Chapter 31

Potentiality in the application of polymeric complexes in plant extract of babassu coconut (Orbignya sp.)

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ABSTRACT
The objective was to conduct a technological and bibliographic survey regarding the application of polymeric materials in the development of products based on the vegetable extract water-soluble powder of babassu coconut (Orbignya sp). The databases of the PTO, EPO, USPTO, and WIPO were searched for the survey of patents and the databases of SciELO, Scopus, and Web of Science journals were searched for articles. Forty-six patients were found, but only two of them that were listed in the Subclass A23L of the International Patent Classification (food products or non-alcoholic beverages, their preparation or treatment), but none were related to the production of vegetable milk, let alone the application of a polymer in the process. With researched articles, it was observed that even though patent records are not found, there are studies that have already addressed the elaboration of vegetable extract powder based on the use of babassu almonds, mainly bringing to light the use of polymers in their methodologies, such as maltodextrin as a way to optimize drying by milk spray, gum as an encapsulating agent. The application of these polymers is promising if combined correctly in the formulation of the vegetable extract water-soluble powder of babassu coconut.

Keywords: Polymeric materials, Babassu almonds, Vegetable milk.

1 INTRODUCTION

The babassu (*Orbignya sp.*) is the generic name given to oilseeds belonging to the *family Palmae and* members of the genera *Orbignya* and *Attalea*, and the first of these genera are represented by species predominantly native to the states of Maranhão, Piauí, Pará and Tocantins (Zylbersztajn et al., 2000). However, it is not only in Brazil that palm trees can be found, occurring in other countries of the Americas, such as Mexico and Bolivia (Lima et al., 2006).

The plant is considered one of the most important Brazilian palm trees for its economy, with numerous applications, ranging from power generation to handicrafts, food, pharmaceutical excipients, etc. (Carrazza, Silva & Ávila, 2012). The fruit, coconut, stands out in economic, technological, and industrial use, often having some of its products exported abroad (Brazil, 2009; Gouveia, 2015) and the physical composition of coconut indicates four usable parts: epicarp (11%), mesocarp (23%), endocarp (59%) and almond (7%) (Sousa et al., 2014).

The epicarp is the rigid and fibrous outer layer with application in the upholstery industry of car seats, pots, plates, packaging in place of Stporin, burning in homemade or commercial ovens and as organic fertilizer among other things (Ferreira, 2011). The mesocarp (20.4%) is the layer below the epicarp (with 0.5 to 1.0 cm), rich in starch and used in food through the production of flour, among others (Ferreira, 2011). The endocarp (58.4%) is the toughest layer, with 2 to 3 cm thickness, and applications, in food, veterinary, pharmaceutical, chemical, agriculture, handicraft and as a substitute fuel for firewood. Almond (8.7%) with an average of 3 to 4 units per coconut, consists of about 7.25% proteins, 66.0% total fats, 18.0% hydrocarbonates, 7.80% calcium salts, 0.5% phosphoric acid, among others (Ferreira, 2011; Carrazza, Silva & Ávila, 2012).

Almonds, as well as other parts, can be used. However, they are the ones that draw the most attention, given their nutritional and commercial value. These almonds are an important source of oil and can be destined for food, in the manufacture of lubricants and biofuel, as well as in the cosmetic industry (Pessoa et al., 2015, Vinhal, Lima, & Barbosa, 2014).

From the almonds is extracted water soluble liquid, also known and produced by hand in the North and Northeast of Brazil as "babassu coconut milk" (Carneiro et al., 2014). It is a food option capable of meeting the needs of people seeking healthier foods, cholesterol-free, or for people with lactose intolerance. However, babassu milk falls into the category of products called low acidity, because it has a final pH greater than 4.6 and water activity greater than 0.85. Due to these characteristics, it is a good substrate for the development of microorganisms of importance regarding industrial and public health aspects. Thus, the process of obtaining and preserving industrially safe this product must be very well standardized and controlled to attest to the quality of the obtained product (Silva et al., 2010).

At the same time, the application of polymers in its complexation is one of the alternatives already widely used by the food industry, because they have a low friction index and promote resistance to wear, thermal insulation and chemical and microbiological resistance. Among those with the highest prominence and applicability include cyclodextrins, maltodextrins, xanthan gum and cellulose derivatives such as carboxymethylcellulose (CMC) (Rodrigues et al., 2014).

Cyclodextrins (CDs) are formed by D-glucose monomers joined by glycosidic bonds of type α-1.4 (Carneiro, 2006). CDs are used as a solubilizing and stabilizing agent in addition to the inclusion of complex trainers, which can result mainly in improvement in dissolution and bioavailability of the formulation to which it was applied, due to the greater solubility and improvement of chemical and physical stability (Rowe, 2009).

