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Physical-chemical characteristics of sweet cassava varieties

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ABSTRACT

In order to evaluate the physical-chemical characteristics of nineteen sweet cassava varieties (*Milagrosa*, *Paraguai*, *Maragogipe*, *IAC 576-70*, *Saracura*, *Amarela Viçosa*, *IAC Guaxupé*, *Manteiga*, *Aipim Furadinho*, *Calombo*, *BRS Dourada*, *Rosa*, *Manteigão*, *Pão da China*, *BRS Gema de Ovo*, *Colombo*, *BRS Eucalipto*, *Cacau Branca* and *BRS Rosada*) this study was conducted at the State University of Southwest Bahia, in Vitoria da Conquista – BA. It was evaluated the pH, soluble solids, acidity, texture, cooking time, starch, amylose, amylopectin content, protein content and ash content of roots harvested at 12 months of age. We used a completely randomized design, with 3 repetitions. The data were submitted to analysis of variance and subsequently the treatment means were grouped by the Scott-Knott procedure, a 5% probability. There were differences between all the features, except for the ash content. Observed pH near neutral results in all varieties, with the highest values found in varieties Calombo and BRS Gema de Ovo. The Milagrosa variety had a higher percentage of soluble solids and higher texture. The IAC 576-70 stood out as the texture, the cooking time, the starch content and protein content. The highest percentage of amylose and amylopectin the lowest percentage was observed in the BRS Dourada.

Key words: starch; baking; *Manihot esculenta* Crantz; post-harvest; genetic variability

Características físico-químicas de variedades de mandioca de mesa

RESUMO

Com objetivo de avaliar características físico-químicas de dezenove variedades de mandioca de mesa (Milagrosa, Paraguai, Maragogipe, IAC 576-70, Saracura, Amarela Viçosa, IAC Guaxupé, Manteiga, Aipim Furadinho, Calombo, BRS Dourada, Rosa, Manteigão, Pão da China, BRS Gema de Ovo, Colombo, BRS Eucalipto, Cacau Branca e BRS Rosada) foi realizado este estudo na Universidade Estadual do Sudoeste da Bahia, em Vitória da Conquista – BA. Avaliou-se o pH, sólidos solúveis, acidez titulável, textura, tempo de cozimento, teor de amido, teor de amilose, teor de amilopectina, teor de proteína e teor de cinzas de raízes colhidas aos 12 meses de idade. Utilizou-se o delineamento inteiramente casualizado, com 3 repetições. Os dados foram submetidos à análise de variância e, posteriormente, as médias dos tratamentos foram agrupadas pelo procedimento de Scott-Knott, a 5% de probabilidade. Houve diferença entre todas as características, à exceção do teor de cinzas. Observou-se resultados de pH próximos a neutralidade em todas as variedades, sendo os maiores valores encontrados nas variedades Calombo e BRS Gema de Ovo. A variedade Milagrosa apresentou maior porcentagem de sólidos solúveis e maior textura. A variedade IAC 576-70 destacou-se quanto à textura, tempo de cozimento, teor de amido e teor de proteína bruta. A maior porcentagem de amilose e a menor de amilopectina foram observadas na BRS Dourada.

Palavras-chave: amido; cozimento; *Manihot esculenta* Crantz; pós-colheita; variabilidade genética

Introduction

Cassava (*Manihot esculenta* Crantz) is a rustic plant of Brazilian origin with tolerance to different climatic and soil conditions, cultivated in most family farms, and used as a source of carbohydrates in human and animal food (Olsen, 2004; Shons et al., 2009).

With typical agronomic propagation, its multiplication is carried out by means of segments of the stem, denominated branches or manivas. Despite this, cassava presents a wide genetic variability due to the high frequency of cross-pollination, fruit dehiscence and high heterozygosity, which continuously produces a multitude of new materials (Rodrigues et al., 2008).

