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Use of the Endogenous Resources of the Palestine Settlement, Cravolândia-BA: The Potentials of Quixabeira (Sideroxylon obtusifolium [Humb. ex Roem. & Schult.] T.D. Penn.)

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***Abstract*— The persistence of poverty in semiarid regions resides, among other difficulties and limitations, in the inability to use its endogenous elements in a rational way. Thus, this article aimed to investigate the content of total phenolic compounds in the pulp and residues of quixaba fruits (Sideroxylon obtusifolium) in ethanol extracts and evaluate properties (pH, acidity and soluble solids) essential to the fermentation process with a view to developing products for school meals and also low-alcohol beverages capable of generating income for the local population from the use of an endogenous resource available in the legal reserve areas of the Palestine Settlement located in the municipality of Cravolândia, Bahia. In addition to documentary studies, the chemical characterization of quixaba fruits was carried out. An analysis of all parts of the quixaba fruit, in terms of total soluble solids content, pH and acidity, indicates potential for its agro-industrial processing. In addition, the high ° Brix indicates that the pulp has sugar levels that make it ideal for flavoring yogurts that can be offered at school lunches. The phenolic compounds present in different parts of the quixaba indicated a possible antioxidant potential. Even though the use of quixaba is currently neglected, it is possible to use it agro-industrially.*

I. INTRODUCTION

Of the 9,428 rural settlers managed by National Institute for Colonization and Agrarian Reform (INCRA), 2,246 are located in the northeastern semi-arid region, totaling an area of 4,665,101.25 hectares serving 116,976 families [1]. It is a territory where a high rate of insolation, high temperatures and low thermal amplitudes predominate, marked by low rainfall, irregular distribution of rain in time and space, low humidity, high evapotranspiration rate and predominance of xerophilous vegetation [2].

The Brazilian semiarid has most of its territory occupied by vegetation adapted to drought and extremely important from a biological point of view, called Caatinga [3]. According to [4], in addition to having endemic species, this biome is the center of diversification of several rare biological interactions, it has a relevant biodiversity, represented by animal, plant and microorganism species that cannot be found in other places. elsewhere on the planet.

According to [5], the Caatinga biota is currently composed of 3,150 vascular plants, 276 ants, 386 fish, 98 amphibians, 191 reptiles, 548 birds and 183 mammals. These endogenous resources constitute the greatest wealth of this biome, awaiting public policies and institutional arrangements aimed at sustainable development, compatible with the rational use of territorial elements [6].

According to the Ministry of the Environment, the biodiversity of the Caatinga supports several economic activities [7]. Despite this, it is the scene of a complex reality of exploitation and inadequate use of natural resources, being often destroyed to make way for pastures, supply bakery ovens, produce charcoal and for the implementation of various crops. In fact, this devaluation and human action has already resulted in the deforestation of 46% of its area [7] and about 500 thousand hectares of this biome are deforested per year [8].

As an aggravating factor and also a challenge, the implementation of rural settlements in semi-arid regions intensifies the exploratory pressure on the Caatinga, promoting greater use of water resources, soil and animal and plant biodiversity. The settlers, in turn, face great difficulty in structuring productive and sustainable systems in the face of social, economic and environmental conditions in the new agricultural units.

According to [9], the persistence of poverty in semi-arid regions lies in the inability to use their endogenous elements in a rational way. Thus, considering that the Caatinga bears the title of one of the richest dry forests in the world [5], the sustainable use of its biodiversity presents itself as a viable economic alternative [3].

Regarding plants with food potential, the amount of these resources in the Caatinga is much greater than, at first glance, one could imagine [10]. Despite this, several native species, especially fruit, have neglected use and are still poorly studied, even though they are known and used by local communities, they do not participate in a family chain of agro-industrialization, nor are they present in school meals and in the set of commercialized products. or produced, in order to contribute to the composition of the income of local families. An example of this is the quixabeira (*Sideroxylon obtusifolium* [Humb. ex Roem. & Schult.] T.D. Penn.), a species that grows and produces abundantly in the Caatinga region of northeastern Brazil [11] but which, despite this, has its neglected use.