Another potential application of CD in food formulations occurs to decrease non-enzymatic darkening, which in some foods generates a loss of sensory quality of the product (Carneiro, 2006) and can be used to increase the stability of food components that are susceptible to the action of light, temperature and oxidation, besides decreasing the speed of loss of volatile compounds present. With this, there is an increase in the stability of aromas, vitamins, fats and other food components (Rowe, 2009).

Maltodextrin is generated as a product of the partial hydrolysis of starch and can be defined as a glucose polymer. It has been widely used in many types of processed foods, being widely used as a food additive, performing the function of gelling agent and thickener, to prevent crystallization, assist in dispersibility, and control freezing (Livesey & Tagami, 2009). As a carrier agent, this polymer is commonly used in atomization drying, due to its low hygroscopicity, and high solubility in cold water, besides being a low-cost additive (Ferrari, Ribeiro & Aguirre, 2012).

Xanthan gum is a polysaccharide hydrocolloid that has excellent rheological properties of interest for use in food, produced by species of bacteria of the genus Xanthomonas, which synthesizes the gum to prevent its dehydration. It is an additive widely used in the food, pharmaceutical, hygiene and cosmetics industry as a stabilizer, thickener and emulsifier. It is also used in the oil industry, due to its high viscosity even at low concentrations, high pseudo plasticity and viscosity stability in the presence of salt, at different temperatures and in a wide pH range. Its worldwide production is around 50,000 ton./year (Borges, & Vendruscolo, 2008).

Carboxymethylcellulose (CMC) is easily dispersed in water at all temperatures, forming clear and colloidal solutions. The aqueous solubility varies with the degree of replacement. It is practically insoluble in acetone, ethanol (95%), ether and toluene. CMC is used as a disintegrant, water-absorbing agent, binder and stabilizer. It is a stable material, albeit hygroscopic. Under high humidity conditions, carboxymethylcellulose sodic can absorb a large amount (>50%) of water and is incompatible with xanthan gum. It is widely used in food, cosmetic and pharmaceutical products. However, ingestion of large amounts has a laxative effect. The World Health Organization (WHO) has not specified an acceptable daily intake of sodium carboxymethylcellulose as a food additive provided that the levels needed to achieve the desired effect are not considered hazardous to health (Thompson, 2013).

Because of what was exposed, the objective of this work was to conduct a technological and bibliographic prospection on the application of these main polymeric materials related to the food industry, in the development of complexes for the powdered hydrosoluble plant extract based on babassu coconut almond (*Orbignya speciosa*).

2 METHODOLOGICAL PROCEDURES

This article is a search for anteriority to investigate the existence of patents related to polymeric complexes in plant extract of babassu coconut, besides being bibliometric research that in Vanti's view (2002) can be understood as a quantitative evaluation technique, to measure dissemination knowledge and the flow of information from some point of view. For Silva, Durante and Biscoli (2017), bibliometric studies aim to list, systematize and evaluate scientific works in an area of knowledge established to verify trends.

The work consisted of two analyses, one of the patents and the other on the articles available in their respective databases. For the first case, an earlier search was carried out verifying the protection

applications filed in the following databases: National Institute of Industrial Property (INPI), *European Patent Office* (EPO), *United States Patent and Trademark Office* (USPTO) and *World Intellectual Property Organization* (WIPO). For this, the inclusion criterion was the international patent classification table, seeking results that belong to the human needs section (Section A), subclass A23L, since it classifies certain types of non-alcoholic beverages, in addition to their preparation or treatment. It should also be emphasized that the searches occurred with the exclusion criterion of patents not belonging to subclass A23L, in addition to cases in which repetitions occurred among the databases searched.

The articles, in turn, were analyzed in the databases of *SciELO*, *Scopus* and *Web of Science*. For this, the same combinations were used in patent searches using as exclusion criteria articles that were repeated between the bases, while the inclusion criteria were works related to food technology and/or human food and/or that addressed the use of babassu in the production of vegetable extract (milk) of babassu coconut powder, in addition to the cases in which some of the mentioned polymers (cyclodextrins, maltodextrin, xanthan gum or carboxymethylcellulose) could arise in the preparation of this product.

The search s foram performed with the insertion of the keywords in the field entitled as title and/or abstract and/or keywords, so that the terms "*Orbignya", "babassu", "milk", "powder", "milk", "cyclodextrin", "maltodextrin", "xanthan gum" and "carboxymethyl cellulose*" were used. It is noteworthy that the time frame considered is of the entire historical series available in the periodic databases and patents consulted up to the date of the consultations, that is, in May 2022.

3 RESULTS AND DISCUSSION

3.1 PATENT ANALYSIS

The searches were carried out in the databases of the PTO, EPO, USPTO and WIPO using the descriptors of the work and its combinations. At the end, a total of 46 localized patents were obtained (Table 1).

