https://dx.doi.org/10.22161/ijaers.712.25 *ISSN: 2349-6495(P) | 2456-1908(O)*

Physicochemical characterization of six yam (*Dioscorea* spp) species

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Received: 1 Nov 2020; Received in revised form: 20 Nov 2020; Accepted: 25 Nov 2020; Available online: 22 Dec 2020

Abstract**—** *Yam is a crop with economic and social significance for the Brazilian Northeastern region. The objective of the present work was to analyze the physicochemical characters of six yam species in order to verify variations in chemical composition within the species (inter and intra-species) germplasm. The experimental was performed under a completely randomized design with six treatments and three replicates. Contents of lipids, humidity, ashes, proteins, starch, reducing sugars and the content of total sugars were evaluated. Regarding physical measures, weight of tubers with peel (kg) and weight of tubers without peel (g), tuber length (cm), longitudinal and transversal diameter (cm), longitudinal and transversal thickness (cm) were determined. The results were submitted to analysis of variance (ANOVA), F test and means were compared by the Tukey test ($p<0.05$) using the statistical software R. High significant statistical difference ($p<0.05$) was observed for all physicochemical characteristics analyzed. Yam species designated as 'Jiboia' showed the highest tuber weight (76.96), higher pulp weight (76.26), higher tuber length (74.76) and higher longitudinal diameter (67.76). The species Dioscorea rotundata was also prominent showing higher contents of ashes (1.40), starch (85.20), lipids (1.23) and protein (2.14) and the species D. trifida showed the lowest contents of lipids (0.59), protein (1.07) and reducing sugars (1.06). Results in the present study evidenced inter-specific and intra-specific variations in chemical composition of yam germplams.*

Keywords**— Variability, nutrient contents, yam tubers.**

I. INTRODUCTION

In addition to its excellent nutritional and energetic qualities, Yam (*Dioscorea* spp.), has an accessible price in the market and its tubers have been of great importance in Brazilian nourishing, yam can also be considered as a raw material source for the food industry [14]. For millions of people around the world it constitutes a food with accessible prices and it has been widely used as raw material in a food production chain with benefits for farmers and consumers [6]. Yam has nearly 600 species, with the most important being those originated from tropical regions in Asia and West Africa, which produce edible tubers: *D. cayennensis, D. rotundata and D. esculenta* originated from Africa; *D. alata* originated from Asia [13], [18], [17]. These species are preserved by small traditional farmers [8].

Due to its nutritional value and astringent some *Dioscorea*species have been used against malnutrition and to treat various diseases, such as diabetes and to help reducing cholesterol.

Despite the species *Dioscorea spp.* having high nutritional value, research regarding this tuber are still scarce and consequently their nutritional properties are unknown [9]. The objective of this study was to perform physicochemical analyses in order to identify if there are variations in the chemical composition of yam access at intra- and infra-species level.

II. MATERIAL AND METHODS

Physicochemical analyses were performed at the Laboratory of Food Sciences and Technology from Embrapa Yam and Fruit Culture, in Cruz das Almas,

https://dx.doi.org/10.22161/ijaers.712.25 ISSN: 2349-6495(P) | 2456-1908(O)

Bahia-Brazil. Yam tubers were firstly visually inspected and evaluated regarding their sanity, physical integrity, size and form. Then, tubers were washed in tap water and then weighed in semi analytic balance, peeled and mechanically sliced.

Physical measurements consisted in: weight of tuber with peel (kg) and weight of tubers without peel (g) obtained using a digital balance (Ramuza®, model DCR-15 Bat); tuber length (cm), longitudinal and transversal diameter (cm), longitudinal and transversal thickness (cm) using a ruler graduated in mm and a digital caliper (Ford®); then tubers were cut in halves and the longitudinal and transversal thickness was evaluated, as well as the weight of the tuber without peel. After peeled and measured, tubers were cut in smaller pieces obtaining a sample of 600 g for each species for chemical analysis.