Some studies have proven the anti-inflammatory, hypoglycemic and antioxidant activity in the leaves, stem and ribs of quixaba [12]; [13]; [14]. However, studies are still needed on the antioxidant activity and the content of total phenolic compounds in the pulp, peel and seed of the quixaba fruit. Dedicating attention to the study of native fruits such as quixabeira is extremely important, as it can result in the offer of new alternatives of fresh fruits for fresh consumption and also of raw material for agroindustry, constituting a precious source of food and wealth [15]; [16]; [17].

In this sense, agricultural policy for the semi-arid region, especially in agrarian reform settlements, needs to be associated with endogenous local development (DLE). This process involves the proper use and valorization of available endogenous territorial elements, and can also be understood as a means capable of promoting transformations in a community [18].

In view of the above, the present article aimed to investigate the content of total phenolic compounds in the pulp and residues of quixaba in ethanolic extracts, as well as to evaluate chemical characteristics (pH, acidity and soluble solids) essential to the fermentation process with a view to the development of products for food. school and also low-alcohol beverages capable of generating income for the local population from the use of an endogenous resource available in the legal reserve areas, collective areas and lots of the Palestine Settlement

II. MATERIALS AND METHODS

The research used documentary studies as well as theoretical support in references in the area. Documentary research was carried out mainly on the website of the Electronic System of the Citizen Information Service (e-SIC) to obtain ordinances, reports, statistical and descriptive reports from federal agencies, such as the National Institute of Colonization and Agrarian Reform (INCRA) and the portal of the Brazilian Institute of

Geography and Statistics (IBGE) will be used as a source of statistical information.

At state level, the Access to Information Law (LAI) and at the level of scope of documents with the Superintendence of Economic and Social Studies of the State of Bahia (SEI) Company for Regional Development and Action (CAR). The files of the Association of Agricultural Workers of Cravolândia (ATAC) also provide a document for analysis: the location map of the Settlement, including the lots and legal reserve areas. For [19], the main characteristic of documentary research is restricted to the source of data collection, which is restricted to written or unwritten documents, and can be collected at the time it occurs or fact or later.

Characterization of the Study Site

The study site covers the Palestine Rural Settlement, originated through an expropriation action (for social interest) of the set of lands of the former Palestine/Timbó/Salobro farms with an area of 4,327.45 hectares initially occupied by 180 families. The settlement is located in Cravolândia-BA, belongs to the Vale do Jiquiriçá Identity Territory, located mainly in the South Center of Bahia, has an area of 12,233km^2, with an estimated population of 313,678 inhabitants, representing 2.24% of the Bahian population. , with 134,176 individuals located in rural areas and 179,502 in urban areas [20]. Another predominant characteristic in that territory is the high level of land concentration and low indicators of economic and social development, aspects that interfere in the socio-spatial dynamics.

Among the 20 municipalities that make up the territory of identity, Cravolândia was the first in the region to host actions to promote access to land when the National Institute for Colonization and Agrarian Reform (INCRA) transformed a camp for landless rural workers into a rural settlement. of agrarian reform in 1999.

The city of Cravolândia borders the municipalities of Santa Inês, Itaquara and Ubaíra, has the Caatinga as the predominant biome in most of its territory, has an area of 160 km2, a population of 5,145 inhabitants, distributed in urban and rural areas [21]. Of this total, 1,148 individuals are in extreme poverty and 1,072 in total poverty. It is one of the 20 municipalities in Bahia with the lowest tax collection. It has a low human development index (HDI), of 0.599, occupying the 155th position in the HDI ranking of the state of Bahia and the 4,167th position in Brazil [20].

Chemical Characterization

The fruits of the quixabeira (*S. obtusifolium*) were collected in the legal reserve areas of the Palestine Rural Settlement (13°24'39.2"S 39°48'47.6"W), in accordance with the Regulatory Framework for Biodiversity, with registration with the SISGEN (A2085D3), in Cravolândia, a municipality belonging to the Vale do Jiquiriçá Identity Territory, in the State of Bahia.