Table 1 - Number of patents with the name of the genus, the edible part and the composition of the babassu.

Descriptors	**Patent base**			
	INPI	**EPO**	**USPTO**	**WIPO**
Orbignya ***and*** milk	0	0	0	0
Babassu ***and*** milk	1	10	0	7
Babassu ***and*** Powder	0	13	0	10
Babassu ***and*** milk *and* powder	0	3	0	2
Babassu ***and*** milk *and* cyclodextrin	0	0	0	0
Babassu ***and*** milk *and* maltodextrin	0	0	0	0
Babassu ***and*** milk *and* xanthan gum	0	0	0	0
Babassu ***and*** milk *and* carboxymethyl cellulose	0	0	0	0

Source: Own Authorship (2022)

For the International Patent Classification, the development of almond-based hydrosoluble extract of babassu powder should be classified in the human needs section (Section A), subclass A23L. The term "*Orbignya*", when combined with the word "*milk*", showed no results in any of the databases surveyed.

The patents filed in which the keywords "babassu" and "*milk*" were used totaled 18 records, 1 patent filed with the PTO, 10 in the EPO and 7 in the WIPO (Table 1). Of these, only 2 that were in the EPO belonged to Section A, subclass A23L (Chart 1).

Table 1 – Patents with the descriptors "*Orbignya*", "*babassu*", "*milk*", "powder" classified in Section A, A23L of CIP

Patent	**Inventor (Year)**	**Depositing country**	**Formulation/Summary**
GB889321A	Shell int research (1962)	United Kingdom	It comprises a stabilization process of organic materials subject to oxidative deterioration (Only addresses babassu oil in its summary).
JP3021499B2	Tomaretsuri, R. M. (1990)	Japan	It is a composition of a palm oil-based drink for infant prescription" and refers to a beverage that may have the same nutritional and absorption qualities of a breast milk and may be a substitute in specific cases, consisting of plant extracts of randomized palmitic acid; soluric acid, babassu, olive, cottonseed, mits, soybeans, sunflower, canola and linoleic acid, such as corn oil, cotton seed oil, matham oil, soybean oil, sunflower oil.

Source: Own Authorship (2022)

The first (GB889321A), which only mentions babassu oil in its abstract, and the second, refers to the "composition of a beverage based on palm oil for infant prescription" (JP3021499B2), and is classified in the CIP, among others, in subclass A23L 33/00 (Modifications in nutritional qualities of food; Dietary products; Its preparation or treatment) and refers to a beverage that may have the same nutritional and absorption qualities of a breast milk and may be a substitute in specific cases, being composed of plant extracts of randomized palmitic acid; solic acid, babassu, olive, cotton seed, mits, soybeans, sunflower, canola and linoleic acid, such as corn oil, cotton seed oil, matham oil, soybean oil, sunflower oil.

In this case it was necessary a larger explanation of the latter patent because it is a drink that can replace milk, but as can be observed it is not powdered and is reasonably distant from the composition of the water soluble plant extract based on babassu almond.

Continuing the analyses, now with "*babassu*" and "*powder*", 23 results were found, of which 13 are in EPO and 10 in WIPO (Table 1), of which only 1 in EPO is section A, subclass A23L and which has already been mentioned with the research in "*babassu*" and "*milk*", under registration number GB889321A (Chart 1).

When considering the descriptors "*babassu*" and "*milk*" and "*powder*", the research shows 5 patents filed (3 in EPO and 2 in WIPO, in Table 1). Once again having Section A, subclass A23L of the International Patent Classification, there was only 1 in the EPO that belonged to this classification (GB889321A). This in turn also appears in the research records for "*babassu*" and "*milk*" and "babssu" and "*powder*" (Chart 1).

Finally, the technological prospecting showed that no patents were found filed in any of the bases when researching the terms "*babassu*" and "*milk*" and "*cyclodextrin / maltodextrin / xanthan gum / carboxymethyl cellulose*". In other words, the number of patents is reduced to zero when considering any of the polymers used in this search.

3.2 ANALYSIS OF ARTICLES

Here are presented the results of articles found in the databases of *SciELO*, *Scopus* and *Web of Science.* Table 2 below presents the number of publications obtained in each of these information banks with the combinations between the descriptors used in the research and their respective results about being related to human food and/or food technology or that has used one of the polymers considered in this research.

