AMBIENTE & SOCIEDADE 25 anos años years

Discarding and final destination of açaí in the Oriental Amazon - Brazil

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Abstract: The intensification of the production of açaí (Euterpe oleracea Mart.) and the increase in consumption resulted in the generation of significant amounts of waste that require an adequate final destination. The objective of the research was to evaluate how occurs the discarding and final disposal of açaí lumps processed in Macapá and Santana counties-AP. Thus, semi-structured forms were applied to 212 artisanal açaí beaters (151 in Macapá and 61 in Santana). Information on the disposal and destination of seeds from the açaí mixers were spatialized using the ArcGis software. The results showed that the form of discarding of processed açaí lumps and their final destination are not determined by the size of the açaí-processing shops. However, final disposal was influenced by the higher estimated profit ($p<0.05$). Most of the disposal and destination are inadequate (53%) and still depend on specific management and legislation that result in environmentally sustainable alternatives.

Keywords: Artisanal açaí-processing; Solid wastes; Amapá; Sustainability.

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São Paulo. Vol. 25, 2022

Original Article

DOI: http://dx.doi.org/10.1590/1809-4422asoc2020138r2vu2022L2OA

Introduction

The açaí palm (Euterpe oleracea Mart.) is native to the floodplains of central and South America and is cultivated in Brazil for its berries, which are considered to be a 'superfood' (SATO et al., 2020). Açaí palms can be found as simple component of native forests, or as natural massifs, in the entire Amazon estuary region (AGUIAR et al., 2018; CARVALHO; NASCIMENTO, 2018).

Açaí fruits are sessile, drupaceous, spherical, and present black-purple color at the ripe stage (NOGUEIRA et al., 2015; MARINHO et al., 2018). Açaí stands out for its nutritional value; it is rich in lipids, proteins, fibers and anthocyanins (CEDRIM et al., 2018; PALA et al., 2018); and plays an important socioeconomic-environmental role in producing regions (GASPARINI et al., 2015; NOGUEIRA et al., 2015).

The açaí lump, which corresponds to the endocarp and almond of the fruit, is a byproduct of the açaí production chain (CEDRIM et al., 2018). It is a rich organic material (ERLACHER et al., 2016) that has aroused the interest of many national and international scientists and institutions from different fields due to its peculiarities, with emphasis to its use and waste energy reuse.

In Amapá State the production of the açaí fruit reached 27 thousand tons in 2017. But the total produced in the region, considering the municipalities around and Pará State (the largest Brazilian producer), this production was 57 thousand tons (IBGE, 2017; BEZERRA, 2018; D'ARACE et al., 2019). Its economic importance has been considerable for forest conservation and represents a significant potential for improving the socioeconomic patterns of the local population. The local productive arrangement (LPA) of the açaí is the most important agrarian-based system in the state of Amapá, presenting a gross present value (GPV) of more than R$ 500 thousand, generating a currency of more than USD $ 10 million per year which can be optimized with appropriate public policies (CARVALHO et al., 2017; D'ARACE et al., 2019).

Waste generation is associated with input misuse, with losses between production and consumption, and with materials generated along the agro-industrial chain, whose economic value is not yet defined or evident (BARBOSA NETO et al., 2015; RENDEIRO; NOGUEIRA, 2008; RENDEIRO et al., 2008). However, wastes must have environmentally appropriate destination, which may lie on processes such as recycling, composting, recovery, energy use, among others, in order to avoid damages, or risks, to public health and safety; and to minimize adverse, or unknown, environmental impacts (BRASIL, 2010).

Lumps resulting from açaí pulping processes are often treated as urban wastes by processing shops and public authorities, fact that hinders the collection of such waste (ALMEIDA et al., 2017). The problem emerges when açaí lumps are dumped on public roads near the shops, used as landfilling material in construction sites or simply discarded in dumpsites (BARRETO; BORGES, 2018; PADILHA et al., 2006; BARBOSA NETO et al., 2015).

The need of improving the waste management process is based on Law 12305/10

(BRASIL, 2010); thus, the non-generation, reduction, reuse, recycling, treatment and, finally, the environmentally appropriate disposal of solid wastes are part of a public sectorial policy that should be shared among different social actors such as government, market and society, to enable a sustainable development. This natural resource has proved to be a relevant biomass used for energy production purposes, with emphasis to the economic and socio-environmental potential and benefits arising from its reuse (ALMEIDA et al., 2017; BARBOSA NETO et al., 2015). For instance, its core constitutes about 83% of the fruit and is an organic material rich in carbon (about 48% by weight) (MARINS et al., 2014).

Menezes et al. (2008) and Lima Júnior (2007) characterized the açaí as a fruit that has a single seed, surrounded by a fibrous tissue and covered by a layer of thin and dry pulp, but slightly oily, globose, measuring from 1.1 to 1.5 cm in diameter. The seed fibers are fixed around the seed of the açaí fruit after the juice is processed, as they are located in the fruit's mesocarp, exactly where the pulp is located. The açaí lumps are, therefore, a by-product of the extraction of açaí juice or pulp.

