thickness of membranes with fixed vegetable oils of babaçu (BA1, BA2 and BA3), buriti (BU1, BU2 and BU3) and pracaxi (PR1, PR2 and PR3).

Membranes	Thickness (mm)
Control	0,12±0,02
BA1	0,16±0,07
BA2	0,13±0,02
BA3	0,13±0,05
BU1	0,18±0,06
BU2	0,18±0,03
BU3	0,13±0,01
PR1	0,12±0,02
PR2	0,15±0,04
PR3	0,10±0,02

The solvent evaporation technique is one of the most used methodologies for film production, due to its multiple advantages. However, one of its disadvantages is the difficult control of the thickness of the films, due to the complex prediction of mass transport that occurs during drying[14]. The appropriate range of film thickness for medical application is between 0.26 to 0.841 mm[15]. Although the films have a thickness smaller than the range presented, the thin films can obtain advantages such as rapid action of the oil and wounding, and the need to use high concentrations. Nevertheless, for optimization purposes, it is necessary to re-evaluate the process parameters to obtain membranes of uniform thickness and mechanical stability.

4 CONCLUSION

The therapeutic potential of Amazonian biodiversity, especially oilseeds, has been shown to improve human health due to its high concentration of bioactive compounds and essential fatty acids. The results obtained in the analysis of fixed vegetable oils of babaçu, buriti, and pracaxi showed the presence of these fatty acids in their composition, especially oleic acid which made up 75% of the oils, evidencing their therapeutic application. In addition, the acidity index of the oils was adequate according to ANVISA standards. Regarding the degree of deacetylation, the commercial chitosan used has a percentage of 77.28%, which reveals the quality of the biopolymer used. However, it is still necessary to carry out further studies to optimize the process parameters to improve the uniformity of the membranes and take them to in vitro tests to evaluate and ensure the efficacy of the skin dressing.

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