Table 2 - Published articles and their quantity related to human food and/or food technology

Descriptors	**Articles found in the databases (and selected after the inclusion criteria)**		
	SciELO	**Scopus**	**Web of Science**
Orbignya ***and*** milk	1 (1)	9 (4)	4 (2)
Babassu ***and*** milk	2 (2)	13 (6)	16 (7)
Babassu ***and*** Powder	6 (1)	19 (4)	16 (4)
Babassu ***and*** milk *and* powder	1 (1)	3 (3)	3 (3)
Babassu ***and*** milk *and* cyclodextrin	0 (0)	0 (0)	0 (0)
Babassu ***and*** milk *and* maltodextrin	0 (0)	1 (1)	1 (1)
Babassu ***and*** milk *and* xanthan gum	0 (0)	0 (0)	0 (0)
Babassu ***and*** milk *and* carboxymethyl cellulose	0 (0)	0 (0)	0 (0)

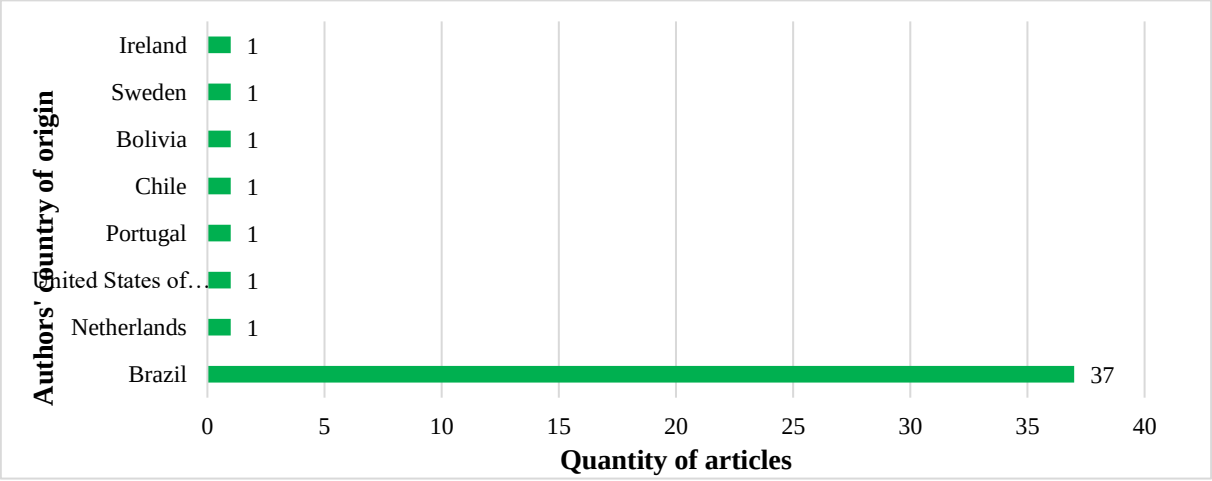
Source: Own Authorship (2022).

The data in the table show a total of 95 articles published among the databases involving the descriptors surveyed. Of these, the repeated ones were excluded, obtaining 40 studies in the most different research areas. After this, 8 articles corresponded to the research criterion of being related to human food and/or food technology or that has used one of the polymers considered in this research.

3.2.1 General information about the articles searched

Figure 1 shows the nationality of the authors who published their works related to babassu and/or application of this in some process. In it it is possible to observe a clear domain of Brazil, in which 92.5% of the articles (37/40) had Brazilian researchers.

Figure 1 - Countries of origin of the authors of the research with babassu and its applications



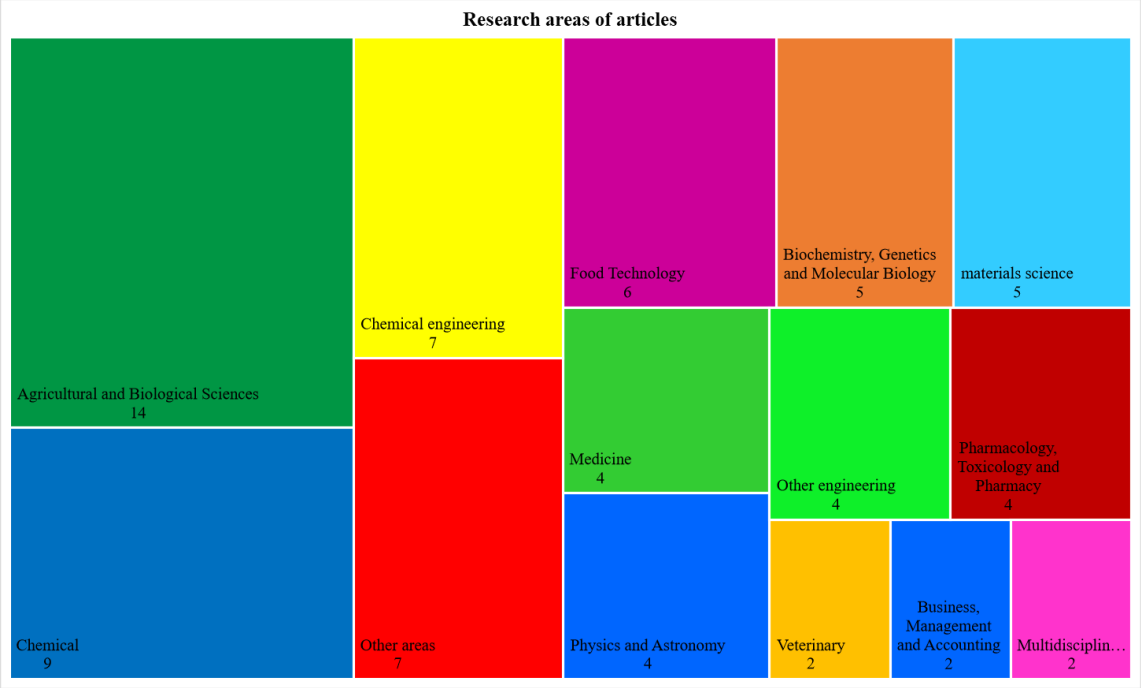
Source: Own Authorship (2022).