The analyzes of total phenolic compounds and chemical characteristics of the fruits were carried out at the Microbiology Laboratory of the Instituto Federal Baiano campus Governador Mangabeira. The whole process started with the washing of the fruits in running water and sanitization using mixkill organic chlorine at 200 ppm for 15 min and rinsing at 3 ppm. The quixabas were stored at -18ºC, in a freezer, and then they were manually pulped and the seeds, husks and pulp were separated.

Acidity

The determination of acidity was carried out by weighing the samples (5g) and homogenizing them in 50 mL of distilled water. 2 to 4 drops of the phenolphthalein solution were added. Then, the samples were titrated with 0.1 N sodium hydroxide solution until the pink color changed [22].

Total Soluble Solids (°BRIX)

In order to determine the content of soluble solids existing in the pulp and residues of quixaba, direct reading was used in a model refractometer (BRASEQ) in which the samples were inserted on the surface of the prism. The procedure was as follows: With the aid of a pipette, drops of water were added over the lower prism, taking care to avoid the presence of air bubbles in the liquid, so as not to reduce the contrast of the limit line. It was waited a few minutes for the liquid to come into thermal equilibrium with the prisms. With the separation line very clear, the division between the two regions was positioned exactly at the center of the reticle and the refractive index of the sample was read [22].

Hydrogenionic Potential (PH)

In order to determine the pH of each sample studied, a pH meter (model PH21 mv meter, Hanna brand) was used under direct reading. Initially, the pH meter was calibrated with buffer solutions of 4.0 and 7.0. Then, 5 g of each sample was weighed and these were diluted in distilled water, after homogenization, a direct reading was performed [22].

Determination of the Content of Bioactive Compounds

Obtaining Ethanol Extracts

The samples of pulp, peel and seed of the quixaba in natura were initially ground in an industrial mixer until it became powder, then 5g of each sample was weighed, which were homogenized in 50mL of ethanol at 12% and 70%, stirred for 30 min on a shaker plate and protected from light. In the second step, the extracts were centrifuged at 12000 rpm for 15 min in 30 mL centrifuge tubes. The supernatant was reserved and subjected to a new centrifugation (1200 rpm for 15 min), this time using 2.0 mL eppendorfs in order to remove small particles still present in the extracts. Final extracts were used immediately. Figure 3 shows the extraction scheme.

Determination of Total Phenolic Compounds

The quantification of phenolic compounds was determined according to [23] adapted by [24]. 1mL aliquots of aqueous or ethanolic extracts were transferred to test tubes, to which were added in this sequence: 1mL of 95% ethanol solution, 5mL of distilled water and 0.5mL of 1N Folin-Ciocalteau reagent. Homogenization was carried out immediately. Then, 1mL of 5% (w/v) sodium carbonate solution was added, followed by a new homogenization. The test tubes were kept in a darkroom for 60 min, at the end of which they were once again homogenized. The samples had their absorbances measured at a wavelength of 725nm against a blank, consisting of 95% ethanol solution. For the quantification of these extracts, a calibration curve was constructed based on different concentrations of gallic acid (0.035-2.82 mg/mL), in order to convert the absorbances and express the results in terms of micrograms of gallic acid equivalent. (GAE) per gram of sample weight (µg GAE eq/g sample).

In the present study, all analyzes were performed in triplicate and the results were presented as mean±standard deviation.

III. RESULTS AND DISCUSSION

The Palestine settlement has 07 legal reserve areas in which the vegetation is preserved (Fig. 1). The largest of them has 313,802 hectares, and the smallest 27,028 hectares, totaling 908.37 hectares. In these areas, quixabeiras occur spontaneously and abundantly, the fresh consumption of the fruit is practiced by the local population, however, no type of processing is carried out to originate drinks, flour or any other product.