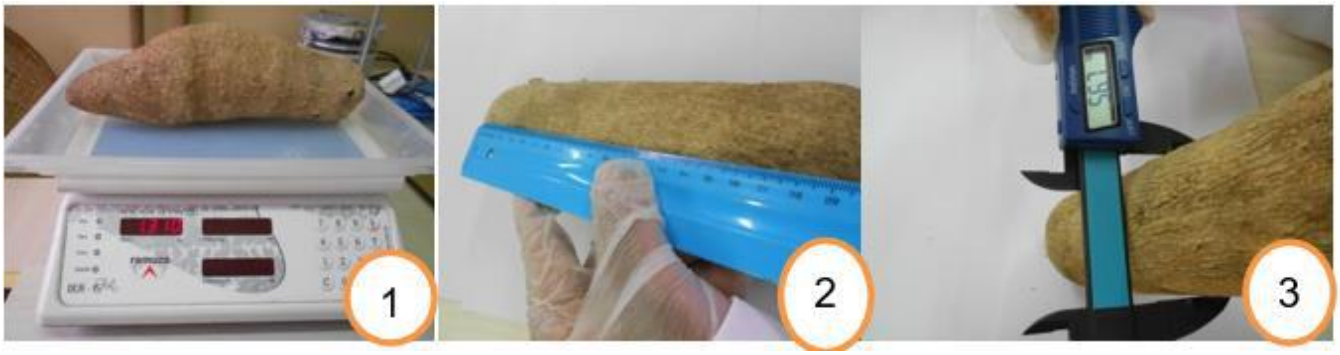

Fig.1: Weighting of yam tubers (1); measuring length of tubers (2); measuring tuber diameter (3)

Fig.2: Cutting tubers (1); weighting tubers without peel (2); measuring tuber thickness (3)

Chemical analyses included the content of ashes, lipids, humidity, protein, starch, reducing sugars and contents of total sugars, obtained according the recommendations from [9]. The experimental design chosen was completely randomized with six treatments and three replicates. Results were submitted to analysis of variance (ANOVA), F test and means compared by the Tukey test ($p<0.05$). The statistical software R® was used to perform all data analysis [15].

III. RESULTS AND DISCUSSION

Mean values from the physical analysis of yam tubers are showed in Table 1. Yam tubers form the species denominated 'Jiboia' showed higher tuber weight (76.96), higher pulp weight (76.26), higher tuber length (74.76) and higher longitudinal diameter (67.76). 'Da Costa' yam showed higher transversal diameter (63.76), transversal thickness (71.50) and longitudinal thickness (72.30). Yam species called 'Iambu' showed the lowest values for tuber weight (8.46), pulp weight (8.00), tuber length (8.66), transversal diameter (14.60), transversal thickness (14.66) and longitudinal thickness (14.53).

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Table 1.Values of tuber weight, pulp weight, tuber length, longitudinal diameter, transversal diameter, transversal thickness and longitudinal thickness of six yam species.

Yam species	Tuber weight	Pulp weight	Tuber length	Longitudinal diameter	Transversal diameter	Transversal thickness	Longitudinal thickness
Jiboia	76.96 a	76.26 a	74.76 a	67.76 a	56.73 ab	65.40 ab	69.96 ab
Da Costa	66.66 b	67.66 b	74.83 a	70.60 a	63.76 a	71.50 a	72.30 a
São Tomé	52.36 c	54.53 c	44.10 b	63.46 a	51.60 abc	60.03 b	61.73 b
Roxo	46.00 c	42.63 d	48.30 b	32.30 b	46.16 bc	43.03 c	23.50 c
Fígado	22.53 d	23.90 e	22.33 c	12.60 c	40.13 c	18.36 d	30.96 c
Iambu	8.46 e	8.00 f	8.66 d	26.26 b	14.60 d	14.66 d	14.53 d

Means followed by the same letter do not differ statistically by the Tukey test at 5% probability.

'Da Costa' and 'Roxo' yam species showed the highest content of ashes. The lowest contents of ashes were observed in 'São Tomé' and 'Iambu' (Table 2). Contents of ashes were considered within the expected values, as previously reported [10], when the total content of ashes varied from 0.05 to 1.76. In a similar manner [12] observed an average of 0.90, while [3] in a study characterizing *Dioscorea alata* as food product, registered values varying from 3.83 to 6.49 for the content of ashes.

