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ENERGY RECOVERY OF WASTE FROM AMAZON REGION

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ABSTRACT

In the Amazon, the production of wine of acai berry generates a large amount of waste, as only between 5% and 15% of the total fruit is consumed. One of the ways of using this residue is through the production of briquettes or pellets. Thus, the objective of this research was to evaluate the effects of the densification process on the properties of briquettes obtained from acai berry seeds. The biomass was characterized by physico-chemical analysis, subsequently densified and the effects of processing the production of briquettes analyzed through the response surfaces generated from a 2 level and 3 factors full factorial design of experiments. In the acai berry seeds analysis, excellent fuel properties were found, such as a higher heating value of 19.01 $MJ.kg^{-1}$ and a lower heating value of 15.25 $MJ.kg^{-1}$, volatile material corresponding to 79.95%, fixed carbon of 18.51% and low ash content of 1.49%. According to the response surfaces, the optimum point was obtained for briquettes produced with 10.5% moisture, temperature of 101°C and maximum particle size of 2.99 mm, obtaining briquettes with mass variation of 0.56%, volumetric expansion of 1.42%, mechanical resistance of 0.083 MPa and energy density of 16321.70 $MJ.m^{-3}$

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INTRODUCTION

According to National Energy Balance (EPE, 2022), Brazil has an electrical matrix with a large share of renewable sources, and 53.4% of the total electric energy generated in Brazil comes from hydroelectric power. Even though it is the second largest generator of electric power by means of hydroelectric plants, the North region still cannot effectively supply the energy demand for the entire Amazon region, causing some localities to still live without electricity. The lack of interconnected systems makes this region present a large number of isolated systems, which are characterized by small generating units based on diesel oil and an enormous difficulty of supply, besides producing pollution in the region (Guerra; Nogueira, 2008). Oliveira and Lobo (2002) emphasize that in the Amazon there is a very large diversity of biomasses, and even with this variety, there are no incentive programs and no technical projects to implement the use of biomass as the main source of energy for the region. However, the cost of biomass and the high efficiency of modern systems in the generation of electricity justify the need for the development of this technology, highlighting the importance of identifying other wastes that may have a potential for energy use (Januzzi, 2003). In this context, the acai berry, a fruit of the acai berry tree (*Euterpe oleracea*, Mart.), is an abundant food, traditional and daily consumed in the region and is important for agroindustry development of the Amazon region. However, the fruit has a very thin epicarp, of which 83% of the total fruit is represented by acai berry seed, generating a large amount of waste in the act of pulping (Araújo, 2006; Schreckinger *et al*., 2010). According to Brazilian Institute of Geography and Statistics (IBGE, 2022), in 2020, about 220,489 tons of acai berry were extracted in the country, generating approximately 192,000 tons of waste from the pulp of the fruit, where its inadequate disposal becomes an environmental and sanitary problem. Thus, a possibility to minimize the energy problem in the Amazon and to address the problem of waste disposal, offering sustainability to the process, may be the application of these seeds as densified products (briquettes or pellets). This type of technology can be a solution for hard-access regions, since it provides a better advantage comparing to in natura biomass, mainly regarding to handling and storage, besides increasing its density, heating value and combustion rate (Werther *et al.*, 2000). Therefore, this article aims to characterize the biomass and evaluate the effects of the conditions of the densification process in order to optimize the production process of briquettes obtained from acai berry seeds originated from the pulp of this fruit, seeking their energetic use as an alternative source of fuel and a solution for the disposal their waste by riverside communities of the North Region.

MATERIAL AND METHODS

Obtaining and preparation of the sample: The acai berry used in the study was collected in the municipality of Almeirim, which is located in the west of the state of Pará, a region of the lower Amazon. The samples were transported to the state of São Paulo and analyzed at the Biomass Analysis and Characterization Laboratory, at the Federal University of ABC (UFABC), São Bernardo do Campo campus. The pulping was carried out through a manual process, similar to that carried out in remote areas in the Northern Region. Firstly, the fruits of the acai berry were soaked in water at a temperature of 70°C for 2 hours, so that they could be pulped by means of friction, leaving only the fibers and the seeds remaining in the process. The collected acai berry pulp was discarded, since it was not used in the study.