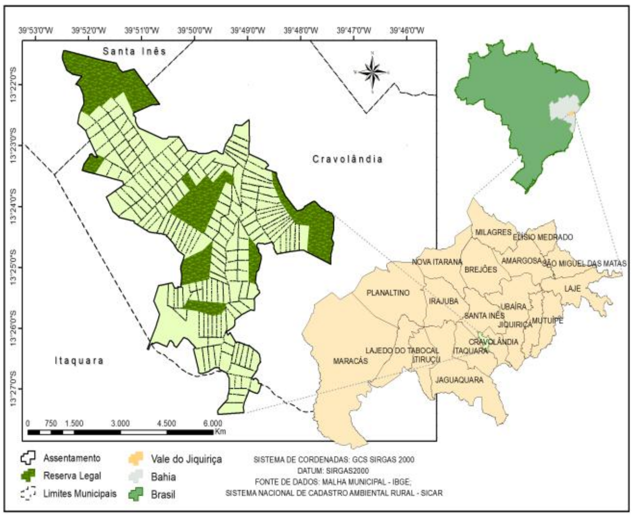

Fig.1 Cravolândia (BA): Legal reserve area in the Palestine Settlement, 2021.

The devaluation of local products was exacerbated by the Green Revolution, which encouraged the adoption of plants and seeds said to be superior and improved to the detriment of local and adapted species and cultivars, which may also explain the community's estrangement from the great value and richness of its natural environment. it has. Contradictorily, the idea still prevails that the Caatinga biome is dry, poor in diversity and with few possibilities, the opportunity to value its resources and even obtain income from their sustainable management is lost.

Studies carried out by [25] states that all territorial communities have a set of resources (economic, human, institutional and cultural) that constitute their potential for endogenous development. Therefore, it is possible to implement a public policy aimed at a form of development that bets on the existing potential in the territory, on the use of plant species from the Caatinga biome, on the rational use of land and water, on the valorization of the rural man and on the and dissemination of social technology for coexistence with the semiarid region. In this sense, it is understood that Social Technologies are “a set of transforming techniques and methodologies, developed and/or applied in the interaction with the population and appropriated by it, which represent solutions for social inclusion and improvement of living conditions” [26].

Chemical Characteristics of Quixaba

The quixaba fruits present a globular shape with a dark purple color when ripe, similar to the jabuticabeira fruits (Fig. 2). In addition, they present little variation in length, diameter and weight.

Fig. 2 – Quixaba (S.obtusifolium): Fruits

The results of the composition of the pulp and the residues (peel and seed) of the quixaba are described in Table 01. The pH is established as a quality attribute by the legislation, as it favors the conservation of the pulp, preventing microbial growth, although there is no index used as a standard for the quixaba fruit. In this study, the average pH for quixaba pulp (5.28) was similar to that found by [27] who found a pH value of around 5.4 in quixabas from Mossoró-RN and by [28], in fruits from the Barrocas site in the semiarid region of Paraíba, a value of 4.8. In residues, the values were similar to those found by [28] who showed a titratable acidity of 1.01 (% citric acid).

Table 1- Quixaba (S. obtusifolium): Results of pulp composition and bark and seed residues

AMOSTRAS	PH	AT(%)	°BRIX
Resíduo (casca+semente)	4,32±0,15	1,20±0,02	22,01±0,02
Polpa	5,28±0,01	4,13±0,11	25,02±0,01

In the evaluation of total soluble solids, mean values of 22.01 were obtained for the skin and seeds and an average of 25.02 °Brix only in quixaba pulps. In a fermentation process, the contents of soluble solids, expressed in °Brix, are 18 °Brix and 18 °Brix, consequently, implying in this smaller addition of study, the potential of verification for this purpose. Similar results were found by [29] that the Brix value for quixa pulp was 24.23°.

An analysis of all parts as parts (peel, pulp and seed), in terms of soluble solid fruit content at such, pH and agro-industrial calculations, indicates potential for its agro-industrial processing, as the high content of soluble solids (22–25 %) and pH conducive to the degradation of the substrate (4.32 – 5.28), make it suitable for application in fermentation processes. In addition, the high sugar indicates that the pulp has sugar contents that make it ideal for flavoring yogurts that naturally have a slightly sour taste. These, in turn, can be offered in school lunches via the National School Feeding Program (PNAE).