Cassava varieties can be classified as brave or tame. Wild varieties have bitter taste, high content of cyanogenic glycosides (above 100 mg of HCN equivalent kg^{-1} of fresh root pulp) and are consumed after processed into flour, starch and other products. Tamed, or eatable, varieties are not bitter, have low cyanogenic glycoside content, and are consumed either processed or unprocessed, specially through simple household preparations (Valle et al., 2004).

Besides the hydrocyanic acid content, other characteristics are important in the selection of cassava varieties, such as: low cooking time, good quality of the cooked pasta, absence of straps and pedicel, ease of peeling and absence of fibers (Carvalho et al., 1999). These must be related to good agricultural performance and nutritional value (Mezette et al., 2009).

Starch is the most abundant compound in the roots of cassava and also the most important. It has an initial role of biological energy source and influences various food industry technologies (Denardin & Silva, 2009), as well as, culinary qualities. According to Oliveira et al. (2005), during hydrothermal processing, the starch undergoes modifications that are related to gelatinization and associated properties, such as water absorption and volume increase. These, in turn, are associated with different ratios of amylose and amylopectin, which influence the cooking time and cooked root quality.

Cassava genetic materials from different places and with different levels of improvement are usually found in germplasm banks. Its characterization is necessary for the selection of varieties that present desirable characteristics for producers of a certain region. The objective of this study was to evaluate the physical and chemical characteristics of nineteen tamed cassava varieties grown in Vitória da Conquista - BA.

Material and Methods

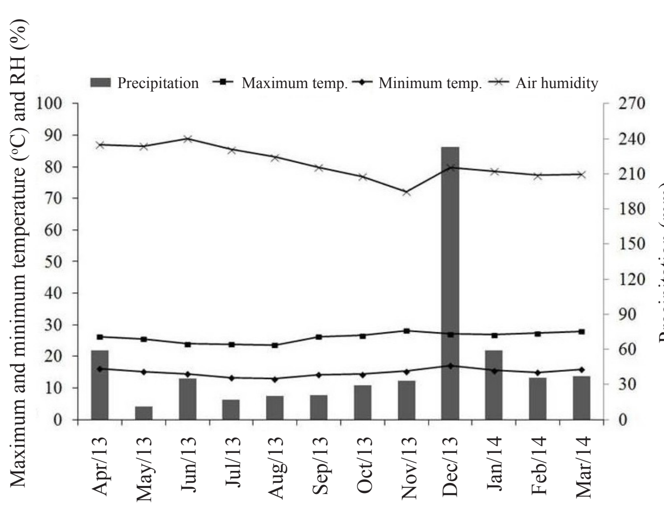
This work was carried out at the State University of Southwest of Bahia (UESB), Vitória da Conquista *Campus* , located at coordinates 14°50'19" South Latitude and 40°50'19" West Longitude, with an average altitude of 928m. The climate of the region is Monsoon-influenced humid subtropical climate (Cwa) according to Köppen's classification. The average annual precipitation is 733.9 mm, concentrated in the months from November to March, and the average annual temperature is 20.2°C with the maximum and minimum varying between 26.4°C and 16.1°C, respectively (SEPLANTEC, 1994). Meteorological data of the period of the experiment are shown in Figure 1.

The soil of the area was classified as Typical Yellow Dystrophic Latosol, with clay-sandy loam texture and flat relief.

Nineteen cassava varieties were evaluated: Milagrosa, Paraguai, Maragogipe, IAC 576-3, Saracura, Amarela Viçosa, IAC Guaxupé, Manteiga, Aipim Furadinho, Calombo, BRS Dourada, Rosa, Manteigão, Pão da China, BRS Gema de Ovo, Colombo, BRS Eucalipto, Cacau Branca, BRS Rosada, obtained from the Cassava Germplasm Collection of the UESB. The design was completely randomized with three replications in which the roots of a plant representative of the useful area were considered the plot.