Characterization of biomass*:* Bulk density*:* Bulk density was defined according to ASTM E873-82, for the whole seeds and for the granulometry defined for the production of the briquettes.

Proximate analysis and moisture: Volatile material contents (ASTM E872-82), ashes (ASTM E1755-01), fixed carbon (ASTM D5142-02) were determined for the acai berry seeds. Moisture (ASTM E871-82) was determined after being dried indoors for 45 days after pulping, with average relative air humidity of 80 % and temperature ranging from 16°C to 27°C.

Heating value: The higher heating value (ASTM D2015-00) was verified through a calorimetric pump (C5000, IKA) and, finally, the lower heating value was determined according to Equation 1 proposed by Van Loo and Koppejan (2008).

$$LHV = HHV \cdot (1 - (H_2O) / 100) - 2.444 \cdot (H_2O / 100) - 2.444 \cdot (h / 100) \cdot 8.936 \cdot (1 - H_2O / 100) \quad (1)$$

Where LHV is lower heating value on wet basis (MJ / kg); HHV is higher heating value on dry basis (MJ / kg); H_2O is the wet mass of the fuel (% weight) and h is the hydrogen concentration on the dry basis (% weight).

Elemental analysis of ashes: It was performed after the calcination of the biomass by means of a scanning electron microscope coupled to an energy dispersive X-ray detector (JCM-600, JEOL).

Characterization of briquettes

Briquetting: Briquettes were produced with 50 g of sample with granulometry, moisture and temperatures defined by the experimental design, using a hydraulic briquette (LB-50, Lippel) under pressure of 200 bar defined in the equipment, with a pressing time of 120 seconds.

Mass variation: The mass change was analyzed by the determination of the briquette mass every 24 hours during a period of 72 hours after the densification, by means of an analytical balance.

Volumetric expansion: To determine the volumetric expansion, the longitudinal length of the briquettes (direction of briquette compaction) and its diameter were measured, with the aid of a pachymeter, every 24 hours in a period of 72 hours after densification.

Mechanical resistance: It was determined by adapting the standard NBR 7222 (ABNT, 2011), the tests were carried out applying a load in the transverse direction of the briquette, that is, perpendicular to the compaction pressure with loading speed of 3 mm/min.

Energy density: Finally, the energy density of the briquettes was calculated from the product between the apparent density of the briquette and the useful calorific value, in this case the LHV.

Design of experiments (DOE): A 2 level and 3 factors full factorial DOE was designed with triplicate at the central point, where they were used as independent variables: moisture content (M) (10-15%), compaction temperature (T) (47-107°C) and granulometry (G) (1.18-2.99 mm) to evaluate its influence on mass variation (MV), volumetric expansion (VE), mechanical resistance (MR) and energy density (ED). When performing the DOE, it was aimed to obtain a briquette with lower mass variation, lower volumetric expansion, higher mechanical resistance, and higher energy density. In order to do so, an analysis of the surfaces of responses was carried out aiming to find the region that would best satisfy the objectives of the present study. Considering the existence of a mathematical function for each response as a function of the independent variables, represented by Equation 2, the coefficients of the equations were obtained by means of Analysis of Variance (ANOVA) for each response using the software Statistica® 13.3 (STATSOFT).

$$Y = b_0 + b_1M + b_2T + b_3G + b_{12}MT + b_{13}MG + b_2TG + b_{123}MTG \quad \text{……………}(2)$$

Where Y is the response variable (MV, VE, MR, ED); b_n are the estimated linear coefficients; M, T and G are the coded independent variables (-1, 0, 1).

RESULTS AND DISCUSSION

Characterization of biomass: The biomass was characterized according to its physico-chemical properties, the Table 1 shows the results of the bulk density analysis, proximate analysis and heating value.

Bulk density: According to Table 1, the bulk density obtained for whole seeds, that is, unground seeds, was 477.62 $kg.m^{-3}$, with an increase in bulk density of 538.71 $kg.m^{-3}$ for the opening mesh of 2.99 mm, 543.32 $kg.m^{-3}$ for the mesh of 2.08 mm and, finally, 613.81 $kg.m^{-3}$ for opening of 1.18 mm. The increase of the bulk density occurs with the reduction of the samples' particle size, because a better compactness of the particles occurs in relation to a bigger particle size, since they lead to a loose arrangement and, consequently, in a lower bulk density (Vale *et al.,* 2017).