The Food Acquisition Program (PAA) and the National School Feeding Program (PNAE) are public policies that can significantly stimulate the local market, including introducing typical fruits and products from the region in school meals. In this way, the use of native plants (fruit and roots) would contribute to income generation, in addition to strengthening the local culture, which is also related to food customs.

According to [30], the mentality that favors the acquisition of local products will enable the introduction of exotic genres from the perspective of a locality. In this way, the strengthening of local markets is one of the ways to face the oligopolistic control of food [31], as well as a way to build production chains of species that, despite their great nutritional and economic potential, are neglected by the big industry.

The production and consumption of native fruits is also a strategic issue for the health and well-being of the population, as it is linked to the access and maintenance of diversity, being a form of resistance to an agri-food system lacking nutrients, controlled by powerful corporations. [32]. In addition, the conservation of the local biodiversity of the Caatinga can be encouraged from a design of production, processing and distribution of food based on the production chain of native fruits, as well as support for solidarity economy initiatives.

Among the guidelines defined by the National Education Development Fund (FNDE) for the PNAE, the first says that the agricultural vocation of the region must be respected, prioritizing raw materials and food produced and marketed in the region as a way of encouraging production place, giving preference to products of traditional consumption. The twelfth guideline mentions that the selection of foods that make up the program's menu must be consistent with the agricultural and agro-industrial vocation of the locality, with the purpose of encouraging Local Development, supporting food acquisition projects from family farming and cooperatives. of small producers [33].

The Production Cooperative of the Piemonte da Diamantina Region (COOPES), located in Capim Grosso-Ba, a semi-arid region, has been inserting products from licuri and native fruits into the PNAE. The Agricultural Production Cooperative of Giló and Region (COOPAG), from the cities of Várzea Nova and Miguel Calmon, in Bahia, also offers PNAE flavored yogurts with fruits from the Caatinga, such as licuri and umbu [34]. The Delícias do Jacuípe fruit pulp factory, located in the city of Pintadas in Bahia, is also supplied with fruits from agroforestry systems or from extractivism from the Caatinga itself, from small peasant farmers. It currently produces various pulps and meets the PNAE and PAA with the offer of its products [35]. These initiatives first show that the non-timber territorial resources of the Caatinga have the potential to be used as instruments to promote DLE.

Another initiative is that of the Cooperativa Agropecuária Familiar de Canudos, Uauá and Curaçá (COOPERCUC) which benefits native fruits of the Caatinga with strong socioeconomic potential, but until then, little valued, such as umbu (Spondias tuberosa) and passion fruit (Passiflora cincinnata). This self-managed cooperative encourages members to feel a sense of belonging, uses social technologies to harmoniously develop strategies that make it possible to face difficulties related to water deficit, as well as link economic performance to environmental preservation. As a result, there is an endogenous local development model (DLE), in which the resources of the Caatinga, in this case the fruits, instead of being placed in the hands of middlemen, are benefited or even in natura placed in school meals via PNAE. and PAA.

Bioactive Compounds

Fig. 3 shows the steps in the process of extracting phenolic compounds from quixaba fruits using 12% and 70% ethanolic solvents, under agitation for 30 minutes in the dark and subsequent centrifugation at 1,200 rpm for 15 minutes.

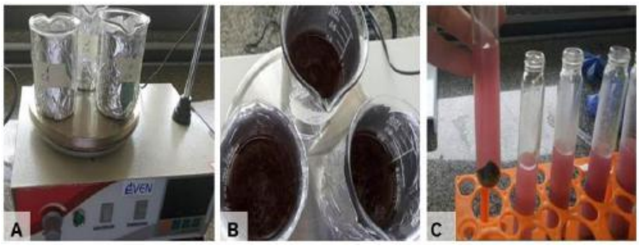

Fig. 3 – Stages of the phenolic compounds extraction process.