The açaí lump is considered to have a slow decomposition, due to its high lignin content, when compared to other plant materials such as leaves. The açaí seed, devoid of epicarp and part of the mesocarp, is formed by an embryonic axis and abundant endospermatic tissue, which represents 73 to 90% of the total fruit mass (VILLACHICA, 1996; MARTINS et al., 2009). As it is more difficult to decompose, compared to materials richer in nitrogen, such as cattle manure and biosolids, it is a structuring material to be used in the production of organic fertilizer as it is a source of carbon during the entire decomposition process. Therefore, the açaí lump is an organic residue rich in carbon and of low environmental impact (ERLACHER et al., 2016; YUYAMA et al., 2011) and has been arousing interest from many national and foreign institutions and institutions from different areas (SCHIEBER et al., 2001).

Disposal is defined as the action of, or result from, discarding. The meaning adopted in the current study regards the act of removing açaí lumps from processing shops. The destination (treatment or final disposal) given to açaí lumps must comply with the classic concept of solid waste management hierarchy, according to the Law 12305/10 (BRASIL, 2010), which encompasses waste generation stages such as prevention, minimization, reuse, recycling, treatment and disposal (in this order of priority).

For instance, pulped açaí lumps can be used as follows: seedlings production, coal, fuels and raw materials for the automobile and ethanol industry, fertilizers, bran and, compost (PAES-DE-SOUZA et al., 2011) and even in the civil construction after burning and combination with clay material. That is, research results in the area of materials showed that levels of the order of 15% ash from the açaí lump to 1050 °C, in association with clayey mass for the manufacture of structural ceramics, improved the physical and mechanical properties of the samples (MARINS et al., 2014).

The NBR 10.004 (ABNT, 2004) considers the açaí seed as a compostable waste because it is classified as Class IIA (Non-inert - which do not fit in the waste classifications), Biodegradable and Easily Degradable Waste (EDW) (remains of food, kitchen waste, leaves, grass, fruit peels, dead animals and excreta). Besides that, the inadequate disposal of açaí residues added to other dumping causes the eutrophication process, which is the excess of nutrients and the reduction of dissolved oxygen in water (BOD), which causes various environmental impacts such as the death and consequent decomposition of many organisms, decreasing water quality and eventually profoundly altering the ecosystem (MARANHÃO; PAIVA, 2021).

In experiments carried out with composted açaí kernels (a method of aerobic decomposition of organic materials), it is common to use around 70%, combining it with urban organic waste (30 to 35%) and grass and leaves, as it was performed by Teixeira et al. (2004) for considering the need for structuring and durable material until the end of composting.

The açaí seed can be used for multiple purposes such as energy, organic compost, briquettes, handicrafts and animal feed (REIS et al., 2002; RODRIGUES et al., 2002; TEIXEIRA et al., 2004). The use of seeds as a raw material for energy purposes is a great advance in the environmental issue, because generally this environmental liability is destined to organic fertilizer and filling gardening pots.

The caloric value of the açaí kernel is considered high (4,500 kcal/kg) (MARTINS et al., 2009). Such characteristics make the lumps of açaí an energy efficient and potentially profitable input. The high basic density is also an advantageous feature of açaí waste in the context of bioenergy (BUFALINO et al., 2018).

Despite several studies on the excellent physical, chemical and biological properties of açaí products (MAGALHÃES, et al., 2020), there are very few studies that care or analyze how the disposal of açaí stone occurs as well as what are the final destinations (SATO et al., 2020).

The waste açaí fiber and seeds obtained after fruit processing pose a challenge since they remain unutilized despite being an abundant waste by-product of açaí processing. This leads to a build-up of waste, irregular dumping and environmental management challenges (SATO et al., 2020). Therefore, studies have addressed the reuse of açaí lumps in activities such as fertilizer production, oxidant extraction, enzymatic substrates and, energy generation (LIMA et al., 2016; RODRIGUES et al., 2017).

Other potential use of açaí seeds is as an alternative ingredient in the feed of slow-growth broilers, representing a viable alternative for broiler production, with potential for reduction of the negative impacts generated by açaí residue in the environment (ARRUDA et al., 2018).

Açaí residual biomass can be a potential source for a wide range of applications, especially biotechnological, such as solid-state fermentation processes and production of fermentable sugars (mannose), such as raw material for food, pharmaceutical, and other industries (DE LIMA et al., 2019). The açaí fibers could be a potentially useful raw material for the production of medium density homogeneous particleboards and consequent commercial use in the construction and furniture industries (MESQUITA et al., 2018).

Besides that, in addition to the problem of uncontrolled final destination of the açaí lump, which causes serious environmental problems, it is important to note that the organic content of the kernel itself is a treasure in itself, because it has an impressive pharmacological value that could be better exploited economically, instead of being dumped into the environment, causing collateral pollution effects. For instance, research for literature and patent technological prospecting has been performed on the use of palm tree, included lumps, to treat and prevent diseases as well as to prepare pharmaceutical formulations (MAGALHÃES et al., 2020).

In other words, the açaí lump has multiple alternatives for use. And even when it cannot be rationally used in the production of energy, organic fertilizer, composition of ceramic material (ashes), etc, it is potentially being wasted when not a noble alternative is presented for its use. In these cases, there is a triple waste: 1) its non-use for more noble purposes, 2) its non-rational use – landfill or similar, 3) its complete waste polluting the environment.

