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EFFECT OF DRYING METHODS ON THE NUTRITIONAL COMPOSITION OF SOME SELECTED YAM VARIETIES CULTIVATED IN UMUDIKE, ABIA STATE, NIGERIA

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Abstract

Yams are widely grown and consumed in various forms; these tropical food crops are abundant at a particular period. Since these food crops are highly perishable after harvest, drying is a common practice for preserving them. White yam (*Dioscorea rotundata*) and water yam (*Dioscorea alata*) were collected from (National Root Crops Research Institute Umudike) yam barn. The study investigated the effect of sun-drying and oven-drying methods on the nutritional composition of water yam and white yam varieties. Oven-drying was done at 60°C for 72 hrs, while sun drying was for 3 days, until a constant weight was obtained. The functional properties, proximate composition, mineral contents and pH were determined to investigate the effect of dry methods on the nutritional value of the yam flour. It was observed that all parameter examined were affected by the dry methods as they varied in composition with two different processed samples (sun and oven dried). The result showed that the proximate composition for samples sun dried were 5.01%, 3.45%, 1.93%, 0.65% and 85.63%, while samples oven dried were 6.46%, 1.23%, 2.26%, 1.60%, 0.77% and 87.35% respectively. Bulk density, water absorption capacity, oil absorption capacity, swelling power and gelation temperate for samples sun dried were 0.66%, 3.54%, 2.73%, 4.22% and 70.58[b]% respectively. The results of the experiment shows that sun dried yam flour retained the highest value in protein, ash, fiber, CHO and bulk density, and also in minerals (Ca, Mg and P), compared to oven dried method except moisture content which had a higher value than samples sun dried. Therefore, sun dried yam flour had the highest value, thereby retaining the best nutritional composition of the samples.

Keywords: **Sun dry, oven dry, *Dioscorea alata, Dioscorea rotundata***

Introduction

Yams are widely grown and consumed amongst various communities in the tropics, among them are *D. rotundata* and *D. alata* which are important tubers in West Africa. These tropical food crops are abundant at a particular period, when they are in season, and scarce during the off season (when they are out of season). Since these food crops are highly perishable after harvest; drying is a common practice for preserving them, in order to make them available throughout the year (Habou *et al*., 2003; Eklou *et al*., 2006). Sun and oven drying are the popular drying methods used in drying these food crops; with sun drying as the most common practice (Matazu and Haroun, 2004). These food crops, when dried, are processed to produce flour which can be reconstituted to form paste or dough (Emperatriz *et al*., 2008; Bricas *et al*., 1997). In West Africa, Nigeria, yam flour is used to produce a paste known as *amala* that is eaten with soup by the consumers (Akingbala *et al*., 1995; Akissoe *et al*., 2001; Hounhouigan *et al*., 2003). These two drying methods (sun and oven) utilize heat to remove water from food by evaporation. The removal of water by heat has been reported to affect the nutrient contents of food in various ways (Matazu *et al*., 2004). It can either increase the concentration of some nutrients by making them more available, or decrease the concentration of some nutrients (Hassan *et al*., 2007; Morris *et al*., 2004; Ladan *et al*., 1997). This study was therefore carried out to establish the effects of these various drying methods on the nutrient composition of these important food crops, in order to determine the most suitable method that will not only increase their shelf life, but also retain their nutrients adequately.

Materials and Methods

White yam and water yam were collected from NRCRI Umudike yam barn.

Sample preparation

The yams were washed with clean water, peeled using stainless kitchen knife and sliced into smaller pieces of about 3mm thickness. The slices were divided into two sets, one set sun-dried for 3 days until a constant weight was obtained, while the other set was oven dried at 60°C for 72 hrs. The dried slices were milled with a hammer mill, and then sieved under laboratory sieve of 600mm aperture size, and stored in an air tight container for further laboratory analysis.

Determination of proximate composition

Moisture, protein, crude fat, crude fibre and ash contents of the four yam flour samples were determined according to standard methods described by AOAC (1995), carbohydrate was determined by difference.

