

TECHNOLOGICAL FORECASTING OF OBTAINING OF COCONUT WATER ALCOHOLIC FERMENTED BEVERAGE

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Abstract— Coconut water from *Cocos nucifera* is a food that has many health benefits, resulting in a significant increase in fruit demand. In order to add value to the fruit, the present work proposes a technological forecasting of coconut water alcoholic fermentation ("coconut water wine"). The research was carried out through the search of scientific articles, theses and patents related to the subject in the databases of Scielo and CAPES and in the INPI, Espacenet and WIPO banks. Most of the search results have been found on international platforms. Although Brazil is the largest producer of coconut water in the world, the results have shown little research with fermented alcoholic products. These data may represent a driving force in the search for new products and processes that value the coconut culture in Brazil.

Keywords— coconut water. alcoholic fermented. *Cocos nucifera*.

1 INTRODUCTION

Coconut is the fruit from the *Cocos nucifera* L. plant, known as the "Tree of Life" (OHLER, 1984) due to its multiple uses and the fact that it is fully usable except for its root. Coming from the *Arecaceae* family (palm family), its length can reach up to 35 m. It is easily adaptable to adverse weather and soil conditions, well resisting long dry spells and growing satisfactorily in regions of poor and saline soils (FERREIRA, 2007).

According to data from the Food and Agriculture Organization of the United Nations (FAO) (2016), Brazil occupies the fourth position in the world ranking of coconut production with an amount of approximately 2.65 million tons produced per year. According to the Brazilian Institute of Geography and Statistics (IBGE), the territorial area intended for planting and harvesting the product exceeds 200,000 hectares annually (IBGE, 2018).

Additionally, Brazil is the world leader in the marketing of coconut water in long-life packaging, regardless of the marketing of the product "in natura" (EUROMONITOR, 2011). Brazilian coconut water exports reached about US \$ 4.5 million and 4.3 million kilograms in 2018, with Ceará accounting for 97% of sales destined mostly to the United States. These numbers correspond to a financial amount 20 times greater and a quantity of coconuts 59 times higher compared to indicators of imports of the product in the same month, what shows the good acceptance of coconut water in the market (SINDCOCO, 2018).

in order to diversify the use of this nationally produced fruit and add more value to it, it is possible to use it to produce alcoholic fermented from coconut water. The alcoholic beverage industry is an important sector of the manufacturing industry, having achieved revenues of R \$ 127.7 billion in 2018, which is equivalent to 1.9% of annual Brazilian GNP (ABIA, 2018).

In this context, the present work aims to evaluate the theme about coconut water and alcoholic fermented in the academic and patent scope through the study of prospecting in consolidated databases. From the analysis of the information obtained, it will be possible to verify the indications that the alcoholic fermented coconut water production sector is really promising with positive impacts on the economy, the environment and society.

2 THEORIES

2.1. COCONUT WATER

Coconut water comprises a liquid from the endosperm of the coconut fruit (*C. nucifera*). It is a natural solution containing mineral salts, sugars, essential amino acids and has low caloric value, so it is considered a food with several benefits (CARVALHO et al, 2006). Due to this, there is a significant increase in demand for coconut water, which can also be attributed to a growth in per capita income of the population combined with healthier living habits (CUENCA, 2016; ALMEIDA et al, 2018).

Decree Law No. 6,871 of June 4, 2009, defines coconut water as the unfermented, undiluted beverage obtained from the liquid part of the coconut fruit, by means of an appropriate technological process, and can be found as chilled, pasteurized, frozen, sterilized, concentrated, dehydrated according to Normative Instruction No. 27 of July 22, 2009 (BRAZIL, 2009).

Water begins to form in the central cavity of the fruit from the second month after the natural opening of its inflorescence and reaches its maximum volume around the sixth and seventh month of ripeness, reaching up to 500 mL or more depending on the crop. During this period, it is sweeter due to a higher amount of sugars, which reflects a higher brix degree. This volume is kept constant for one or two months and, due to evaporation and absorption by the solid albumen that forms during ripening, decreases thereafter until the final maturation of the fruit (approximately 1 year), when it reaches 100 ml to 150 ml (ARAGÃO et al, 2001). The physical chemical characterization of coconut water can be observed in Table 1.