Our research addresses only two knowledge gaps, given that both the disposal and the final destination of the lumps are eminently little studied and unknown in the literature and has become a serious environmental problem for many cities in the Amazon, especially in two capitals of Amapá State, Macapá and Santana. Our main hypothesis is that the largest fraction of açaí lumps (quantity) is discarded and collected by payment at the production site, followed by "discarding" without specific criteria. On the one hand, if the collection of the lumps is paid, to avoid legal problems, it can cause significant financial impacts on the daily income of the beater, regardless of the size of the shops. On the other hand, when the collection of the lumps is not paid, these tend to be discarded randomly, but causing serious damage to the environment, being a problematic component of the açaí production chain that has not yet been solved. Specifically: 1) The form of disposal and destination of the açaí lumps adopted by the beaters is related to daily profit, as the açaí beaters with higher income dispose of the açaí lumps in the most environmentally appropriate way; 2) The açaí beaters properly dispose of the lumps for use in potteries; 3) The form of final disposal of the lumps is influenced by the size of the açaí-processing shops in urban areas, as the large ones redirect the pulped lumps to the potteries, while the small açaí-processing shops dispose of them inappropriately in vacant land, undertow or vitiated dumps.

The objectives of the research are: 1) to quantify the socioeconomic variables of the açaí beaters in the urban municipal seats of Macapá and Santana; 2) estimate the amount of fresh açaí fruit purchased and açaí kernels pulped and discarded daily; 3) check the destination of the pulped açaí lumps in the urban area of Macapá and Santana and 4) carry out a geospatial analysis of the results of the field research.

Materials and Methods

The research was carried out in the urban areas of Macapá and Santana counties, in Amapá State, Brazil. Macapá is the capital of Amapá State and its population comprises 493,634 inhabitants: 380,937 of them live in the urban area (IBGEa, 2018). Santana is the second largest county in the state and its population comprises 119,610 inhabitants:

99,094 of them live in the urban area (IBGEb, 2018).

Given the undefined sampling universe of açaí-processing shops, the option was made for adopting a species distribution model to determine the species distribution amplitude (GUILLERA-ARROITA et al., 2015), because the sample universe of açaí-processing shops is undefined. When defining the sample, the places with the highest concentration of artisanal açaí-processing shops were considered, using the Survey method, which examines a “population sample” (CENDÓN et al., 2014).

An Etrex 10 Garmin GPS, configured with DATUM WGS 1984, was used to register (geographical coordinates) every açaí-processing shop found in the field research. An integrated set of Geographic Information System software (ArcGIS) was used to spatialize information about different açaí lump discarding methods and about the final destination of it in an urban cartographic base comprising Macapá and Santana counties.

Nine hundred and one (901) açaí-processing shops, in total, were found in both counties. Based on this number, a sample comprising açaí-processing shops was calculated to assure representativeness in the study (SIEGEL; CASTELLAN, 1975) (Equation 1):

$$n = \frac{N.Z^2.p.(1-p)}{Z^2.p.(1-p) + e^2(N-1)}$$

Wherein:

n - calculated sample

N - population found (901)

Z - standardized normal variable associated with the confidence level (95%=1.96)

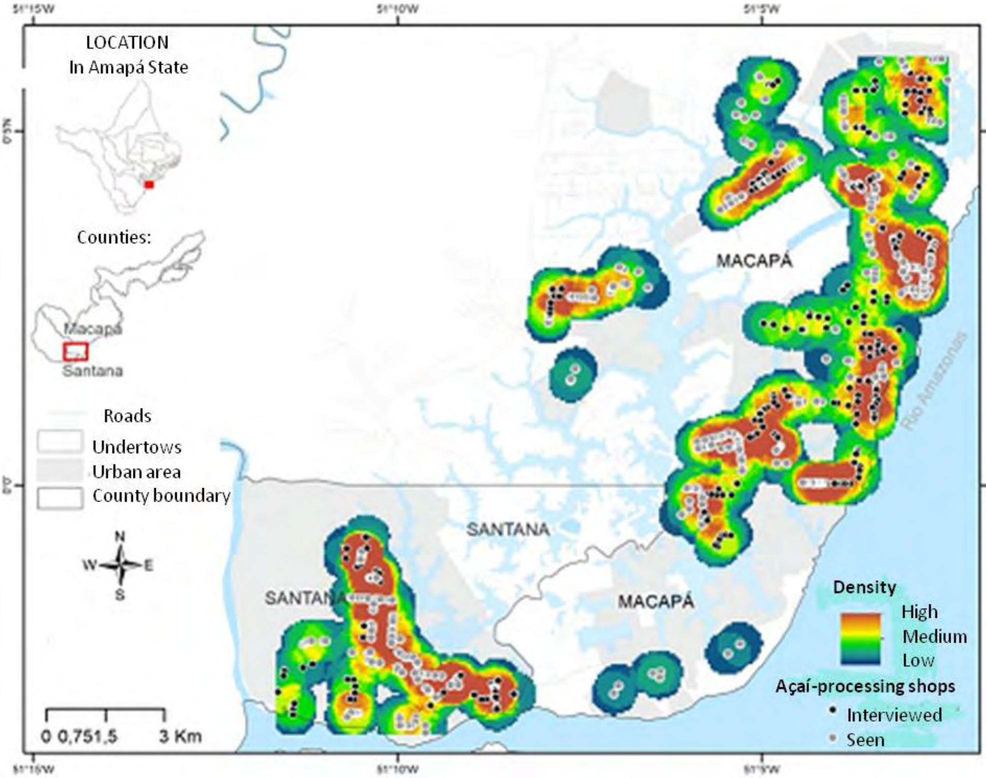
p - real likelihood of the event (0.2)

e - sampling error (5% =0.05)

One hundred and fifty-one (151) forms were applied in Macapá County from May to June 2017, whereas 61 forms were applied in Santana County from June to July 2017 (when Amapá State presented the greatest açaí fruit abundance) (D’ARACE et al., 2019). Thus, 212 forms were applied, in total. The applied form comprised open and closed questions focused on collecting information about the social (gender, age, schooling) and economic (income) aspects of açaí-processing shop workers (Table 1). The age group classification was carried out based on basic IBGE criteria. Data collection was approved by the Ethics Committee of Federal University of Amapá, under CAAE number: 63789717.3.0000.0003. The approval allowed the free participation of every individual in the research after they signed the Free and Informed Consent Term.