Determination of functional properties

The water absorption capacity and oil absorption capacity were determined by the method of *et al*. (2007) with some modifications. One gram (1g) of each sample was weighed into a beaker, 10ml of water was added and the suspension stirred with magnetic stirrer for 1min. The suspension was then allowed to stand for 30mins at room temperature, after which it was centrifuged (New Life Centrifuge NL-90-2) at 5,000rpm for 30mins. After centrifugation, the volume of the supernatant was measured and the result expressed as volume (ml) of water absorbed per 100 g of the sample. The same procedure was used for oil absorption capacity, except that water was replaced with vegetable oil of specific gravity of 0.98g/ml. The swelling power of the samples was determined according to the method described by Leach *et al*. (1959), with some modifications. The weight of centrifuge tube containing 1.25g of the sample was taken; the sample was turned to slurry by adding 10ml distilled water. Slurry was heated at a temperature of 70°C for 30mins. in a water bath, cooled to room temperature and centrifuged at 2300 rpm for 30 min. The supernatant was decanted and the centrifuged tube was placed in a hot air oven to dry for 30 min. at 45°C, the residue was then weighed. The swelling power was expressed as the ratio of the weight of flour paste to the weight of dry flour. The bulk density was determined by the method describe by Onwuka *et al*., (2007).

Determination of the gelation Temperature

The least gelation concentration was determined by the method of James *et al*. (1995). Test tubes containing suspensions of 2, 4, 6, 8, and up to 20% (w/v) flour in 5ml distilled were heated for 1h in boiling water, followed by cooling in ice and further cooling for 2h at 4°C. The least gelation concentration was the one at which the sample did not fall down or slip when the test tube was inverted.

pH determination

Ten gram (10g) of the sample was dispersed in 100ml distilled water, mixed thoroughly and filtered; the pH of the filtrate was measured using pH meter (Starter 2100 Bench pH Meter) which had been previously standardized with buffer solution of pH 4 and 9. The energy value was calculated using Atwater factor.

Determination of minerals (calcium, magnesium and potassium)

The mineral content of each sample was determined by James *et al*. (1995); dry ash extraction method following specific mineral element. Exactly 2g of the sample was burnt to ashes in a muffle furnace at 500ºC. After complete ashing, the ash was diluted with 1% Hydrochloric (HCl) acid, then filtered into a 100ml standard flask, and made up to the mark with deionized water. The solution was read with AAS machine (model No: Analysis 400, Serial No 201510114102) for the determination of potassium, iron, magnesium and sodium. All values was expressed in mg/100g

Statistical analysis

One way analysis of variance (ANOVA) was used to compare means of variables and results were expressed as means of variables, with the statistical package for social sciences (SPSS).

Results and Discussion

The proximate composition of the yam samples are shown in Table 1: moisture content of processed sample ranged from 5.01% (sun dried white yam) to 7.82% (oven dried water yam); Protein, 0.79% (oven dried water yam) to 5.56% (sun dried white yam); ash, 1.89% (oven dried water yam) to 3.23% (sun dried white yam); fiber, 1.11% (oven dried water yam) to 1.93% (sun dried white yam); fat, 0.18% (oven dried water yam) to 0.75% (sun dried white yam) and CHO, 80.74% (oven dry water yam) to 88.74% (sun dry white yam). The functional properties of yam tuber are shown in Table 2. Bulk density ranged from 0.61 to 0.67%; high in sun dried white yam flour and lower in oven dried water yam flour. Water absorption capacity ranged from 2.52 to 3.54%; high in sun dried white yam flour and lower in oven dried water yam flour. The oil absorption capacity ranged from 2.21% to 2.73%; high in sun dried water yam flour and lower in oven dried white yam flour. The range of swelling power and gelation temperature for oven dry water yam four was 3.30% and 60.45°C, and for sun dried; 4.48% and 70.58°C respectively. For minerals in the processed yam tuber: calcium ranged from 1.12% (oven dried water yam) to 3.82% (sun dried white yam); magnesium, 1.23% (oven dried water yam) to 2.74% (sun dried white yam); potassium, 2.44% (oven dried water yam) to 4.63% (sun dried white yam); tannins, 0.21% (oven dried water yam) to 1.14% (sun dried white yam). ph ranged from 5.21% (oven dried water yam) to 6.10% (sun dried white yam).