For establishment of the experiment, the soil was plowed, barred and then 10 cm deep furrows were opened. Manivas measuring approximately 20 cm in length, with 5 to 7 buds, and 2 to 3 cm in diameter. The spacing was 1.0 m between rows and 0.60 m between plants. The planting was carried out in April 2013, with fertilization according to the recommended for the crop. As a consequence of the low rainfall, irrigation was necessary in the first three months to promote budding and survival of plants.

Evaluations were carried out in April 2014, after harvesting the roots. The following parameters were analyzed: a) pH: determined by the AOAC method (1982) in fresh root samples using a Mars, MB10 pH meter; b) Soluble solids: obtained by the AOAC method (1982) in fresh root samples using refractometry in a portable Atto WYT-4 refractometer; c) Titratable acidity: obtained in fresh root samples by titration with 0.1 N NaOH solution and phenolphthalein indicator according to the methodology of the Adolfo Lutz Institute (1985); d) Texture: determined in fresh root samples using a Texture Analyzer TR, model WA68, Italy; e) Cooking time: determined by the method of Pereira et al. (1985); f) Starch content: starch extraction was done according to the methodology adapted from McCready et al. (1950) and the



Source: National Institute of Meteorology - INMET/Vitória da Conquista, State of Bahia.

Figure 1. Monthly averages of rainfall, relative air humidity, and average maximum/minimum temperatures from April 2013 to March 2014 in the city of Vitória da Conquista, BA.

quantification was performed according to the Phenol-Sulfuric method (Dubois et al., 1956); g) Amylose and Amylopectin content: determined in starch according to ISO standards (1987); h) Crude protein: determined in starch by the method of Silva & Queiroz (2002); I) Starch ash content: following the methodology of Silva & Queiroz (2002).

Statistical analysis was performed using the SAEG software version 9.1 (Ribeiro Júnior, 2001). Analysis of Variance was performed and the means of the treatments were grouped by the Scott-Knott criterion, with a 5% probability. The Pearson's correlation coefficient was also calculated at 5% probability.

Material and Methods

Root pulp

Significant differences between varieties were found for pH, soluble solids, titratable acidity, texture and cooking time of cassava roots (Table 1).

The pH values ranged from 6.23 to 6.84 (Table 2), with the Calombo variety having the highest value. Similar results were observed by Oliveira & Moraes (2009) when cultivating IAC 576-70 at 12 months of age. The pH is one of the characteristics that stands out in the post-harvest evaluation of vegetables. It is an important indicator for chemical and biological evaluations in foods and used for recognition and control of natural or artificial processes of the product.

The pH value determines the enzymatic activity, the degree of deterioration of the food, the variation of texture, the degree of maturation of fruits and vegetables, and the choice for the most appropriate packaging and storage medium (Chitarra & Chitarra, 2005). According to Franco & Landgraf (2005), foods with low acidity (pH > 4.5) are more susceptible to microbial development, either pathogenic or deteriorating. In this context, the pH observed in all varieties is favorable to the development of these microorganisms, which may cause a decrease in the storage time of roots.

For soluble solids, the Milagrosa, Manteigão and Pão de China varieties showed higher values, ranging from 8.83% to 5.33% (Table 2), close to that found in the literature (Luna et al., 2013; Andrade, 2013). According to Castricini et al. (2014), soluble solids represent an important parameter used in the post-harvest evaluation, since they alow to infer on the taste of the vegetable. This characteristic can influence the final quality of cassava-based products such as cakes, ice cream, biscuits, purees etc. Higher soluble solid contents tend to provide more sweetness and better taste, meeting the preference of the consumers.

In the present study, there was a negative correlation between soluble solids and starch (r = 0.22*). This result can be explained by the conversion of starch to sugars during root growth and development, which may increase sweetness (Andrade, 2013).

Milagrosa, IAC 576-70, Manteiga, Aipim Furadinho and BRS Dourada varieties presented higher values of titratable acidity (Table 2), which is among the indispensable post-harvest attributes of greenery, According to Chitarra & Chitarra (2005). The values found in the present study are close to those obtained by Luna et al. (2013).