In geospatial terms, Macapá County presented a larger number of artisanal açaí-processing shops than Santana County. The straight line “pattern” in the location of açaí-processing shops showed that they are mostly concentrated in the busiest streets of the neighborhoods. The density of açaí-processing shops in Macapá and Santana counties (minimum distance = 6 meters; maximum distance = 280 meters) indicates clustering patterns between them they are a single block that is not restricted to the boundaries of neighborhoods, fact that reinforces the relevant role played by açaí businesses in the local market (Figure 1).

Figure 1 - Açaí-processing shop clustering points in Macapá and Santana counties



Source: the authors, 2019.

Data analysis was performed through the application of tests in the free R-project software (CRAWLEY, 2007). Statistical analysis used social and economic variables to characterize the profile of açaí-processing shop workers. Results were expressed in frequencies, which allowed presenting them in a more concise way, in order to extract more information about the sample distribution. Friedman's non-parametric multicomparison test ($\alpha<0.05$) was used to investigate significant differences between independent variables (gender, age, schooling, income, discarding and destination methods), since the premise of non-normality of data was observed.

In this study, the following variables were correlated: 1) The variable "size of açaí-processing shop" with the variable "way of disposal", Friedman's multi-comparative method confirmed that statistically the "size açaí-processing shop" is not a secondary influencing factor in the “way of disposing of the lumps”; 2) The variable “size açaí-processing shop” is a factor that complements the variable “how the lumps are disposed of” ($p < 0.05$); And 3) The “earning estimate” is an influencing factor complement the “way of disposing of lumps” ($p < 0.001$), since those who have a higher estimate of earnings use a more appropriate form of disposal, that is, “pay for the collection”.

Açaí-processing shops in Macapá and Santana counties were classified (adapted from SANTANA et al., 2014) as small-, medium- and large-sized, based on the amount of açaí fruit sacks (1 sacks = 50 kg) purchased per day throughout the most abundant period.

In this study, the amount of fresh fruit acquired and the amount of peeled seeds discarded were estimated based on information obtained from the consultation of the 212 açaí beaters surveyed. To measure the estimated purchase of in natura seed, the bag weight of 50 kg was considered, and to measure the pulped kernel estimate, the bag weight of 54 kg was considered (hydrated lumps) (Friedman test, $p<0.05$). They were weighed in the field with a manual scale.

Results and Discussion

Social and economic characteristics of artisanal açaí-processing shop workers

The social and economic profile of artisanal açaí-processing shop workers in Macapá and Santana counties showed that 77% of them were men and 23% were women (Table 1). This outcome corroborates studies that have concluded that this activity finds more representativeness among men (INSTITUTO PEABIRU, 2011).

Table 1 - Socioeconomic characteristics of artisanal açaí-processing shop workers (Groups, Numbers and Frequencies in Macapá e Santana Counties)

Characteristics	Groups	Macapá (n)	Santana (n)	Relative (%)
Gender	Male	114	50	77
	Female	37	11	23
Age Group	Young (18 to 29 years old)	46	14	28
	Adult (30 to 59 years old)	87	42	61
	Elderly (older than 60 years old)	18	5	11

Schooling	Illiterate	6	1	3
	Primary School I	27	16	20
	Primary School II	46	26	34
	High School	65	16	38
	Incomplete Higher Education	7	2	4
Relatives member working on the activity	Yes	101	25	59
	No	52	35	41
Daily Profit Estimate	≤ USD $ 30	112	57	79
	> USD $ 30 and < USD $ 61	31	4	16
	≥ USD $ 61	7	1	4

Source: the authors, 2019.

With respect to the age group of açaí-processing shop workers, 28% of them were 18-29 years old (young), and 11% were older than 60 years old (elderly) (Table 1). Youngsters start working in açaí-processing shops in functions such as utensils and açaí-processing equipment washers, attending customers at the sales counter, moisturizing açaí lumps, delivering the product at costumers' homes or discarding lumps after açaí fruits were processed (FONTES; RIBEIRO, 2012). The workforce used for the activity is familiar and is performed by adults (61%). For 68% of respondents, it is the main source of family income.

Schooling among açaí-processing shop workers was distributed as follows: 3% of them were illiterate; 20% completed primary school I (1st to 5th grade); 34% completed primary school II (6th to 9th grade), 38% completed high school and 4% were attending higher education courses (Table 1). Low schooling results were also found in similar research conducted in Manaus City (SILVA et al., 2014). The number of açaí-processing shop workers presenting low schooling level hinders the açaí production chain, since they have difficulty to understand the important role played by adequate handling procedures in assuring food security (MARTINOT et al., 2017).