TABLE 1
Physicochemical characterization of 7 months old green dwarf coconut water.

sucrose (mg/100mL)	280
glucose (mg/100mL)	2378
fructose (mg/100mL)	2400
P (mg/100g)	7.40
Ca (mg/100g)	17.10
Na (mg/100g)	7.05
Mg (mg/100g)	4.77
Mn (mg/100g)	0.52
Fe (mg/100g)	0.04
K (mg/100g)	156.86
Acidity (% v/p)	1.11
pH	4.91
total solids (g/100g)	5.84
Brix	5.00
Vitamin C (mg/100mL)	1.2
total glycidis (g/100g)	3.46
protein (mg/100g)	370
caloric value (Cal/100g)	27.51

Source: Rosa & Abreu, 2000.

The coconut tree was introduced in Brazil in the mid-1950s in Bahia, it was also called coco-da-baía, being initially expanded along the northeastern coast, where are some of the main national producers, Bahia, Ceará and Sergipe. Since it is a typical fruit of tropical climate, it found in this region favorable conditions for its cultivation. Subsequently, it was disseminated throughout most of the country, except for the states of Amapá, Santa Catarina and Rio Grande do Sul (ARAGÃO et al, 2009; MARTINS et al, 2014; BRAINER, 2017).

Among the main varieties of coconut found in Brazil, we highlight Typica (giant var.) And Nana (Dwarf var.). The first is characterized by semi-extracting forms of exploitation, low productivity and production is mainly intended for dry coconut. The second, the green dwarf variety, was responsible for adapting the crop in nontraditional areas such as the northeastern semiarid and southeast, midwest, north and south. It uses technology-intensive production systems and irrigation techniques that generate high productivity, mainly intended for coconut water production (ALMEIDA et al, 2018; BRAINER, 2017).

Although coconut water is the most abundant component of the coconut production chain, other derivatives are also relevant, with copra, coconut oil, coconut milk and flour being the most widely used products in the food, cosmetics, soaps and detergents industries, etc. These factors contribute to the development of the national agricultural economy, generating jobs and adding value to the product after harvest. These characteristics have multiplier effects on other links in the coconut production chain such as agricultural supplement industries, processing industries, transportation and logistics, retail, marketing, etc. In addition, it results in increased use of dwarf coconut, promoting direct impact on the generation of business opportunities and consequent appreciation of this market niche (CUENCA, 2016; ALMEIDA et al, 2018).

2.2 FERMENTED BEVERAGES

According to the Ministry of Agriculture, Livestock and Supply, fruit fermented is the beverage with an alcoholic strength of 4 to 14% by volume at 20 ° C, obtained from the alcoholic fermentation of healthy, fresh and ripe fruit must (BRAZIL, 2009). Alcoholic fermentation is a process that results from the transformation of ethanol-soluble sugars using yeasts, most notably *Saccharomyces cerevisiae* (GAVA, 1984). In theory, any fruit or vegetable containing enough moisture, sugar and nutrients for yeast can be used as a raw material to produce fermented alcoholic beverages (MARTINELLI FILHO, 1983).

Fermented fruit drinks are products with considerable acceptance in consumer research and contribute to the reduction of postharvest losses of perishable fruits (SANDHU and JOSHI, 1995). The elaboration of these beverages is one of the oldest processes that accompany civilization, being started with the production of wine and beer for thousands of years (Venturini, 2010). There is a lot of interest about obtaining wines from various fruits, but few studies are found on the production of alcoholic fermented from coconut water (CUARTO E MAGSINO, 2017).