Proximate analysis and moisture: For the percentage values of the proximate analysis of the residual biomass on a dry basis, it is observed that it has in its composition the prevalence of volatile materials and fixed carbon, representing 79.95% and 18.51%, respectively. According to Gentil (2008), high contents of volatile materials indicate the willingness biomass has to ignite, because the higher the volatiles content, the greater the reactivity, causing it to accelerate the combustion process for energy conversion. As for fixed carbon, the higher its content, the greater the heat generated in the combustion of the material, since fixed carbon allows heat units to diffuse at all points of the material during the carbonization process (McKendry, 2002; Juizo; Lima; Silva, 2017). The fixed carbon content found in acai berry seeds has a high percentage compared to the value found by Juizo, Lima and Silva (2017) for charcoal of *Eucalyptus grandis*, one of the main materials used in thermochemical processes, which has 14.47 % of fixed carbon in its composition. The ash content of the acai berry seeds does not exceed 2% and the moisture was below 12%, considering the process conditions previously reported. These values are good indications for the application of this biomass in thermochemical processes, since high ash and moisture contents reduce the available energy in the fuel and can cause operational problems in the process (McKendry, 2002). It should be noted that the ash content found in the acai berry seeds is more than 40 times smaller than that produced by coal, which reaches 60.44% on a dry basis (Soares, 1998). The values found for volatile materials, ash and fixed carbon in the proximate analysis corroborate the literature data found by Ita *et al.* (2014) and Rambo *et al.* (2015), with volatile materials above 79%, fixed carbon above 18% and ash below 2%. However, the moisture adopted for this work had its percentage lower than the one found by the authors, this happens due to the moisture of the discarded acai berry seeds after the pulping vary between 70% and 10% when discarded (Itai *et al.*, 2014). That is, after pulping, the acai berry seeds are arranged in any place without any control, and this causes a great variation in their moisture.

Table 1. Physico-chemical characterization of acai berry seed biomass

Analysis	Results			
Bulk density (kg.m^{-3})	Wholeseeds	< 2.99 mm	< 2.08 mm	< 1.18 mm
	477.62	538.71	543.32	613.81
Proximateanalysisandmoisture (%)	Volatilematerials	Ashes	FixedCarbon	Moisture$_{w.b.}$
	79.95	1.49	18.51	11.54
Heatingvalue (MJ.kg^{-1})	PCS$_{d.b.}$		PCI$_{w.b.}$	
	19.01		15.25	

d.b.: dry basis w.b.: wet basis

Table 2. Elementary composition of the ashes of acai berry seeds

Composition	K_2O	P_2O_5	SiO_2	MgO	CaO	SO_3	Cl	Na_2O	FeO	Others
%	30.96	18.96	15.60	12.71	7.68	3.76	3.37	2.26	0.50	4.21

Table 3. Test results for mass variation, volumetric expansion, mechanical resistance and energy density

Test	Codedindependentvariables			Response			
	M (%)	T (°C)	G (mm)	MV (%)	EV (%)	MR (MPa)	ED (MJ.m^{-3})
1	-1 (10)	-1 (47)	-1 (1.18)	0.53	5.48	0.03	16208.58
2	+1 (15)	-1 (47)	-1 (1.18)	- 3.10	3.21	0.01	12592.13
3	-1 (10)	+1 (107)	-1 (1.18)	0.81	1.74	0.06	16129.67
4	+1 (15)	+1 (107)	-1 (1.18)	- 1.56	0.93	0.03	13375.47
5	-1 (10)	-1 (47)	+1 (2.99)	- 0.21	4.19	0.05	16081.31
6	+1 (15)	-1 (47)	+1 (2.99)	- 3.33	2.00	0.02	12838.31
7	-1 (10)	+1 (107)	+1 (2.99)	0.73	2.50	0.10	16835.46
8	+1 (15)	+1 (107)	+1 (2.99)	- 2.37	-1.59	0.06	14791.60
9	0 (12.5)	0 (77)	0 (2.08)	- 1.26	1.11	0.03	14531.42
10	0 (12.5)	0 (77)	0 (2.08)	-1.13	1.13	0.04	14565.13
11	0 (12.5)	0 (77)	0 (2.08)	- 0.47	0.52	0.05	15013.12