Fifty-nine percent (59%) of açaí-processing shop interviewed in Macapá and Santana counties had relatives member working on the activity, whereas 41% of them had not. Having relatives working in açaí-processing shops shows the tradition of such profession, which, along with the sales point, is passed on from generation to generation. The research showed that family members remain in the activity, and this observation confirms the hypothesis that açaí production units are essentially family businesses

(SEBRAE, 2006; REYES JUNIOR; SEABRA, 2015).

Based on daily profit estimates (Table 1), 79% of the respondents in Macapá and Santana counties earn less than, or equal to, R$ 100.00 per day (US $ 30 dollars), 16% of them presented profit estimate lower than, or equal to, R$ 200.00 (US $ 60 dollars) and 4% had daily profit higher than R$ 61.00 (US $ 61 dollars) (US dollar exchange rate in April/2018 - R$ 3.41). In the municipality of Macapá, the monthly income from the sale of processed açaí is US $ 1,204.50 and the annual income is US $ 14,454.00. In the municipality of Santana, the monthly income from the sale of processed açaí is US $ 451.50 and the annual income is US $ 5,418.00.

Characterization of the açaí-processing shops

Sixty-eight percent (68%) of the shops related with the açaí activity belonged to the respondents, whereas 32% of them were rented. Most açaí sales points in the Northern region are run at the respondents' own residence or in small informal shops, fact that explains the high ownership rate (SANTANA et al., 2014).

Most açaí-processing shops are medium-sized; they represent 67% of the shops and process 2 to 5 sacks of fruit per day. Small-sized açaí-processing shops purchase less than 2 açaí sacks per day and they represent 22% of the shops in these counties. Large-sized açaí-processing shops process more than 5 açaí sacks per day and they represent 11% of the local shops. It is noteworthy that low-income people who live on the outskirts are the ones who most consume açaí at a lower cost and that is why small-sized açaí-processing shop are abundant. The large ones are located in the urban center of Macapá and Santana and mainly serve the middle and high income people.

Describing this activity allowed understanding its production mode, local market and income generation, which are essential data about the way small and medium-sized businesses organize their production. Açaí subsistence clusters in Macapá and Santana counties play a key role in job and income generation processes (REYMÃO; SILVA, 2018).

The artisanal açaí-processing shops commercialize açaí fruits and discard pulped lumps on a daily basis (MENDONÇA et al., 2014; SANTANA et al., 2014). Fresh açaí fruits are transported to both counties through vessels coming from islands located in Pará State and in the estuarine region of Amapá State, as well as through road transportation within Amapá State (MIRANDA et al, 2012; FERNANDES et al., 2018).

The amount of purchased fresh fruits and discarded pulped lumps

The amount of purchased fresh fruits and discarded pulped lumps was estimated based on information gathered during the interviews conducted in the herein investigated 212 açaí-processing shops. Sacks weighing 50 kg were taken into consideration at the time to estimate the amount of purchased fresh lumps, whereas sacks weighing 54 kg (lumps hydrated) were taken into account at the time to estimate the amount of discarded lumps (Table 2).

Table 2 – Estimates of açaí fruits purchased to be processed, and lumps discarded in the 212 açaí-processing shops

Counties		Purchased açaí fruits (kg)		Both counties
Macapá	Day	20,08	Day	27,600
	Week	140,53		
	Month	602,25	Week	193,200
Santana	Day	7,525		
	Week	52,68	Month	828,000
	Month	225,75		
Counties		**Discarded açaí lumps (kg)**		**Both counties**
Macapá	Day	17,70	Day	24,455
	Week	123,87		
	Month	530,85	Week	171,185
Santana	Day	6,76		
	Week	47,32	Month	733,650
	Month	202,80		

Source: the authors, 2019.

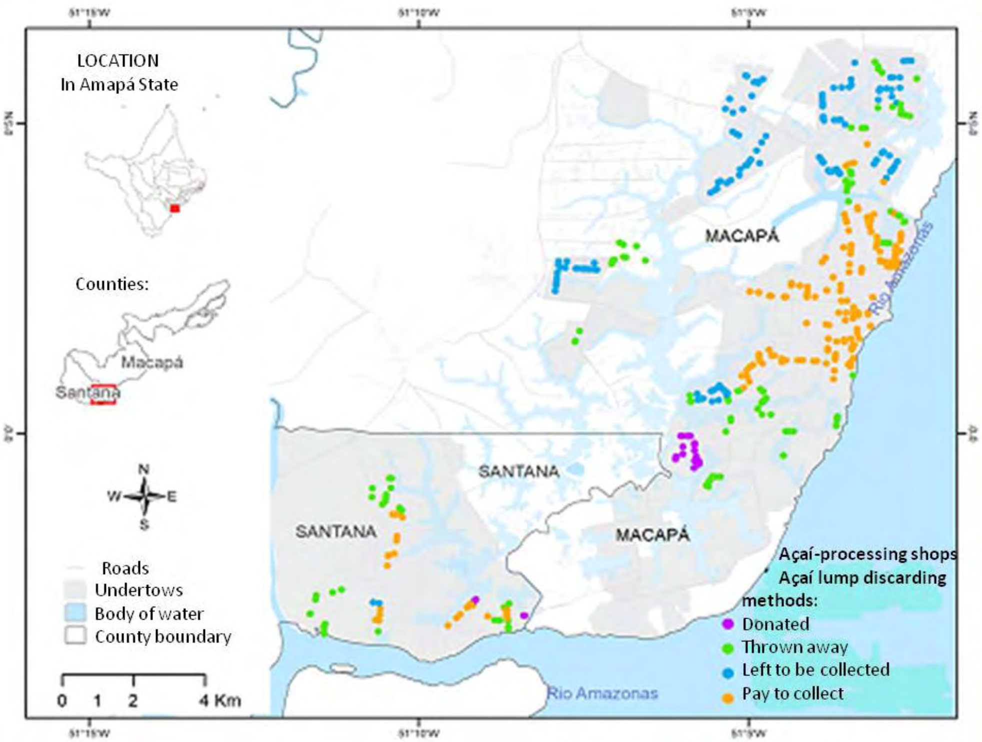
Açaí-processing shop Interviewed from Macapá and Santana counties reported to discard açaí lumps in different ways - the main discarding method lies on paying third parties to collect them in their shops. Estimates based on the herein investigated sample showed that 15,875 kg of lumps/day are discarded through the “pay to collect” method, 6,055 kg/day are thrown away, 1,185 kg/day are left to be collected in front of the shops and 1,340 kg/day are donated.