'Da Costa' yam showed the higher content of lipids and the lowest content was verified in 'Iambu' species (Table 2). The values for lipid contents observed in the present study are similar to those observed by [7], while studying the composition of nutrients in *D. bulbifera* with a lipid contents varying from 0.11 to 0.3. The majority of tubers showed low contents of ashes, lipids and proteins; and predominance of high values for total carbohydrates' contents in the form of starch, therefore, being considered energetic foods [5].

'Da Costa' yam showed the highest protein content, while the lowest protein content was observed in the species 'Iambu'(Table 2). These results are similar to [2], when studying Indonesia yam with protein contents varying from 1.2 to 1.8. On the other hand, [15] observed values from 4.03 to 6.52 in Ghana yams. Low protein concentrations may be justified due to the gathering starch during tuber development.

Yam form the species *D. alata*has high contents of starch and has been part of the Southeast Asia and African diets in addition to Chinese traditional medicine due to its anti-inflammatory properties. Starch is an edible polymer derived from vegetals an one of the most important ingredients to prepare several meals [1]. Our results are in agreement with [11] who emphasize the contents of starch in tubers from within the same species or from different species may diverge due to the differences in the activity of enzymes participating in starch biosynthesis. The lowest starch content was observed in the species*D. trifida* (Table 2).

Yam species *D. rotundata*showed higher contents of reducing sugars and total sugars, with the lowest contents of reducing sugars registered in the species *D. trifida* (Table 2).

Table 2. Mean values for contents of ashes, lipids, proteins, starch, reducing sugars and total sugars in six yam species.

Yam species	Ashes	Lipids	Moisture	Proteins	Starches	Reducing sugar	Total sugar
Da Costa	1.40 a	1.23a	76.16 a	2.14 a	85.2 a	2.47 a	12.34 a
Roxo	1.39 a	0.93 b	75.44 b	1.91 b	78 b	2.04 b	9.32 b
Jiboia	1.23 b	0.83 c	72.59 c	1.45 c	63 c	1.42 c	7.40 c
Fígado	1.21 bc	0.71 d	66.00 d	1.38 cd	60 c	1.16 d	6.62 d
São Tomé	1.16 bc	0.70 d	65.40 e	1.33 d	60.02 c	1.14 d	5.91 d
Iambu	1.08 c	0.59 e	65.11 e	1.07 e	43. 0d	1.06 e	5.90 d

*Means followed by the same letter do not differ statistically by the Tukey test at 5% probability.

A significant effect was observed for contents of ashes, lipids, proteins, reducing sugars, total sugars and humidity, as shown in Table 3. The coefficient of variation was of 4.32% for contents of ashes, 3.09% for lipids contents, 2.20% for protein contents, 2.58% for starch

https://dx.doi.org/10.22161/ijaers.712.25 *ISSN: 2349-6495(P) | 2456-1908(O)*

contents, 1.60% for contents of reducing sugars, 3.53 for total sugar contents and 0.16% for humidity.

Table 3. Analysis of variance (ANOVA) obtained for physicochemical characterization of different yam (Dioscorea spp.) species, analyzing the contents of ashes, lipids, proteins, starch, reducing sugars, total sugars and humidity.

VS	LD	SM						
		Ashes	**Lipids**	**Humidity**	**Proteins**	**Starch**	**Reducing sugars**	**Total sugars**
Treatment	5	0.68**	0.72**	81.49**	0.73**	673.36**	0.67**	18.23**
Residue	12	0.29	0.67	0.13	0.16	2.79	0.61	0.83
Total	17							
CV(%)		4.32	3.09	0.16	2.2	2.58	1.6	3.53

VS (Variation source), LD (Liberty degrees), SM (Square medium), ** and * = significant at 1 and 5%, respectively, by the F test, ^{ns}non-significant.

IV. CONCLUSIONS

We have verified the importance of studying the chemical composition of tubers in order to contribute to the understanding and knowledge of nutritional properties of yam species that have been neglected.

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