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Influence of Technique Cultivation on Some Properties of Two Varieties of Yam (*Dioscorea spp*) Flour

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

All most of roots, tubers and seeds studied have been carried out under environmental control or glass. These methods had an advantage to minimize environmental effects on crop due to unequal distribution of the nutriment in the soil. This, have been often observed through the variability of size and form of the tubers harvested generally in farm condition. In order to evaluate the variations occurred on the nutritional (Ash, while protein and fat) and functional (clarity and swelling-solubility) values, yams cultivated in nursery gardener sachet have being compared to those of famer condition. This study has been conducted 2013-2014. Yam grown in nursery gardener sachet has the highest ($p < 0.05$) ash content (4.58 ± 2.18%) than this of field (1.53 ± 0.35%). Flour clarity is also affected by technical cultivation. This property is more improved by the cultivation in nursery gardener ($p < 0.05$). The cultivation in nursery gardener improved ash content and clarity of the suspension of yam flour.

Keywords: Yam; flour; cultivation technique; nutritional values; mound; nursery bag.

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1. INTRODUCTION

Yam is a tuberous plant belonging to the genus dioscorea with more than 600 to 800 species [1]. Some of these species are exploited for economic purposes including food and pharmaceutical industries where they are used for more than 2/3 of the world production in sex hormones and corticosteroids [2]. A number of species represent an important source food for African populations [3]. It is a demanding plant in terms of nutrients and therefore requires fertile soil. Several factors, including viral threat, photoperiod, culture period, influence plant growth and yield [4]. Generally, late plantings are less productive [5]. Yam production is heavily dominated by West Africa with over 95% [6]. However, the scarcity of fertile land due to the extensive mode of agriculture practised by the farmers leads them to opt for other less demanding crops such as cassava, rubber. In practice, the farmers redouble efforts in soil preparation. Because the cultivation of yam in the mound or ridge of larger size (0.8-1 m high) requires more work and means [7]. This agricultural practice could be a factor contributing to soil degradation through the resulting erosion. Also, global warming and reduced rainfall could have an adverse effect on yam productivity. According to modelling work, production yield is expected to fall by 2050 [8]. In order to cope with the decline in production, it would be wise to find ways and techniques that could contribute to improving the cultivation of yams in this new climate change context. This is how the cultivation of yams in biodegradable nursery bags was initiated. It uses cow dung, pork dung, sawdust and poultry manure as inputs. It thus contributes to the reduction of the pollution caused by the activities generating this waste encountered in the city or in the periphery.

The objective of this study is to compare the nutritional and functional properties of flour obtained in nursery culture with that obtained in mound.

2. MATERIALS AND METHODS

2.1 Experimental Field

Two yam varieties: bête-bête (*Dioscorea alata*) and kangba (*Dioscorea cayenensis*) were grown in nursery gardener sachet (Fig. 1a) and field (Fig. 1b) at University of Nangui Abrogoua (Abidjan, Côte d'Ivoire). The watering has been done what is necessary. The nursery gardener sachet has been filled up with the same land of field enriched with droppings and arranged (1 m x 0.5 m). For the field conditions, the mounds are distant from more than one meter. The plots (625 m^2) and climate condition were the same. Randomized block design with three replications was used for the experiment.

2.2 Methods Analysis

Flour preparation: After peeled and washed, yam tuber was cut into small lamella, oven-dried at 50ºC for 48 h then ground. The moisture content of samples was determined by ovendrying for 24 h at 105ºC. The flour obtained from was submitted to nutritional tests. Ash was obtained by incineration of yam flour into a furnace mitten at 550ºC for four houses. Fat content was determined by Soxhlhet. Crude protein was calculated from nitrogen (Nx6.25) obtained using the Kjeldahl method described by AOAC [9]. Paste clarity was determined according to the method described by Craig et al. [10]. Transmittance was determined for 1% (w/w) of yam flour dispersion, employing a spectro-photometer (MILTON Roy, United States).

Fig. 1. Yam fields; a) yam cultivation in mound, b) yam cultivation in nursery bags. Planting density is higher in cultivation in the nursery bags than the mound

s: stakes, ys: yam stem, m; mound, nb; nursery bag

In order to study the influence of the cultivation technique on the swelling power and solubility of starch, two temperatures (65ºC and 95ºC) was used. The flour suspension of 1% (w/w) was of starch, two temperatures (65ºC and 95ºC) was used. The flour suspension of 1% (w/w) was stirring. After cooling for 15 min at room temperature, it was centrifuged (SIGMA 3-16P, Germany) at 5000 rpm for 30 min. the supernatant was immediately separated from the sediment, both were oven-dried (105ºC for 24 h), weighed. The swelling power and solubility was determined according to [11]. Samples were analyzed in triplicates. The average comparison was made by the software SPSS Statistics 25.0 at the threshold of α equal to 5%.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Nutritional values

Flours obtained from the bete-bete species grown in buttes and nursery bags have statistically identical sugars, lipids, proteins and pH (*P = 0.05*), except for ash content. The pH values are respectively 1.53 ± 0.35% and 4.58 ± 2.15% of dry matter for yam flour grown in the mounds and that obtained in cultivation in the nursery bag. For the kangba variety, the statistical analysis shows significant differences (*P = .05*) only in the sugar content.