In this context, it is possible to find in the literature studies on alcoholic fermented fruits such as jackfruit (ASSIS NETO et al, 2010), umbu (SILVA, 2017), orange (ARCARI et al, 2013), strawberry (ANDRADE et al, 2013), mandacaru (ALMEIDA et al, 2011), acerola (SEGTOEWICK et al, 2013), among others. Regarding coconut, Idise (2011) obtained a natural alcoholic fermented from coconut milk with different concentrations of sugar and bread yeast. Cuarto & Magsino (2017) fermented pasteurized coconut water with the addition of ginger and lemongrass after product aging. On the other hand, Soares et al (2013) made the elaboration and sensory analysis of an alcoholic fermented beverage from a solution of coconut water, sodium bisulfite and sucrose. Zhang et al (2018) studied the improvement of the matured coconut water's quality by low alcoholic fermentation with *Saccharomyces cerevisiae*. Shanika & Wansapala (2018) made the optimization of a submerged batch fermented coconut water vinegar production process. In addition, Bitencourt et al (2018) performed a chemical physical characterization of an alcoholic fermented coconut water through a yeast strain isolated from a cachaça's farm in Minas Gerais.

3 METHODOLOGY

The present technological forecasting was carried out in December 2018, through the investigation of patents, theses and scientific articles about alcoholic fermented coconut water in free databases.

The journals of Scientific Electronic Library Online (SciELO) and CAPES were used to search for articles and theses. Patents were mapped in the database of the National Institute of Industrial Property (INPI) of Brazil, European Patent Office (Espacenet) and the World Intellectual Property Organization (WIPO).

The strategy adopted for searching the databases mentioned was the use of the “Advanced Search” mode and the “and” Boolean operator. The combinations of the keywords, terms and phrases “fermented and beverage”, “coconut and wine”, “coconut water and wine”, “coconut and fermentation”, “coconut and beverage”, “coconut and alcoholic beverage”, “coconut water and fermented beverage” and “fermented drink” were considered in the search.

The terms and expressions chosen for the search were used in Portuguese for the national databases and in English for the other platforms.

4 DISCUSSION AND RESULTS

4.1 ARTICLES AND THESES

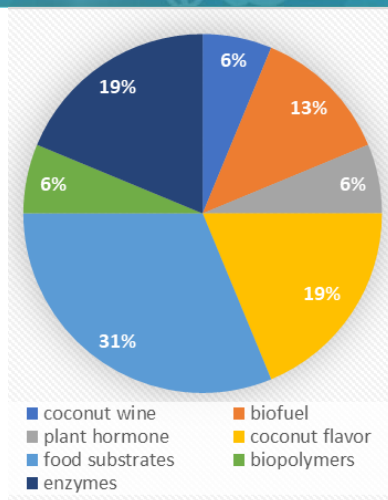
Table 2 presents the data obtained from searches of scientific articles and theses, totaling 38,637 files according to the keywords used in the research. The number of articles and theses decreases with increasing specificity of keywords, demonstrating more specific results related to the topic of interest. 99.7% of the total obtained were found in CAPES Journals, while the Scielo platform presented less than 1% of the data. This result corroborates the reality of each of these databases. The CAPES database has access to more than 45,000 journals distributed worldwide, while Scielo has a database mainly focused on Latin American and Caribbean journals.

TABLE 2
NUMBER OF ARTICLES AND THESES BY KEYWORDS IN ANALYZED DATABASES.

Number	Keywords	CAPES	Scielo	Total
1	<i>Fermented and beverage</i>	10,954	70	11,024
2	<i>Coconut and wine</i>	10,261	1	10,262
3	<i>Coconut water and wine</i>	6,088	1	6,089
4	<i>Coconut and fermentation</i>	5,133	16	5,149
5	<i>Coconut and beverage</i>	4,660	8	4,668
6	<i>Coconut and alcoholic and beverage</i>	805	2	807
7	<i>Coconut water and fermented beverage</i>	638	0	638
Total		38,539	98	38,637

From the analysis of the data found in the Scielo bank using the keyword coconut in combination with the other keywords, it was found that the most part of the studies are related to the production of food substrates, followed by coconut flavor production. and enzymes. Only one article on this platform is related to the use of coconut water to produce alcohol (“wine”), representing 6% of the total found, as shown in Figure 1.