It is notepoint that these are studies involving a very significant fruit due to the area of coverage, located in 11 Brazilian states, which together obtains more than 67 tons of babassu coconut produced (with highlights for Maranhão [56,858 tons], Piauí [6,052 tons], Tocantins [1,359 tons] and Ceará [1,201 tons]) according to the Agricultural Census of the Brazilian Institute of Geography and Statistics – IBGE (2017) in an area of 13 to 18 million hectares scattered throughout Brazil, as well as the numerous potentialities and economic activities that can be developed from it (Carrazza, Silva, & Ávila, 2012).

Figure 2, in turn, demonstrates the areas of study that are most frequently researched in publications involving the *descriptors "Orbignya*" and "*milk*", "*babassu*" and "*milk*", "*babassu*" and "*babassu*" and "*milk*" and "*powder*" and "*babassu*" and "*milk*" and "*maltodextrin*". There is a greater predominance of articles in the area of "Agrarian and Biological Sciences", of which many of these are directed for use as feed and/or supplements for cattle (Araújo et al., 2021, Castro et al., 2021, Maciel et al., 2022, Morais et al., 2021) or for sheep (Parente et al., 2020, Santos Neta et al., 2017) as a way to seek improvement in the quality of milk and dairy products.

However, the same article can be classified into more than one category in the databases consulted and, for this reason, works in the area of "Agrarian and biological sciences", previously seen only in research for the use of babassu for animals, are also found in areas such as "Food Technology", "Biochemistry, genetics and molecular biology", "Química" and/or "Engenharia química" (Carneiro et al., 2014, Fioroto, Nascimento, & Oliveira, 2015, Gioielli et al., 1998, Santana et al., 2013, Silva et al., 2021). And when it is not classified as any other additional area, scientific production is specifically for obtaining a food product (Fronza et al., 2020). For this reason, these and other studies are analyzed in more detail in the next section so that there is greater knowledge about their purposes.

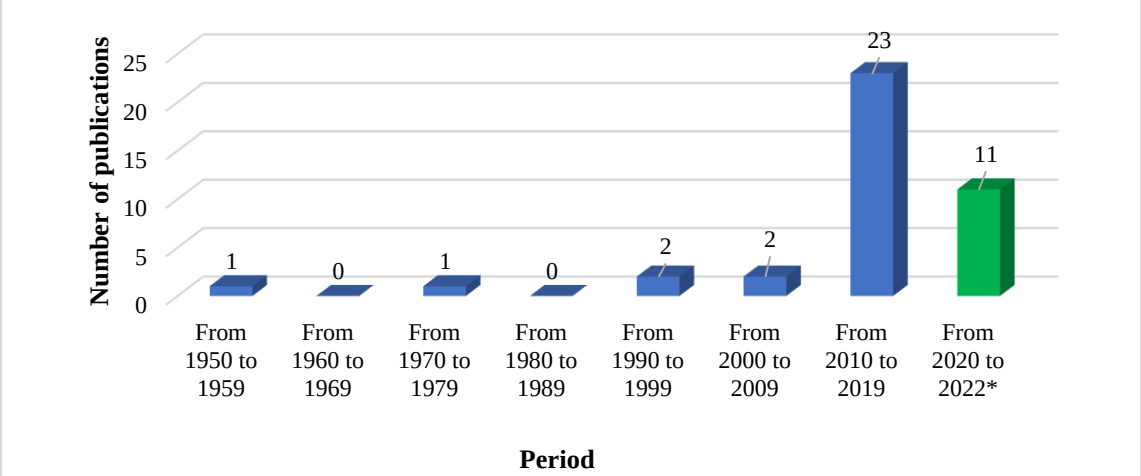
Figure 2 - Main areas of study of the articles published with the terms researched.