Heating value: Demirbas (2005) points out that the higher heating value in a biomass dry basis varies between 14 and 21 MJ.kg^{-1}, with an average value of 19.01 MJ.kg^{-1}, which is relatively high when compared to usual biomasses destined to thermochemical processes, this can occur because a high fixed carbon content results in a positive relation to the heating value (Trugilho; Silva, 2001). The LHV, on a wet basis, presented a value of 15.25 MJ.kg^{-1}, which can be justified by the low moisture content, since the lower the moisture content the higher the heat production per unit of mass. It should be noted that the HHV of the acai berry seeds is comparable to the biomass of sugarcane bagasse, one of the most used biomasses for energy conversion and has a HHV around 18.17 MJ.kg^{-1} (Ángel, 2009).

Elemental analysis of ashes: The inorganic materials content found through the elemental composition analysis of the ashes of the acai berry seeds' biomass are presented in Table 2. By means of the elemental analysis of the ashes of acai berry seeds, it is observed that they are composed predominantly by K_2O, P_2O_5, SiO_2 and MgO, corresponding to 30.96%, 18.96%, 15.60% and 12.71% of the content, respectively. The content of alkali Na_2O, which may favor fouling and corrosion formation in boilers, is relatively low with an average value of 2.26%. For sugarcane bagasse, the Na_2O content is lower than that found in acai berry seeds ashes, reaching only 0.22% (Bahurudeen *et al.*, 2014). However, Bahuredeen and Santhanam (2015) found a silica content in the ash of sugarcane bagasse almost five times higher than the Si_2O content present in the acai berry seeds, reaching 72.95% of the total ash of sugarcane bagasse. Considering the percentage of chlorine present in the ashes, the acai berry seeds have a moderate value of the element, since the average amount found in the samples was 3.37%. However, when compared to the content of most alkalis, the chlorine amount is lower, and this has a greater impact on the production of alkali steam than the alkali content (Miles, 1996). Therefore, fuels with high alkali content and low chlorine content may generate less incrustation than a low percentage of alkali fuel but with a higher chlorine composition.

Characterization of briquettes: The briquettes were characterized by analysis of mass variation, volumetric expansion, mechanical resistance and energy density, through experimental design. The results of the tests for each of the analyzes are presented in Table 3. The values shown in parentheses are the actual data used in DOE. ***Mass variation:*** For the tests performed it is possible to observe that the greatest mass variation occurred in Test 6, where, with moisture at 15%, temperature at 47° C and particle size less than 2.99, there was a mass loss higher than the other tests. The lowest mass loss was observed in Test 5 where the levels of the independent variables were with minimum moisture, minimum temperature and maximum particle size. The negative variation of the mass occurred in Test 6 may have been due to the high moisture (15%) of the briquettes produced in this test, since a high moisture in briquettes makes it more unstable which can cause a greater mass loss during storage or transport (EMBRAPA, 2012). It was verified that in some tests which the moisture is at its level (-1), that is, 10% moisture (w.b.), the mass variation was positive, as is the case of Test 7. This may have occurred due to the small moisture gain during the storage of the briquettes, which can be justified by the relative moisture of the air at the time of the experimental tests. It is necessary to point out that the loss or gain of mass in the briquettes is directly related to loss or gain of moisture according to the relative moisture of the air at the moment of the analyzes. Since, after compaction, the moisture of the briquette tends to come into balance with the moisture of the environment, it may lose or gain moisture and, consequently, lose or gain mass.