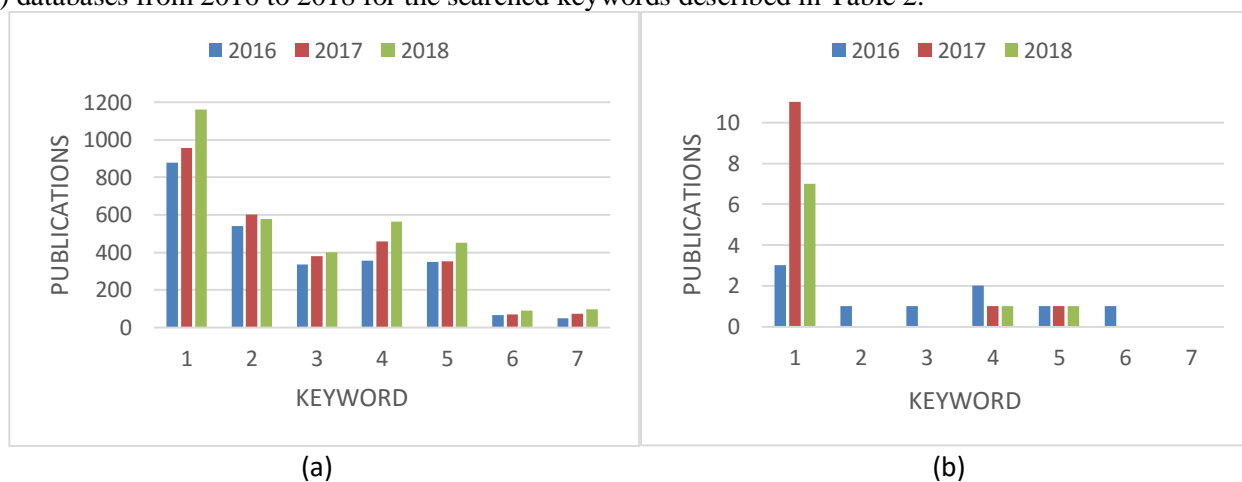
Figure 1. Percentage distribution of articles and theses related to coconut application areas.



By restricting searches to the years 2016 to 2018, it is possible to compare the evolution of the number of articles and thesis publications. Figure 2 presents the data of publications according to the keywords in that period in the CAPES and Scielo databases, respectively.

The results presented in Figure 2 show that there is, in general, a growing interest in the study of researched themes in the international scenario in recent years, due to the increase in the number of publications in the CAPES platform. However, in the national scenario was not observed the same behavior of publications about the researched themes, which may be related to a significant drop in research investments during this period in the country.

Figure 2. Evolution in the number of publications of articles and theses in the CAPES (a) and Scielo (b) databases from 2016 to 2018 for the searched keywords described in Table 2.



3.2. PATENTS

In Table 3, it can be seen that the research generated a total of 6,034 patents, with most of them filed in the WIPO (71%) and Spacenet (28%) databases, including a larger number of patenting countries compared to INPI (less than 0.1%) which is a national institute. The behavior observed in the search results for articles and theses was also repeated with the search for patents, and the number of patents decreased as there was an increase in the specificity of the keywords used.

TABLE 3
NUMBER OF PATENTS FOR KEYWORDS OBTAINED FROM ANALYZED DATABASES.