Source: Own Authorship (2022).

Another highlight point in the present study is the analysis of the number of studies found from the keywords (see Table 2) in recent decades, which can be observed in Figure 3. It is observed that between 1950 and 2009 very few studies in the different research areas related to the use of babassu were published, with only 6 findings in the whole period. However, this picture has changed and between 2010 and 2019 and this number has almost quadrupled and already in the last 2 and a half years (until the date on which this survey was made) there are almost half of scientific productions that it had in the last decade, demonstrating an increasing interest of scholars regarding the applications of this fruit.

Figure 3 - Number of articles published between 1950 and 2022 with the terms searched



*Data until May 2022

Source: Own Authorship (2022).

The reason for the growth in publications from 2010 is not well defined, but of the 8 articles that will be analyzed in the sequence, 7 of them are from 2013 to 2021, which reinforces the fact that studies on the topics involving babassu and/or milk (vegetable extract) have followed this trend and intensified in recent years.

3.2.2 Analysis of articles after screening

The 8 articles that were analyzed are described in Chart 2 in chronological order of publication. The table also presents the title of each work, the references, and a brief summary highlighting the objective of each research.

The work "*Water relations in freeze-dried powdered shortenings from babassu fat*" aimed to evaluate the water activity of the lyophilized plant extract of babassu, through water sorption isotherms and water sorption kinetics and characterize some physical-chemical properties of the products. Their results pointed to a low affinity of water activity, as well as lactose recrystallization phenomena. In addition, high fat content and good thermal stability were observed when submitted to heat treatment of up to 90 ºC. On the other hand, samples heated in an oven at 100 °C for 3 hours presented structural collapse and darkening, probably due to the reaction of Maillard (Gioielli et al., 1998), which is a chemical reaction between an

amino acid or protein and a reducing carbohydrate, in which products that give flavor, color and odor to food are obtained (Chichester, 1986).

The article "*Microencapsulation of babassu coconut milk*", sought to make the drying of babassu coconut milk by spraying besides being microencapsulated. Microencapsulation is the inclusion of the active substance in a solid polymer matrix forming a microsphere (Rosa et al., 2001), that is, it is a technique that basically consists of the isolation of active substances (in the liquid, solid or gaseous state) in a protective casing (thin films or polymeric coatings), to be released in a certain condition (Gharsallaoui et al., 2007, Nesterenko et al., 2013).

Table 2 – Articles that conducted research related to human food and/or food technology and involving the terms "*Orbignya*", "*babassu*", "*milk*", "powder" and "*maltodextrin*" combined with the operator "AND".

Title	Source and year	Summary
Water relations in freeze-dried powdered shortenings from babassu fat	Gioielli et al. (1998)	The objective was to evaluate the water activity of the lyophilized fatty plant extract of babassu. The powders were obtained by drying oil-in-water emulsions of dairy solids and babassu fat, without added emulsion, by lyophilization. The hygroscopic behavior of fat powders was characterized by water sorrtion isotherms and sorcinkinetics. The phenomena of lactose recrystallization were observed and structural changes were not observed in the reduction powders submitted to heat treatment up to 90 ºC, which shows good thermal stability of the product. It was concluded that the powders of vegetable fat presented high fat content, low affinity for water activity and good thermal stability
Microencapsulation of babassu coconut milk	Santana et al. (2013)	The aim of this study was to obtain milk powder of babassu coconut microencapsulated by spray drying process using arabic gum as encapsulating agent. Microencapsulation was optimized for maximum process yield and minimized lipid oxidation. The coconut milk powder obtained under optimal conditions was characterized in terms of morphology, particle size distribution, absolute density and mass, porosity and wettability.
Stability of babassu nut milk pasteurized and storage under refrigeration	Carneiro et al. (2014)	The objective was to develop the technology of conservation of water-soluble babassu extract based on pasteurization and refrigeration. The results showed that there was little variation in the physical-chemical parameters; however, microbiologically babassu milk showed microbial growth from 30 days on, reaching high values, above the microbiological standards established by the legislation, after 60 days of storage.
In Vitro Evaluation of Cu, Fe, and Zn Bioaccessibility in the Presence of Babassu Mesocarp	Fioroto, Birth, & Oliveira (2015)	Gastrointestinal digestion *of the* babassu mesocarp in the absence and presence of milk and lignin was performed to evaluate the bioaccessibility of Cu, Fe and Zn. Extractions using NaOH solutions (pH 7 and 12) were performed to evaluate the interactions of Cu^{II}, Fe^{III} and Zn^{II} with the extracted compounds and with the washed mesocarp. Phytote, a component present in the mesocarp, may be the main compound responsible for the interactions of the elements with the mesocarp. Lignin increases the soluble fractions of the elements; however, the concentrations of the elements in the dialyzed fractions, representing the bioaccessible part, were very low. On the other hand, the bioaccessibility of Cu, Fe and Zn in milk was not influenced by the mesocarp.
Spray drying of babassu coconut milk using different carrier agents	Santana et al. (2017)	It sought to optimize the spray drying of babassu coconut milk, an oil-in-water emulsion extracted from babassu almonds, using maltodextrin 10DE and modified starch as carrier agents. The powders obtained under improved conditions (maltodextrin concentration at 25% and 188 °C and modified starch concentration of 20% and 170 °C) were evaluated according to their morphology, particle size distribution, absolute and volumetric densities, porosity, wettability and thermal analysis.
Production and physicochemical characterization of coconut "milk" and babassu	Oliveira et al. (2019)	The objective was to extract milk from babassu coconut, produce milk microcapsules and characterize its physicochemical compounds of almond, coconut milk, residue (from milk production) and microcapsules of babassu coconut milk.