Volumetric expansion: For the volumetric expansion response, it is possible to observe that the test with the greatest volume expansion recorded was Test 1, presenting an expansion of 5.48% in volume after the compaction and the test with the smallest expansion was one of the repetitions of the central point (Test 11) that presented volume expansion of 0.52% in relation to the initial volume. For Test 8 there was a retraction in the average volume of the briquettes produced, presenting a value of -1.59%. This effect can be justified because the variables moisture and temperature are in maximum points, because with the increase of the temperature the lignin acquires agglutinative effect (Grover, 1996), and as after compacting, the moisture of the densified biomass tends to come into balance with the environment moisture, when losing water the briquette may have been able to

Table 4. Coefficients of the polynomial equations resulting from the effects of the independent variables on the responses analyzed

Source	Coefficients			
	MV (%)	VE (%)	MR (MPa)	ED ($MJ.m^{-3}$)
Global Media				
b_0	-1.0330	1.9278	0.0436	14814.75
MainEffects				
b_1	-1.5265	-1.1712	-0.0154	-1457.19
b_2	0.4637	-1.4120	0.0162	426.48
b_3	ns	-0.5315	0.0137	ns
InteractionEffects	ns	ns	ns	ns

ns: not significant ($p \geq 0.05$)

Table 5. Analysis of variance (ANOVA) of the fitted model

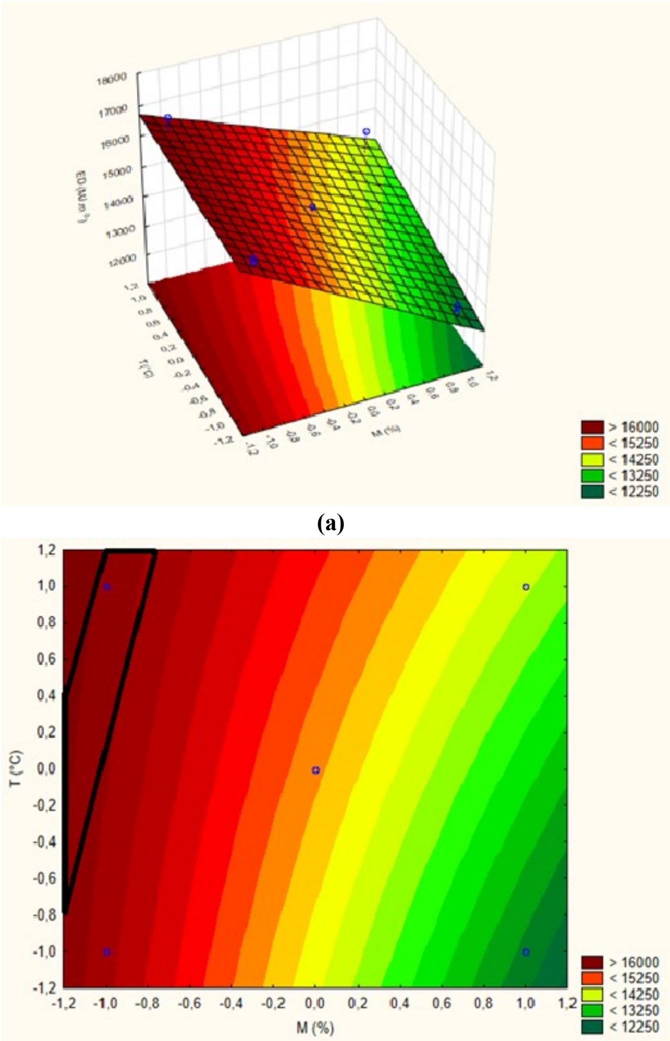
Source	Mass variation					
	DF	SS	MS	Fcal	Ftab	R^2
Regression	2	20.362	10.181	66.648	4.459	0.973
Residual	8	1.222	0.153	-	-	
Lackoffit	6	0.862	0.144	0.797	19.329	
Pure error	2	0.360	0.180	-	-	
Total	10	21.584	-	-	-	
Source	**Volumetricexpansion**					
	DF	SS	MS	Fcal	Ftab	R^2
Regression	3	29.185	9.728	9.445	4.347	0.878
Residual	7	7.210	1.030	-	-	
Lackoffit	5	6.970	1.394	11.633	19.296	
Pure error	2	0.240	0.120	-	-	
Total	10	36.395	-	-	-	
Source	**Mechanicalresistance**					
	DF	SS	MS	Fcal	Ftab	R^2
Regression	3	0.00553	0.00184	15.027	4.347	0.942
Residual	7	0.00086	0.00012	-	-	
Lackoffit	5	0.00058	0.00012	0.856	19.296	
Pure error	2	0.00027	0.00014	-	-	
Total	10	0.00638	-	-	-	
Source	**Energy density**					
	DF	SS	MS	Fcal	Ftab	R^2
Regression	2	18442295.350	9221147.675	36.569	4.459	0.990
Residual	8	2017283.049	252160.381	-	-	
Lackoffit	6	1872663.195	312110.532	4.316	19.329	
Pure error	2	144619.854	72309.927	-	-	
Total	10	20459578.399	-	-	-	