The concentration of sugars in yam flour grown in butte (FKb) is high compared to the ones obtained from in nursery bag (FKs). Total sugar content is 4.54 ± 0.20% and 3.62 ± 0.42% dry matter respectively for FKb and FKs flours. Other parameters studied, namely ash, lipid, protein, and pH, showed no significant differences (*P = .05*).

3.1.2 Functional properties of flour

The solubility and swelling powers of yam flour did not varied according to the cultivation technique (Table 2).This, is not the case for the percentage of transmittance. The clarity of the flour suspension varies considerably from one flour to another, regardless of the type of mound or sachet cultivation. It is 16,50 ± 0,77% and 14,55 ± 0,28% for the FBS and FBb flour respectively and 14,35 ± 0,65% and 12,18 ± 0,48% for the FKS and FKb flour respectively.

3.2 Discussion

Statistical analysis of the results obtained showed that there were no significant differences in swelling and solubility, protein and lipid content of the flours studied. It is concluded that this cultivation technique would not influence these biochemical parameters. In fact, whatever the variety and the cultivation technique, the swelling and solubility increase with the cooking temperature. A rise in temperature would be at the origin of this phenomenon. The swelling and solubilizing powers would be more related to the botanical origin than to the variety as well as the cultivation technique [12,13]. In addition, there is a positive linear correlation

Table 1. Nutritional values of yam flour (g/100 g of dry matter)

Varieties	Sample flours	Ash (%)	Lipids (%)	Total sugar (%)	Reducing sugar (%)	Protein (%)
Bètè-bètè	Nursery gardener	1.53 ± 0.35^{a}	0.16 ± 0.02^{a}	4.54 ± 0.07^{a}	1.4 ± 0.09^{a}	3.66 ± 0.51^{a}
	Field	4.58 ± 2.15^{b}	0.17 ± 0.03^{a}	4.17 ± 0.47^{a}	1.77 ± 0.29^{a}	3.08 ± 0.17^{a}
Kangba	Nursery gardener	1.62 ± 1.08^{a}	0.16 ± 0.05^{a}	4.54 ± 0.2^{a}	1.64 ± 0.01^{a}	1.97 ± 0.21^{a}
	Field	2.5 ± 1.6^{a}	0.15 ± 0.03^{a}	3.62 ± 0.42^{b}	0.94 ± 0.01^{b}	2.4 ± 0.26^{a}

Means with the same letter are not significantly different at P = .05 for each variety and column

Table 2. Two functional properties of yam flour (g/100 g of dry matter)

Varieties	Sample flours	Transmittance (%)	Swelling (%)		Solubility (%)	
			65°C	95°C	65°C	95°C
Bètè-bètè	Nursery gardener	16.5 ± 0.77^{a}	15.2±3.95^{a}	26.1 ±2.5^{a}	7.2 ±1.7^{a}	16 ±.3.5^{a}
	Field	14.55 ± 0.28^{b}	12.3 ±3.8^{a}	29.6 ±3.6^{a}	7.67 ±1.2^{a}	13.3 ±2.6^{a}
Kangba	Nursery gardener	14.35 ± 0.65^{a}	15.9 ±1.3^{a}	28.2 ±1.9^{a}	7.1 ±2.6^{a}	14.3 ±3.5^{a}
	Field	12.18 ± 0.48^{b}	11.2 ±3.5^{a}	31.3 ±3.1^{a}	4.6 ±1.2^{a}	14.7 ±1.6^{a}

Means with the same letter are not significantly different at P = .05 for each variety and column between the absorbency and solubilizing power of the flours studied. This was observed in previous work for other tubers [14]. The levels of lipid and protein obtained did not vary with any cultural technique. The levels obtained ranged from 0.15 to 0.17 g/100 g dry matter for lipids and from 1.97 to 3.66 g/100 g dry matter for protein. These values are lower than those observed by Aruna et al. [15]. According to this work, fermentation of yam flour by Saccharo-myces Cerevisiea improves protein content. On the other hand, soaking in water for hours has no impact on the lipid and ash content [16].

On the other hand, statistically significant differences were observed in clarity, Ash content and sugar content. The values of clarity are generally lower than those obtained for kangba starch (42%) [17] and Bètè-bètè starch (31%) [18]. Craig et al. [10] have shown that the clarity varies considerably with the source of starch, the amylose/amylopectin ratio, the chemical or enzymatic changes, and the addition of solute. Variation in clarity could not be the effect of cultural technique. In fact, it varies within the same tuber, especially for the variety bete-bete. The middle part gives a clearer gel than both ends [19].

Ash levels for the Bètè-bètè variety are higher in the bag culture than in the butte culture. The sugar content for the variety kangba, is higher in the butte culture than in the sachet. These observed variations from one culture technique to another could be explained by the effect of environmental conditions on the structural and physico-chemical properties of starch [20].

4. CONCLUSION

The nutritional composition of the flours studied is not influenced by the technical cultivation, except ash content of bête-bètè variety. Yam grown in nursery gardener sachet has the highest (P = $.05$) ash content (4.58 ± 2.18%) than this of field (1.53 ± 0.35%). Flour clarity is 128 also affected by technical cultivation. This property is more improved by the cultivation in 129 nursery gardener (P = $.05$). The cultivation in nursery gardener improved ash content and clarity of the suspension of yam flour.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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