coconut almond microcapsules		
Microencapsulation of hydrosoluble extract of babassu nut press cake	Fronza et al. (2020)	The objective was to obtain powder extract from the pressed pie of babassu almond and verify the influence of different concentrations of Maltogill®10 and drying temperature on the process yield through a factorial planning, as well as to characterize the final product.
Beverage made from babassu nut kernels and grape fruit: physicochemical properties and sensory acceptance	Silva et al. (2021)	The objective was to develop a vegetable milk of babassu flavored with grapefruit. Four mixed beverage formulations containing 15%, 25%, 35% and 45% grapefruit were produced. PH, titratable acidity, soluble solids, sugar/acid ratio and color analysis were performed, in addition to sensory evaluation by hedonic scale, almost certain scale and purchase intention.

Source: prepared by the authors based on Carneiro et al. (2014), Fioroto, Nascimento, & Oliveira (2015), Fronza et al. (2020), Gioielli et al. (1998), Oliveira et al. (2019), Santana et al. (2013), Santana et al. (2017) and Silva et al. (2021)

Since babassu coconut milk is composed of high content of fatty acids and low molecular weight sugars, its powder form presents low glass transition temperature. This can lead to dust being adhering to the dryer wall and difficult handling, making storage and use substantially more difficult. To overcome these problems, it is necessary to use an encapsulating agent with high molecular weight during spraying, such as arabic gum, to increase the glass transition temperature of the product preventing adhesion and reducing the hygroscopicity of the powder (Santana et al., 2013).

The results obtained in the study pointed to high quality powders with low moisture content, hygroscopicity and lipid oxidation and can be produced by spray drying. In addition, the products that are obtained can be used as new and economical food sources of natural aromas in the production of beverages, dry mixtures, desserts and other products (Santana et al., 2013).

Following, as noted in Chart 2, the article "*Stability of babassu nut milk pasteurized and storage under refrigeration" did* not work with drying processes to obtain powdered food, or to address this topic. In this work, the milks, without and with preservatives, were filled in glass bottles and pasteurized in a water bath at 90 ºC for 30 minutes, cooled to room temperature and kept under refrigeration of 5 ºC, for 60 days. The results obtained show that there was little change in the physical-chemical indicators; however, microbiologically babassu milk showed microbial growth from 30 days of storage and reaching high values, above the microbiological standards established by the current norms and laws, after 60 days of storage (Carneiro et al., 2014).

The work entitled "*In Vitro Evaluation of Cu, Fe, and Zn Bioaccessibility in the Presence of Babassu Mesocarp*" presented in Chart 2 was found in the databases of journals having as one of its areas of classification that of Food Technology, but was the only one that did not develop the research analyzing the plant extract (liquid or powder) as the other. Its analysis was to know the composition of the mesocarp, which is widely used as a dietary supplement, as well as to identify its effect on the bioaccessibility of nutrients using this part of the fruit as a supplement in whole milk powder (of animal origin) and alkaline lignin powder (Fioroto, Nascimento, & Oliveira, 2015).

"*Spray drying of babassu coconut milk using different carrier agents", is* a publication with basically the same authors present in the previous study that addressed the microencapsulation of babassu coconut

milk. They sought to improve, in this work, the spray drying of babassu coconut milk through the use of Maltodextrin 10DE and modified starch as carrier agents, aiming to evaluate the influence of the concentration of these agents and the initial temperature on spray drying performance in addition to the powder properties (Santana et al., 2017).

It is important to highlight that the production of babassu coconut milk powder is not possible without the addition of these carrier agents that are able to modify the physical properties of the product, because coconut milk has in the composition high concentration of low molecular weight fatty acids with melting point around 23 to 25 °C (Hagenmaier, 1983; Hassan, 1985).