Table 2 indicates the content of total phenolics present in the pulp and residues (peel and seed) of quixaba in its in natura form, higher averages were obtained in residues in ethanolic extract at 70% (1222.36±0.06) and % (929.83±0.01), compared to pulps in ethanolic extract at 70% (949.67±0.02) and 12% (646.49±0.01). It was also found that lower ethanol content (12%) was efficient in the extraction process, requiring further studies on this.

Table 2 – Content of total phenolics present in the pulp and residues (peel and seed) of quixaba in its in natura form.

AMOSTRAS	EXTRATO ETANÓLICO A 12% (μG GAE* EQ/G)	EXTRATO ETANÓLICO A 70% (μG GAE* EQ/G)
Resíduo	929,83±0,01	1222,36±0,06
Polpa	646,49±0,01	949,67±0,02

Phenolic compounds, which include anthocyanins, flavonols, catechins and tannins [36] are present mainly in red to purple fruits. According to [37], the antioxidant activity of phenolic compounds is mainly due to their redox properties, so they can play an important role in the absorption and neutralization of free radicals, in addition to exhibiting a wide range of biological effects, including antioxidant, antimicrobial, anti-inflammatory and vasodilatory actions.

In non-astringent fruits, the concentration of tannins is poor, in this case, its antioxidant capacity is determined not only by tannins, but mainly by other phenolic compounds. The concentrations of other phenolic compounds are, in this sense, higher in the skin than in the pulp [38]. This corroborates the values obtained in this study for quixaba as well.

Phytochemical analysis of quixaba bark was performed by Araújo Neto (2009) [39] using the following extracts: a) crude ethanol extract; b) crude ethanol extract diluted in a methanol/water solution (2:3); c) crude ethanol extract subjected to liquid-liquid extraction with hexane (hexane fraction), chloroform (chloroform fraction) and ethyl acetate. After the study, it evidenced the presence of total phenols, tannins, flavonols, flavononols, flavonones, xanthones, catechins, steroids, triterpenoids and saponin heterosides. However, his work did not present quantifications of these compounds in the rind and/or in the quixaba fruit itself as a means of comparison for the present study.

In view of the fact that quixaba is rich in phenolic compounds, an important class of antioxidants of interest to the food industry, it is evident the need to deepen studies capable of identifying and quantifying individually the phenolic compounds with antioxidant potential, as well as applications of the referred to fruit in the preparation of dairy and fermented beverages, jellies, peel flour intended for bakery products, product flavoring, extraction of food pigments, among others. Such studies must take place in order to be supported by the social, economic and environmental tripod, valuing popular knowledge and territorial elements and using them as allies to achieve social well-being, environmental sustainability and local endogenous development.

IV. CONCLUSION

Even though the use of quixaba is currently neglected in the Palestine Settlement in Cravolândia-Bahia, the present research demonstrates that the fruit has agro-industrial potential. Quixaba can be applied in fermentation processes, flavoring of dairy drinks and has antioxidant potential even at low ethanol concentration. The recognition and use of endogenous elements, such as the quixaba species, is a fundamental step in the search for strategies that enable local development. Faced with the process of globalization of markets, the valorization of local products, giving them a territorial identity, can guarantee the success of the family farmer. As well as the quixaba, the Palestine Settlement has, in its 908.37 hectares of legal reserve, several species that can also be used to generate and supplement income, which requires, above all, works of an extensionist nature built together with the members community, valuing their knowledge. In addition, technological practices are needed that allow the use of endogenous resources for the development of new products.

Therefore, we consider that we have achieved the objective of investigating the content of total phenolic compounds in the pulp and residues of quixaba in ethanolic extracts, as well as evaluating chemical characteristics (pH, acidity and soluble solids) essential to the fermentation process, with a view to the development of products for school meals and low-alcohol beverages, capable of generating income for the local population from the use of an endogenous resource available in the legal reserve areas, collective areas and lots of the Palestine Settlement in Cravolândia, Bahia.

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