In the present study, Milagrosa, Paraguay, IAC 576-70, Amarela Viçosa, IAC Guaxupé, BRS Gema de Ovo, Colombo and Cacau Branca presented lower values of texture of the raw roots (Table 2), which is related to the degree of acceptability

Table 1. Summary of the analysis of variance and coefficients of variation of pH, soluble solids, titratable acidity, texture and cooking time of tuberous roots of 19 tamed cassava varieties

Sources of variation	Degrees of freedom	Medium squares				
		pH	Soluble solids	Titratable acidity	Texture	Cooking time
Varieties	18	0.0672*	2.8796*	0.3684*	105.1812*	122.4522*
Residue	38	0.0406	0.0877	0.1328	30.3981	4.4210
Coefficients of variation (%)		0.49	4.04	34.45	18.55	11.60

*Significant according to F test at 5% probability.

Table 2. pH, soluble solids, titratable acidity, texture and cooking time of tuberous roots of 19 tamed cassava varieties.

Varieties	pH	Soluble solids (ºBrix)	Titratable acidity (%)	Texture (N)	Cooking time (min)
Milagrosa	6.39 e	8.67 a	1.7 a	28.10 b	12.0 f
Paraguai	6.63 c	7.83 c	0.9 b	28.60 b	11.0 f
Maragogipe	6.75 b	7.00 d	0.8 b	31.13 a	19.0 e
Saracura	6.47 d	7.67 c	1.1 b	35.02 a	15.0 e
BRS Dourada	6.23 f	8.17 b	1.3 a	31.81 a	15.0 e
Rosa	6.71 b	7.00 d	1.1 b	33.93 a	24.0 c
BRS Gema de Ovo	6.69 b	5.67 f	0.8 b	25.38 b	13.0 f
Eucalipto	6.74 b	7.17 d	0.6 b	34.51 a	16.0 e
BRS Rosada	6.64 c	5.33 f	0.8 b	37.44 a	24.0 c
Pão da China	6.64 c	8.67 a	1.1 b	36.43 a	20.0 d
Manteigão	6.47 d	8.83 a	1.1 b	30.34 a	26.0 b
IAC 576-70	6.61 c	6.83 d	1.7 a	22.66 b	14.0 f
IAC Guaxupé	6.58 c	7.00 d	0.6 b	22.35 b	30.0 a
Colombo	6.65 c	6.17 e	0.8 b	20.61 b	13.0 f
Cacau Branca	6.73 b	7.83 c	1.0 b	26.54 b	10.0 f
Amarela Viçosa	6.49 d	7.50 c	1.1 b	17.25 b	13.0 f
Manteiga	6.42 e	8.17 b	1.7 a	33.92 a	16.0 e
Aipim Furadinho	6.66 c	7.33 d	1.3 a	37.05 a	21.0 d
Calombo	6.84 a	6.50 d	0.6 b	31.71 a	31.0 a

Means followed by the same letter in the column do not differ from each other by the Scott-Knott procedure at 5% probability.
v°Brix: Brix degree (1g of sugar per 100 g of solution); %: Percentage; N: Newton unit; Min: minutes

as a function of smoothness and succulence of the product (Feniman, 2004). The concentration of organic acids is directly related to acidity. Thus, the characteristics of flavor, odor and color can be influenced by the concentration of organic acids present in the food, altering the quality of the product.

The characteristics pH, soluble solids and cooking time were useful to distinguish varieties, with a large oscillation in the results found. Titratable acidity and texture oscillated little, forming only two groups.

Variations in cooking time and culinary parameters of cassava roots can occur between roots of the same plant, between plants of the same variety, between different genetic materials and depending on the physiological state of the plants, as well as on the soil and climate conditions (Fialho et al., 2009) and harvesting seasons, with the plants harvested earlier presenting the shortest cooking time (Oliveira & Moraes, 2009).