The end of the work determined that for the formulation with maltodextrin is recommended an inlet air temperature of 188 ºC and a concentration of 25%, and for modified starch, 170 ºC and 20%, respectively, as conditions to optimize the drying process by spraying babassu coconut milk in relation to lipid oxidation and yield. It was also considered that the powder formulated with modified starch presented a higher yield when compared with maltodextrin, i.e., 41.51% and 30.78% respectively. Moisture content, water activity and lipid oxidation were lower for the powder formulated with maltodextrin. However, the modified starch composition showed a shorter wettability time compared to the powder formulated with maltodextrin, but despite this, babassu coconut powder milk had few reconstitution properties. It is also worth mentioning that the properties of the powder and the performance of the dryer should be considered simultaneously to evaluate the spray drying process (Santana et al., 2017).

The article "*Production and physicochemical characterization of coconut "milk" and microcapsules of babassu coconut almond*" sought to extract the vegetable extract (milk) from babassu, produce microcapsules of this extract and perform a physicochemical characterization of babassu almond, babassu milk and pie obtained from milk extraction. Their findings demonstrated the following characteristics for milk: moisture (76.77%), proteins (2.19%) and lipids (34.42%). In addition, they obtained microcapsules of babassu's milk satisfactorily, being indicated by the authors for flavor aggregation, harmonization of several dishes, as well as protein enrichment (Oliveira et al., 2019).

The penultimate article, called "*Microencapsulation of hydrosoluble extract of babassu nut press cake*" obtained the powder extract from the pressed babassu almond pie and verified the influence of different maltogill®10 concentrations and drying temperature on process yield. The experimental design showed significant influence ($p<0.05$) for the input temperature variables in the linear and quadratic models, focusing only on the linear term and the interaction between them, the model adjusted in the planning was considered predictive; the best yield obtained (80.37%) was for the temperature of 95°C with encapsulating agent in concentration of 18%. Regarding the analysis of the powdered product, low values of hygroscopicity, density, humidity, solubility and water activity were observed (Fronza et al., 2020).

Finally, the researchers of the work "*Beverage made from babassu nut kernels and grapefruit: physicochemical properties and sensory acceptance*" developed a vegetable babassu milk flavored with grapefruit and performed the sensory evaluation of its formulations. The pH values of mixed beverages

decreased ($p<0.05$) when grapefruit concentration increased, while titratable acidity and soluble solids increased ($p<0.05$). The addition of grapefruit provided the product with greater opacity and redness, having good consumer acceptance. For the hedonic scale, the formulations with concentrates of 35% and 45% of grapefruit contributed to the greater acceptance of the attributes color, appearance, flavor and general taste. These same concentrates were also preferred for the purchase intention of most consumers (Silva et al., 2021).

Studies show that babassu is an alternative to vegetable milk, despite being little used industrially and having parts wasted in production processes. However, in order to be inserted in the market it is necessary to apply technologies capable of meeting the challenges of its formulations. In addition, it was observed that resorting to powder fabrications ensure a greater durability of the product. Thus, babassu derivatives have great potential as substitutes for food, being indicated mainly for people with lactose intolerance and/or casein allergy.

4 FINAL CONSIDERATIONS

The prospective study showed that 46 patents were found, but only with 2 cases filed among the databases, which were listed in subclass A23L of the International Patent Classification (food products or non-alcoholic beverages, their preparation or treatment), but none were related to the production of vegetable milk or to the application of a polymer in the process. Among the articles related to the descriptors, the analysis made after screening and exclusion of repetitions showed that even though patent records about the elaboration of the hydrosoluble plant extract in powder were not found based on the use of babassu almonds, there are studies that have already addressed this theme, especially bringing to the fore the use of polymers in their methodologies.

With the completion of the analyses on the selected articles, it was observed that although there are some publications that work with the drying process by spraying the vegetable extract (milk) of babassu coconut and that in cases there is the use of polymers (which are maltodextrin, modified starch and arabic gum), the studies found are still few and mostly recent, in addition to no research has been found with the application of cyclodextrins, carboxymethylcellulose or xanthan gum, which allows many innovations on the production of hydrosoluble plant extract in babassu coconut powder with these substances. Moreover, as previously seen in patent research, no requests for protection were found in any of the databases researched about similar methodologies or considering the search correlating with one of the polymers, which allows to make room for studies as promising materials if correctly combined in the formulation of water-soluble plant extracts in babassu coconut powder.

Finally, it is also emphasized the possibility that future research is carried out with the purpose of developing new formulations of babassu-based products in the use of polymeric materials to be adopted withstabilizers.

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