DF: degree of freedom SS: sum of squares MQ: mean square

adhere better to the particles of acai berry seeds. However, Test 4, even with moisture and temperature levels equal to Test 8, had a positive effect for volumetric expansion. This difference of results can be explained by the granulometry variable, since a larger opening of the sieve achieves a greater variety in the particle diameter causing a better compaction (EMBRAPA, 2012), such as that of briquette produced with opening sieve material 2.99 mm, used in Test 8. It should be addressed that briquettes with lower moisture than balance moisture for packaging, tend to have a greater expansion, as these absorb moisture to get in balance. And the opposite also happens for those that have high moisture, however, they tend to lose moisture for balance moisture of packaging, with a relation inversely proportional to water loss (Aló *et al.*, 2017). However, even with volumetric expansion, the variations in the volumes of the acai berry seeds briquettes presented a very small value when compared to the briquettes produced with sugarcane studied by Brasil et al. (2015) that reached an expansion of 22%. Only volumetric expansions above 10% may influence the mechanical resistance of briquettes.

Mechanical Resistance: For the tests analyzed the briquettes that presented the greatest mechanical resistance were of Test 7, since they obtained tensile resistance by average diametral compression of 0.10 MPa, where the independent variables for these tests had values equal to 10% of moisture, 107ºC of temperature and granulometry with the maximum value of 2,99 mm. While the lowest value of mechanical resistance was that of Test 2, in which the independent variables were with maximum moisture, and minimum temperature and granulometry, presenting an average resistance of 0.01 MPa. The highest resistance shown in Test 7 can be explained by the condition of low moisture, high temperature and the widest variety of particle sizes, since the particles that composed the triplicate for this test should have several sizes ranging up to 2.99 mm. From this, it is possible to justify the positive effect of particle size on mechanical resistance once the increasing levels caused a greater diversification of the particle size of acai berry seeds. This result corroborates the observations made by Dias et al. (2012), who claims that briquettes manufactured with low moisture, high densification temperature (up to 220° C) and granulometry with varying sizes, result in briquettes that are more stable and have greater resistance. Another important point regarding the mechanical resistance of briquettes is the effect of temperature on the lignin present in the biomass. Because during the heating process the polymer chains that make up lignin go from a disordered and rigid (vitreous) state to a larger disordered state in which they have a greater mobility. However, after drying the briquette, it resurfaces, this effect is called the glass transition (Figueroa; Moraes, 2009).

Energy Density: According to the data obtained, it is possible to analyze that the highest value found for the energy density was in Test 7 that presented a value equal to 16838.31 $MJ.m^{-3}$, in that test moisture at 10% was used, temperature at 107°C and particle size less than 2.99 mm. On the other hand, the test that presented the lowest value for the analyzed response was number 2, with moisture at maximum level and temperature and granulometry at minimum levels, presenting a value of 12592.13 $MJ.m^{-3}$. It should be noted that the moisture has a ratio inversely proportional to the value of the lower heating value (LHV), therefore, the higher the moisture, the lower the LHV. This ratio directly implies the energy density of the briquette, since it is calculated by the product between the apparent density and the lower heating value. This may explain the low energy density presented not only for Test 2, but also for the other tests with maximum point moisture.



(a)

(b)

Figure 1. Surface response and level curves for energy density in the process of densification of acai berry seeds with granulometry fixed in central point

Another point to be highlighted is the directly proportional relation of the apparent density to the value found for the energy density of the briquette, because the higher the apparent density value, the higher the energy density of the briquette produced (Freitas *et al.*, 2016). Souza and Vale (2016) found in their study that in order to obtain higher values of energy density the temperature elevation presented more efficient results, which may explain the energetic density found for Test 7, since this test presents a value of higher temperature than in Test 2.