However, the Friedman’s non-parametric multicomparison method ($\chi 2 = 3.5$) statistically showed that the size of açaí-processing shops does not significantly influence the açaí lump discarding method ($p = 0.1778$), since variable “discarding methods” (left to be collected, donated, thrown away and pay to collect) is not influenced by the independent variables “açaí-processing shop classification” (small-, medium- and large-sized) (Refuted hypothesis, $p > 0.05$). The size of the açaí-processing shops influences the destination (hypotheses confirmed, $p < 0.05$).

Besides that, the Friedman’s non-parametric multicomparison method ($\chi 2 = 47.95$) statistically showed that the açaí lump discarding method significantly influences the daily profit estimate for açaí-processing shops ($p = 0.0000$) (hypotheses confirmed, $p<0.05$), since variable “daily profit estimate for açaí-processing shops” is influenced by variable "discarding methods" (left to be collected, donated, thrown away and pay to collect).

With respect to the percentage of açaí lumps discarded by açaí-processing shops, 65% of the respondents pay for the lumps to be collect, 25% of them throw the waste away, 5% leave it to be collected in front of the shops and 5% donate it to vegetable gardens or to other users who work with fresh açaí lumps. Therefore, the lack of concern with environmental topics/issues or with the potential damage that this waste could cause to local ecosystems, mainly in the urban area of the investigated counties, is clear. Most açaí-processing shops, located in the central areas of the assessed counties, pay for the lumps to be collected because these areas are continuously subjected to inspections. Therefore, it is possible inferring that this behavior is based on respondents' fear of being fined by governmental bodies (Figure 2).

Figure 2 - Açaí lump discarding methods in Macapá and Santana counties



Source: the authors, 2019.

Thus, respondents preferred to pay approximately R$ 2.00 to R$ 10.00 per day for the lumps to be collected in trucks/containers that routinely collect and discard such waste. However, the act of paying for collect only reflects a momentary concern with being fined for obstructing the sidewalk, i.e., with not violating any code of conduct of the master plan. Thus, respondents adapted to the environmental legislation by passing on the responsibility over the waste. On the other hand, most açaí-processing shops located in peripheral areas of Macapá and Santana counties directly discard açaí lumps in vacant lots, wetlands (lakes and undertows), illegal dumps, among others (Figure 2).

It is important to note that, in the peripheral area of cities, beaters suffer less pressure from government supervision. For this reason, the closer to the central zones of the cities of Macapá and Santana, the more intense the pressure for inspection tends to be. Therefore, beaters in the most central areas tend to pay more for disposal because they have to avoid inspection more often so as not to be fined.

According to the Federal Law on Solid Wastes (BRASIL, 2010) the inadequate disposal of organic wastes leads to potential damages due to high BOD (biochemical oxygen demand), since it produces a specific type of slurry. Such illegal disposal also enables methane emission into the atmosphere and favors the proliferation of disease vectors. The açaí lump is a commercial activity-related waste; thus, açaí-processing shops must account for the collection and final destination of it. The Law establishing the National Solid Waste Policy (PNRS) is very current and contains important instruments to allow the country to make the necessary progress in addressing the main environmental, social and economic problems arising from inadequate management of solid waste.