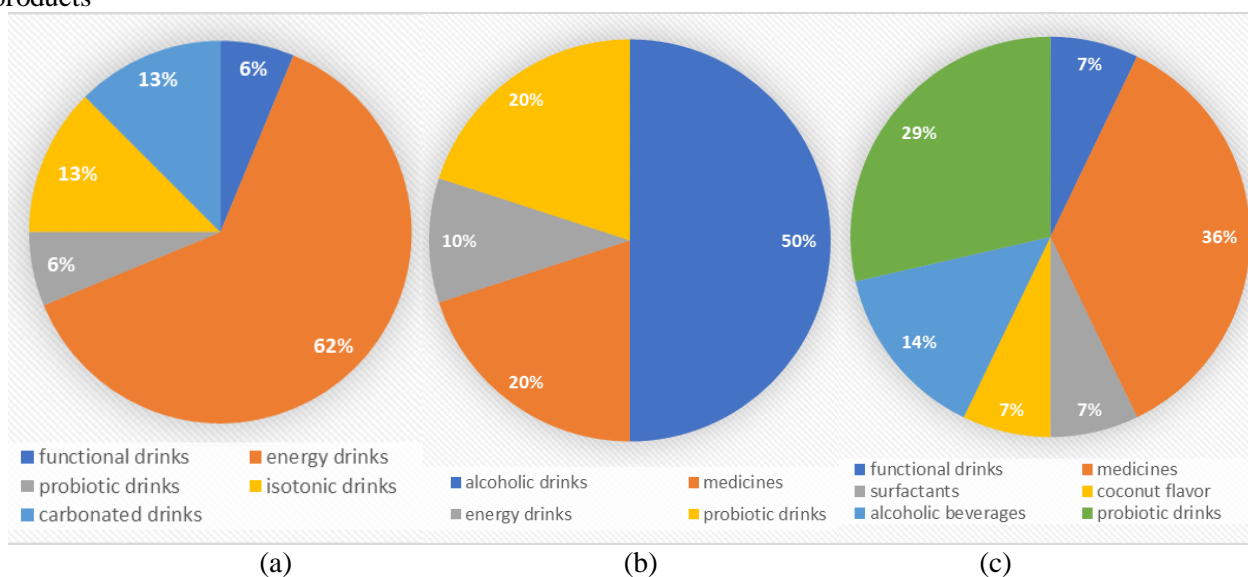
Number	Keywords	INPI	Spacenet	WIPO	Total
1	<i>Fermented and beverage</i>	30	1,514	3,218	4,762
2	<i>Coconut and wine</i>	0	58	289	347
3	<i>Coconut water and wine</i>	0	2	119	121
4	<i>Coconut and fermentation</i>	0	8	315	323
5	<i>Coconut and beverage</i>	16	121	319	456
6	<i>Coconut and alcoholic and beverage</i>	0	1	15	16
7	<i>Coconut water and fermented beverage</i>	1	0	8	9
Total		47	1,704	4,283	6,034

From a more detailed analysis of the data, it was found that the 16 national patents (filed with the INPI) corresponding to the search for coconut drinks are related to nonalcoholic beverages. Most of these are drinks with energy properties, as shown in Figure 3a.

Figure 3b shows the percentage distributions of patents filed on the Spacenet platform found from the combinations of the words “coconut water and wine”, “coconut and fermentation” and “coconut and alcoholic and beverage”, with 50% of these data related to alcoholic beverage from coconut. Among these patents, two refer to the alcoholic fermentation of coconut water through yeast. However, one of them adds cashew juice before fermentation, which gives the product a different flavor. The other patents are related to the alcoholic fermentation of pure coconut milk or added to other ingredients. Therefore, only one patent resembles the proposal of this prospect, through the alcoholic fermentation of coconut water with the addition of sugar and yeast to produce coconut “wine”.

Percentage distributions of patents hosted on the WIPO platform for fermented or alcoholic beverages are summarized in Figure 3c, where most data are for beverages with medicinal properties.