In the present work, cooking time of roots varied 10 to 31 minutes (Table 2). Of the 19 varieties evaluated in this study, 5.26% presented excellent cooking; 63.16% good cooking; 26.32% regular cooking and 5.26% bad cooking, according to the classification proposed by Pereira et al. (1985). The Cacau Branca variety showed better cooking time (10 minutes). Cooking time is the main feature related to culinary quality. Tamed cassava consumers are exigent about cooking time of roots, which must be as short as possible to be considered of good quality.

The average cooking time observed in this work was lower than the values observed by Talma et al. (2013), Fialho et al. (2009) and Mezette et al. (2009) with 24.5 minutes, 24.8 minutes and 43.8 minutes, respectively. Valduga et al. (2011) studied the acceptability of five varieties of manioc, with an approximate age of eight months, in the Region of Alto Uruguay - RS, and verified that the average cooking time was 25 minutes and that the BRS Gema de Ovo and BRS Dourada varieties stood out with respect to acceptance, taste and texture of the cooked pasta. In the present study, the average cooking time of BRS Gema de Ovo (13 minutes), Saracura (15 minutes) and BRS Dourada (15 minutes) was lower than that obtained by these authors.

There was a positive correlation between cooking time and texture (r = 0.34 *). Such a result is supported by Mezette et al. (2009) and Pereira et al. (1985) who reported a strong relation between the cooking time of cassava roots and their texture, stickiness and plasticity. According to Talma et al. (2013), the lower the cooking time, the better the quality of the cooked pasta.

Starch

Table 3 shows the analysis of variance analysis for starch, amylose, amylopectin, crude protein and ash contents. Significant differences were observed between varieties for all traits, with the exception of ash content.

The starch content ranged from 12.96% to 25.92%, with an overall mean of 19.47% (Table 4). These results can be considered low when compared to those found by Couto (2013) and Silva et al. (2014), which evaluated different cassava clones and found mean starch contents of 25.14% and 24.69%, respectively, by means of acid hydrolysis and hydrostatic balance. In addition to the genetic diversity, variation between starch contents can be explained both by the different environmental conditions and the different methods of quantification employed.

Table 3. Summary of the analysis of variance and coefficients of variation of the characteristics: crude protein, ash, starch, amylose and amylopectin of the tuberous roots of 19 table cassava varieties.

Sources of variation	Degrees of freedom	Medium squares				
		Starch	Amylose	Amylopectin	Crude protein	Ashes
Varieties	18	37.6571*	39.2547*	39.2547*	0.0835*	0.0222^{ns}
Residue	38	4.4984	1.8574	1.8574	0.0298	0.0197
Coefficients of variation (%)		13.40	8.21	1.63	22.00	45.77

*Significant according to F test at 5% probability.

Table 4. Starch, amylose, amylopectin, crude protein and starch ash content of 19 tamed cassava varieties.

Varieties	Starch	Amylose	Amylopectin	Crude protein	Ashes
			(%)		
Milagrosa	18.76 b	13.71 c	86.29 a	0.96 a	0.31 a
Paraguai	24.65 a	17.42 b	82.58 b	0.66 b	0.38 a
Maragogipe	18.95 b	14.01 c	85.99 a	0.99 a	0.28 a
Saracura	24.50 a	17.20 b	82.80 b	1.04 a	0.31 a
BRS Dourada	15.64 b	29.91 a	70.09 c	0.92 a	0.37 a
Rosa	21.57 a	14.36 c	85.64 a	1.16 a	0.43 a
BRS Gema de Ovo	25.92 a	19.04 b	80.96 b	0.74 b	0.30 a
Eucalipto	20.63 a	17.90 b	82.10 b	0.72 b	0.26 a
BRS Rosada	15.64 b	15.88 b	84.12 b	0.64 b	0.37 a
Pão da China	18.53 b	17.32 b	82.68 b	0.85 a	0.32 a
Manteigão	22.88 a	14.27 c	85.73 a	0.60 b	0.29 a
IAC 576-70	24.15 a	16.51 b	83.49 b	0.88 a	0.11 a
IAC Guaxupé	17.73 b	13.29 c	86.71 a	0.65 b	0.44 a
Colombo	23.92 a	15.96 b	84.04 b	0.73 b	0.25 a
Cacau Branca	20.93 a	13.39 c	86.61 a	0.75 b	0.25 a
Amarela Viçosa	17.71 b	15.98 b	84.02 b	0.68 b	0.27 a
Manteiga	12.96 b	16.61 b	83.39 b	0.73 b	0.20 a
Aipim Furadinho	20.92 a	17.01 b	82.99 b	0.52 b	0.24 a
Calombo	22.03 a	15.68 b	84.32 b	0.68 b	0.46 a