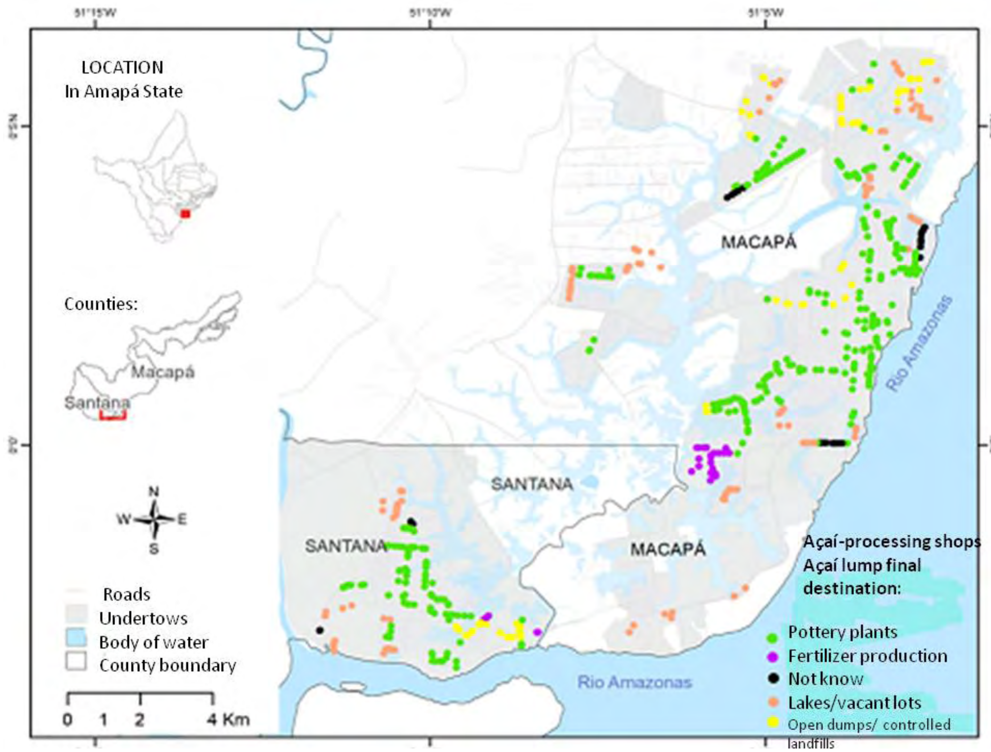
Açaí-processing shop workers were asked about the possible ways of reusing açaí lumps: 6% of them believed that using them to produce fertilizers was a good and sustainable alternative; 42% stated that açaí lumps should be reused for seedling production and oil extraction purposes (alternative ways of using the waste with higher purposes in research); 2% stated that açaí lumps could be used in handicrafts; 11% said that burning it was a great form of reuse; 4% believed that the best alternative was to grind it to produce animal feed; 24% did not respond; 11% had no knowledge about the subject.

Final destination of açaí lumps

With respect to variable 'final destination', 24,455 kg of açaí lumps are discarded in Macapá and Santana counties on a daily basis; 11,580 kg/day of this total are sent to pottery plants, 4,050 kg/day are discarded in lakes, undertows and vacant lots; 3,085 kg/day are discarded in open dumps or controlled landfills, 1,600 kg/day are used as fertilizers and the final destination of 4,140 kg/day remains unknown (Figure 3).

In general the açaí lumps has been tested and reused in the manufacture of animal feed, coffee, substrate, furniture and crafts. In addition, it can be used to produce electrical and mechanical energy and as a fuel for use in boilers (ERLACHER et al., 2016; REIS et al., 2002; RODRIGUES et al., 2002; SILVA et al., 2004; TEIXEIRA et al., 2004).

Figure 3 - Final açaí lump destination adopted by açaí-processing shops in the urban areas of Macapá and Santana counties



Source: the authors, 2019.

It is important to consider that, in Amapá State, lumps are treated as urban waste (ALMEIDA et al., 2017), since they are dumped on public roads near the sales points, used as landfilling material in construction sites or simply dumped in landfills (BARRETO; BORGES, 2018; PADILHA et al., 2006). For these reasons sanitary and environmental problems arise. But there is the National Policy on Solid Wastes to addresses, among other issues, the correct disposal of these wastes.

However, concerning to present study, the Friedman's non-parametric multicomparison method ($\chi 2 = 9.29$) statistically showed also that the size of açaí-processing shops does not significantly influences the final destination of açaí lumps ($p = 0.096$) (but close to the limit of significance), since variable "açaí lump final destination" (fertilizer, discarded in lakes, undertows, vacant lots, open dumps, controlled landfills, unknown, pottery plants) are not influenced by variable "açaí-processing shop classification" (small-, medium- and large-sized).

Açaí-processing shop workers were asked about how the (local/state) government could help them select the final destination given to açaí lumps. Based on the responses, 2% of the respondents believed that the government should help them financially; 17% believed that the government should develop a project focused on improving the final destination given to the waste; 5% stated that the government could allocate a site to receive açaí lumps; 52% declared that the best way for the (local/state) government to help in the final destination given to açaí lumps would lie on providing vehicles to collect the waste in front of the shops; 18% did not respond; and 6% did not know how the government could help in such matter.

Thus, its use should be more noble, given its immense potential for economic application and should not be considered with common solid waste (BRASIL, 2010). Thus, it is necessary both economic and environmental incentive to reverse this trend, starting from the point of view that the açaí lump can have as much value as its pulp.

Based on the current viewpoint, inserting this issue in the integrated solid waste management policy can be the initial solution for the most appropriate and noble use of açaí lump, which is currently dumped in natura in the environment.

Since this issue tends to be specific and recurrent in several regions in the Amazon, we herein propose including this topic in the solid waste-related chapters of Municipal Basic Sanitation Plans (PMSB) by taking into consideration the new legal framework of the Federal Sanitation Law (BRASIL, 2020).

Thus, based on the power of the new Law (BRASIL, 2020), this reflection can help overcoming the old regional issue associated with organic solid waste resulting from açaí processing, as well as finding innovative solutions capable of enabling economic and environmental alternatives, as well as socially sustainable products from this noble product that derives from tropical biodiversity.

Environmental and technological solutions should significantly affect the collection (suitable destinations focused on the local market), transportation (specific), transshipment and final disposal of açaí lump in order to stop it from being improperly dumped in natura in the environment or even unnecessarily sent to Macapá landfill.