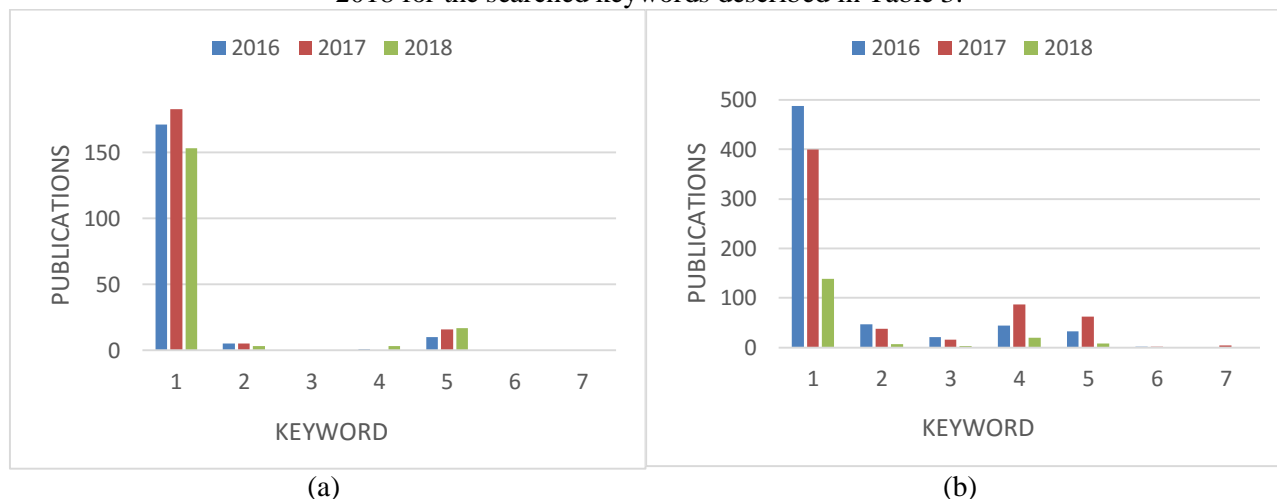
Figure 3. Percentage distribution of patents filed with INPI (a), Spacenet (b) and WIPO (c) of coconut products



By restricting patent searches from 2016 to 2018, almost no patents were filed in the INPI database for that period (less than 1% of the total). This probably indicates a low interest in the study of the alcoholic fermentation of coconut as well as in the commercialization of derivative products, when compared to the

international scenario. Figures 4a and 4b show the evolution of the number of patents in the WIPO and Spacenet databases for the selected period.

Figure 4. Evolution of the number of patents on the Spacenet (a) and WIPO (b) platform between 2016 and 2018 for the searched keywords described in Table 3.



From the analysis of Figure 4a, it is possible to notice that there was an increase in the number of patents related to fermented drinks in 2017, compared to the previous year. However, shortly thereafter, the number decreased by 10.5% compared to 2016. Regarding coconut “wine”, the picture remained practically stable, with a slight decrease in 2018. For coconut fermentation, it is possible view a slight increase in the number of patents. Searches with the other keywords used did not return results for the selected period.

Figure 4b shows that for searches with the keywords “fermented and beverage”, “coconut wine”, “coconut water and wine” and “coconut and alcoholic and beverage” there was a decrease in the number of patents for the three year period selected. For the search with the words “coconut water and fermented beverage”, only 2017 showed results. The keywords “coconut fermentation” and “coconut beverage” filed the highest number of patents in 2017.

It is possible to notice that, in the national scenario, despite the growing number of articles and theses about the alcoholic fermentation of coconut water, there is little interest in patenting this product. Abroad, although the data presented represent a significant number of patents, these numbers have been reduced for the most recent initiatives. This factor may indicate a low industrial interest in product appreciation, or that we are facing a new product with potential to be explored.

4. CONCLUSION

This work aimed to present a study of the research scenario about obtaining fermented beverages from coconut water. From the analysis of the results obtained, it can be concluded that there is a great interest of research on the production of fermented beverages, with most articles, theses and patents on this subject being deposited in international databases. This can be explained not only by the fact that there is large investment in research and development abroad by the industrial sector, but also by the fact that international databases have a larger number of depositors than national ones.

Although Brazil is the largest producer of coconut water in the world, the results show little interest in the alcoholic fermentation of coconut water, given the low number of researches on the subject deposited at Scielo and the absence of patent for alcoholic product of this input in the state. INPI bank. This factor may be a positive point for a future attempt to patent the fermented coconut water for commercialization in the beverage sector, since the result of this technological prospect leads us to conclude that we are facing an innovative product.

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