Means followed by the same letter in the column do not differ from each other by the Scott-Knott procedure at 5% probability.

Determination of starch by specific gravity (Grossmann & Freitas, 1950) is a methodology widely used in industries. Its recurrent use can be attributed to the necessity of a simple and robust method to quantify starch content, since the starch manufacturers pay for the raw material according to the weight of this carbohydrate. Other methods would be impracticable due to their complexity and high cost. However, the use of hydrostatic balance has been put into question because of the lack of accuracy and precision (Carvalho et al., 2009), which may lead to overestimation of values.

Oliveira et al. (2005) evaluated the starch content in 26 cassava genotypes by the enzymatic hydrolysis method and found values that varied considerably, some being lower than 11% and others higher than 30%. Regarding the present work, it is noted that the starch contents of all analyzed materials are within the range found by these authors.

Although the percentage of starch is more important in the selection of genetic material for the industry, this is also taken into account in the improvement of tamed cassava, especially when considering the use of roots for the manufacture of starch and flour (Silva et al., 2014), as well as the culinary characteristics demanded by the market.

According to Burarelo et al. (2004), during the cooking process (hydrothermal), the starch undergoes modifications related to gelatinization, water retention and increased cell volume. These factors directly influence the final characteristics of cooked roots, resulting in products with adequate textural and structural features and also relevant for the acceptability among consumers (Valduga et al., 2011). This assertion corroborates the present study in which a negative correlation (r = -0.20*) between starch content and cooking time was observed.

Besides determining the starch content of cassava roots, it is important to know their composition, which represents an important aspect for industrial processes (Nunes et al. 2009). This information allows to know the behavior of the starch under certain situations such as temperature and pressure, aiding in the choice of the ideal vegetable source to be used in different applications.

Several technological attributes of the food industry (texture and water retention of certain foods) as well as vital metabolic processes of human nutrition (glycemic response to ingested food) may be influenced by the starch source. These events are attributed to many of the starch structural characteristics, particularly the amylose content, amylopectin chain length distribution and granule crystallinity (Denardin & Silva, 2009).

Among the amylose and amylopectin fractions, amylopectin is structurally and functionally the most important. Amylopectin alone it is sufficient to form granules, as it happens in mutants that are devoid of amylose (Denardin & Silva, 2009). However, the ability to form paste after the starch granule has been gelatinized is attributed to the presence of amylose (Weber et al., 2009).

Table 4 shows the amylose and amylopectin contents of the 19 varieties evaluated in the present study. The average proportion of 1/5 was observed, ranging from 13.29% to 29.91% for amylose and 70.09% to 86.71% for amylopectin, similar to vlues found in the literature (Aviara et al. 2014; Charles et al. 2005).

According to Tester et al. (2004), the different proportions between starch structures occur both among botanical sources as well as varieties of the same species. Depending on the degree of maturity of the plant, variation in the proportion of the two fractions may occur in the same variety.