If the final disposal of açaí lumps was properly managed, the environmental, social and economic impacts resulting from their inadequate disposal would also be better addressed and solved in a more sustainable way. For example, legislation has emphasized the need of performing integrated and sustainable management of solid waste in the country (BARROS, 2012) and made it mandatory. In addition, the new legal framework for the Brazilian Basic Sanitation (BRASIL, 2020) has significantly updated the context of Law 12.305/2010 (BRASIL, 2010).

Conclusion

The form of disposal of processed açaí seeds is independent of the size of the açaí-processing shops. Therefore, we refute the hypothesis that the size factor influences the culling ($p > 0.05$). On the other hand, the form of discard is dependent on the estimated profit received by the artisanal beaters. That is, the hypothesis was confirmed ($p < 0.05$). In addition, the destination of processed açaí seeds depends on the size of the açaí-processing shops, that is, the hypothesis was accepted ($p < 0.05$).

Macapá and Santana counties-AP do not receive minimal technical and environmental guidances for the discarding and final disposal of processed açaí lumps. Although the problem of discarding and final destination of the acai lump is a recurrent environmental problem in Macapá and Santana, there is a tendency of the problem to worsen in the future, with insufficient technical progress in solid waste management.

Besides that, it is noteworthy that the geospatial distribution of açaí-processing shops in Macapá and Santana counties suggested a linear agglomeration pattern, which confirms a higher concentration of these production units in the most widely circulated street of the different neighborhoods and a greater dispersion in peripheral urban areas.

However, the permanent solution to the issue involving the final destination of açaí lumps goes beyond legislation and planning. It is necessary implementing effective management, economic valuation, social and environmentally sustainable actions supported by individuals who work with açaí processing in order to provide sustainable alternatives to the fruit production chain, as well as to enable its better exploitation, use and, in the latter case, its appropriate final destination in landfills.

Based on the standard linear distribution in both counties, we recommend it is also possible to propose the creation of strategic points of adequate collection and final disposal of solid waste. This action would be more sustainable. Besides that, this simple procedure would ensure more safety and efficiency of the collection service, facilitating the reuse, recycling and treatment of these wastes, as encouraged and provided for by current legislation.

Based on the current results, we also recommend herein propose that part of the resolution of the issue involving the final destination of açaí lumps should properly and primarily result from well-developed integrated solid waste management plans. It should be so, to potentiate the reduction of eventual damages this waste type may have caused to the environment, specifically to zones and neighborhoods with greater açaí processing capacity.

Acknowledgements

We thank the Programa de Pós-Graduação em Biodiversidade Tropical – PPGBIO/ Universidade Federal do Amapá, Empresa Brasileira de Pesquisa Agropecuária – Embrapa-Amapá, Programa de Pós-Graduação em Ciências Ambientais – PPGCA/Universidade Federal do Amapá, Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and CNPq PQ2 scholarship (Process 314830/2021-9).

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Submitted on: 06/09/2019

Accepted on: 17/01/2022

2022;25:e01382

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AMBIENTE & SOCIEDADE 25 anos años years

SciELO

Descarte e destino final de caroços de açaí na Amazônia Oriental - Brasil

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Resumo: A intensificação da produção de açaí (Euterpe oleracea Mart.) e o aumento do consumo resultaram na geração de significativas quantidades de resíduos que necessitam de um destino final adequado. O objetivo da pesquisa foi avaliar como ocorre o descarte e a destinação final dos caroços de açaí processado nos municípios de Macapá e Santana–AP. Assim, foram aplicados formulários semiestruturados para 212 batedores artesanais de açaí (151 em Macapá e 61 em Santana). As informações de descarte e destinação dos caroços das batedeiras de açaí foram espacializadas usando o software ArcGis. Os resultados mostraram que o método de descarte e destino final independem do porte da batedeira. Entretanto, o método de descarte é influenciado pelo lucro ($p<0,05$). Contudo, o descarte e o destino são inadequados (53%) e ainda dependem de gestão e legislação específicas que resultem em alternativas ambientalmente sustentáveis.

Palavras-chave: Processamento artesanal de açaí; Resíduos Sólidos; Amapá; Sustentabilidade.

São Paulo. Vol. 25, 2022

Artigo Original

AMBIENTE & SOCIEDADE
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Eliminación y destino final de las semillas de açaí en la Amazonia Oriental – Brasil

Lidiane de Vilhena Amanajás Miranda
Silas Mochiutti
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São Paulo. Vol. 25, 2022
Artículo original

Resumen: La intensificación de la producción de açaí (Euterpe oleracea Mart.) y el aumento del consumo dieron lugar a la generación de cantidades significativas de residuos que requieren un destino final adecuado. La investigación evaluó cómo se produjo la eliminación y disposición final de las semillas de açaí en Macapá y Santana-AP. Así, se aplicaron formas semiestructuradas a 212 batidores artesanales de açaí (151 en Macapá y 61 en Santana). La información sobre la disposición y el destino de las semillas de los mezcladores de açaí se espacializó utilizando el software ArcGis. Los resultados mostraron que el método de eliminación de las semillas y su destino final son independientes del tamaño del mezclador. Sin embargo, el método de eliminación se vio influenciada por la ganancia ($p<0,05$). La disposición y el destino son inadecuados (53%) y aún dependen de una gestión y legislación específicas que resultan en alternativas ambientalmente sostenibles.

Palabras-clave: Procesamiento artesanal de açaí; residuos sólidos; Amapá; Sostenibilidad.