Analysis using response surface methodology: The regression coefficients of the polynomial equation are shown in Table 4. According to Table 4 it is possible to observe that there were no significant interactions at a 95% confidence level. Eliminating the non-significant factors, the significance of the regression and the lack of adjustment for a 95% confidence level ($p \geq 0.05$), through the F Test, were verified in the analysis of variance (ANOVA), as shown Table 5. The statistical analysis indicates that the proposed models for mass variation, mechanical resistance and energy density are predictive, presenting a small lack of adjustment and satisfactory values of R^2, 0.973, 0.942 and 0.990, respectively. As for the response to volumetric expansion, it does not show the relation for F Test pointed out by Box and Wetz (1993), which, for a model to be predictive, the calculated F value between the regression and the residue must be at least four to five times the F value found in the table. For the calculated F of the lack of adjustment and pure error, the opposite happens, the calculated F value must present the smallest value possible n relation to the value F of the table, since a high value of the calculated F indicates a great lack of adjustment of the experimental data regarding the obtained model. However, all surfaces response were generated to indicate the best process condition for the production of acai berry seeds briquettes. The surface response and the level curves generated by the model considering the significant variables related to the energy density for the briquettes of acai seeds are represented by Figure 1. It is observed from figure 1 that, with a grain size fixed at the central point (up to 2.08 mm), when the humidity goes from its upper level (+1) to the lower level (-1) and the temperature goes from the level (-1) to level (+1), there was an increase in the energy density of the acai berry briquettes. The positive effect of temperature on energy density may also be associated with the bonding effect that occurs when lignin is exposed to high temperatures, starting at 90ºC, creating an adsorption layer between the solid particles, since an increase of the contact surface occurs between the particles, which increases the molecular binding force between them (Grover, 1996). The area highlighted in Figure 1b represents the optimal region to reach a high energy density (between 16,000 and 17,000 $MJ.m^{-3}$) for briquettes produced with acai berry seeds, within the range adopted in this study. The optimization of the acai berry seeds briquettes production process aimed minimizing mass variation and volumetric expansion and maximizing the mechanical resistance and energy density of the briquettes. Therefore, based on the data obtained by the response surfaces and the selected optimal regions, the optimum point for the production of acai berry seeds briquettes was established: Moisture content (-0.8), that is, with 10.5%; Temperature (+0.8), corresponding to 101º C and Granulometry at the maximum point (+1), being 2.99 mm. Using the independent variables within the optimized values the following responses will be obtained: mass variation of 0.56%, volumetric expansion of 1.42%, mechanical resistance of 0.083 MPa and energy density of 16321.70 $MJ.m^{-3}$. These values were calculated from the mathematical models obtained from each of the experiment design responses.

CONCLUSION

Through the analysis of the proximate composition and calorific value, it was possible to observe that the residual biomass of acai seeds presents a high energy potential to be used in thermochemical processes and can be used as fuel or source of energy for the production of electric energy, being an alternative to the use of diesel oil, still widely used by isolated communities in the Amazon region in internal combustion engines, representing a great polluter in this locality. It is noteworthy that, through ash analysis, biomass presented very significant results, presenting ash content highly below that found by biomasses used in large scale in the national market, and this can be a good indicator for the use of this biomass in the process of combustion in boilers. When densified and analyzed the influences of variables (temperature, moisture and granulometry), the acai berry seeds briquettes showed a very significant performance in relation to the evaluated responses, presenting low volumetric expansion, low mass variation and high energy density, however, compared to mechanical resistance of briquettes produced with other biomasses, the briquette with acai berry seeds obtained a lower value. The optimum condition defined for the densification process of the acai berry seeds was moisture of 10.5%, compaction temperature of 101ºC and particle size less than 2.99 mm. In this condition, mass variation of 0.56%, volume expansion of 1.42%, mechanical resistance of 0.083 MPa and energy density of 16321.70 $MJ.m^{-3}$ is reached.

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