The high amylose value is of fundamental importance in the manufacture of biofilms. Starch with high levels of amylose promotes greater resistance to moisture, one of the problems related to production of biodegradable films (Nunes et al., 2009). Among the varieties of cassava analyzed, BRS Dourada presented the highest amylose content (29.91%) (Table 4), and can, therefore, be indicated for studies on the use of manioc starch in the production of biofilms. The As variedades Paraguai, IAC 576-70, Saracura, Amarelo Viçosa, Manteiga, Aipim Furadinho, Calombo, Pão da China, BRS Gema de Ovo, Colombo, Eucalipto and BRS Rosada varieties were intermediate, being lower than BRS Dourada and superior to the rest (Table 4).

Regarding amylopectin, an opposite result was observed; there was an inverse relation between amylopectin and amylose fractions (Table 4). Correlation between cooking time and amylose and amylopectin fractions was found to be negative (r = -0.26*) and positive (r = 0.26*) for both structures. This effect is explained by Denardin & Silva (2009) who report the importance of amylopectin in the crystallinity of the starch granule and the participation of the amylose as reducer of the melting point and energy required to initiate the gelatinization. Higher amylose content presents more amorphous regions and, therefore, require less time for the gelatinization process to occur. This reflects in a decrease in the cooking time of roots that have higher amylose content in their starch composition.

In this work, the crude protein content of roots varied between 1.16% and 0.68%, with the highest values presented by the Amarela Viçosa, IAC 576-70, Maragogipe, Milagrosa, Saracura, Rosa and Calombo varieties (Table 4).

In a study by Ceni et al. (2009), crude protein values for the BRS Gema de Ovo and BRS Dourada varieties were found to be 1.8%. The Saracura variety, although presenting a value close to the present study (1.2%), showed the lowest result among the varieties evaluated by the authors.

Charoenkul et al. (2011), evaluating flour and starch in twelve cassava genotypes, also obtained crude protein values considered low, similar to those of this study. Similar results were also found by Ladeira & Pena (2011) when evaluating the physical-chemical characteristics of the sour starch of three cultivars of cassava, and by Charles et al. (2004) when evaluating starch extracted from different cassava genotypes. Based on the data of these and the present work, it can be said that such processing methods do not tend to significantly influence the increase or loss of protein.

Cassava-based products are rich in carbohydrates, but deficient in protein. In this context, researches have focused in minimizing this deficiency and turning cassava roots into a more complete food. The fermentation with *Saccharomyces cerevisiae* and the use of *Spirulina platensis* are methods that may be employed for the increase of crude protein content in cassava products. The introduction of *Saccharomyces cerevisiae* in the root pulp prompts an increase of up to 13.5% of crude protein in its composition (Navacchi et al., 2012; Boonnop et al., 2009).

No significant difference of ash in the starch was observed between the varieties analyzed (Table 4). The mean percentage was 0.27%, higher than that found by Silva et al. (2013) who evaluated tapioca flour produced in the state of Pará (0.12% and 0.04%), and lower than that reported by Oliveira et al. (2007) who studied fresh roots of tamed manioc varieties cultivated in a organic system (1.67% to 1.27%).

Luna et al. (2013) reported a considerable decrease in ash content as a result of the processing of cassava. The results obtained by these authors were 1.35%, 1.01% and 0.15% for tubers, flour and gum, respectively. Values found in the present study presented a lower average than that of the tubers and flour, but higher than that of the gum.

Conclusions

The varieties of cassava showed differences in their chemical, physical and culinary composition, indicating variability in the quality of the evaluated materials;

With the exception of ash content, all variables were effective to evaluate the variability in the physical, chemical and culinary quality of the studied varieties;

The IAC 576-70 variety stood out regarding post-harvest characteristics, presenting a satisfactory performance for texture, cooking time, starch content and crude protein. This was considered the variety that most meets the consumer's requirements, since the aforementioned characteristics are closely related to palatability, softness, sweetness and nutritional composition of foods.

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