The moisture content of the yam tuber is usually high which is contrary to the values obtained in this study; however, it is in agreement with the findings as reported by Riley *et al*. (2006). Flour range of crude protein content from 0.79% - 5.56% showed significant difference among the test samples, and of nutritional benefit (Dugler *et al*. 2002). Intake of staple foods with low protein content may lead to several impaired biological processes in the body. This shows that *D. alata* is rich in starch and can provide energy to the consumers. The values obtained in this study have low gelation temperature. Yam has high starch content and thus will take longer time to gel; low gelation temperature is an indication of high starch content. When starch content is low, it takes a longer time to gel (Ojinnaka *et al*., 2016). The increase in bulk density from 0.61% - 0.67% was high in sun dried white yam flour; drying decreases the bulk density of flour, but the presence of moisture increase the bulk density. According to Hayata *et al*. (2006), bulk density gives an indication of the relative value of packaging material required. Also, the water absorption capacity will be high and the wettability is due to the reduced moisture content of the yam flour. Water absorption capacity of 3.54% was high in sun dried white yam flour and lower in oven dried water yam flour. Water absorption capacity is important in the development of ready to eat food and a high absorption capacity may assure product cohesiveness (Houson *et al*., 2002). The oil absorption capacity of 2.21% was low in oven dried white yam flour, Low in oil absorption capacity, and showed no significant difference ($p \leq 0.05$). Presence of moisture content lowers the oil absorption capacity of the flour, Hayata *et al*. (2006). Minerals are biological components of diets which perform biochemical and physiological functions in living cells through synergistic interactions or independent modulation of biological reactions, Dugler *et al*. (2000).

Conclusion

Acceptable yam flour can be produced through different drying methods depending on use. The results of the experiment carried out on the yam flour indicated that some drying methods affect the nutritional component of the dried yam flour, not only altering the biochemical composition, but nutritional contents. The results of this study revealed that sun drying method of drying yam tubers has significant effect on the nutrient content and gelation temperature, protein, ash, functional properties and minerals elements. Sun drying method therefore, has been found to be a good method to produce yam flour with better retention of nutritional contents.

Table 1: Proximate composition of yam flour

Methods	Samples	Moisture%	Protein%	Ash %	Fiber %	Fat %	CHO %
Sun	TDr160	5.01^{h}	3.45^{c}	3.23^{a}	1.93^{a}	0.65^{d}	85.63^{d}
Oven	TDr160	6.49^{f}	1.23^{g}	2.76^{c}	1.60^{c}	0.77^{a}	87.35^{b}
Sun	TDa194	6.54^{e}	2.87^{e}	2.67^{c}	1.75^{b}	0.68^{c}	85.49^{e}
Oven	TDa194	6.73^{d}	0.79^{h}	1.89^{f}	1.42^{d}	0.43^{f}	80.74^{g}
Sun	TDr206	7.55^{a}	5.56^{a}	3.06^{b}	1.66^{c}	0.71^{b}	88.46^{a}
Oven	TDr206	7.67^{c}	3.37^{d}	2.65^{d}	1.23^{e}	0.23^{f}	84.85^{f}
Sun	TDa247	6.05^{g}	4.55^{b}	2.34^{e}	1.04^{f}	0.49^{e}	85.53^{e}
Oven	TDa247	7.82^{b}	2.49^{f}	1.86^{f}	1.11^{f}	0.18^{g}	86.54^{c}

Means with the same letter in a column are not significantly (p _ 0.05) different. **TDr =** ***Dioscorea rotundata*****, TDa =** ***Dioscorea alata***

Table 2: Functional properties of yam flour

Dry Methods	Samples	BDg/m	WAC%	OAC%	SP%	GT°C
Sun	TDr160	0.63^{d}	3.54^{a}	2.21^{f}	3.30^{h}	60.75^{g}
Oven	TDr160	0.61^{f}	2.52^{f}	2.43^{d}	4.48^{a}	60.42^{d}
Sun	TDa194	0.65^{c}	3.32^{b}	2.34^{e}	4.22^{b}	60.75^{g}
Oven	TDa194	0.62^{e}	2.67^{e}	2.54^{c}	3.37^{g}	60.71^{d}
Sun	TDr206	0.67^{a}	2.70^{d}	2.58^{c}	3.62^{e}	70.08^{c}
Oven	TDr206	0.65^{c}	2.84^{c}	2.68^{a}	3.56^{f}	60.51^{f}
Sun	TDa247	0.67^{a}	2.76^{d}	2.73^{b}	3.75^{d}	70.58^{b}
Oven	TDa247	0.66^{b}	2.65^{e}	2.42^{d}	3.87^{c}	70.33^{a}

Table 3: Mineral composition of yam flour

Methods	Samples	Ca %	Mg %	P %	Tan %	pH %
Sun	TDr160	3.82^{a}	2.62^{b}	3.12^{e}	1.14^{b}	6.10^{a}
Oven	TDr160	2.67^{c}	1.42^{f}	2.59^{f}	0.23^{f}	5.70^{b}
Sun	TDa194	2.69^{c}	2.74^{a}	3.26^{d}	0.67^{e}	5.04^{e}
Oven	TDa194	2.19^{e}	1.23^{g}	2.44^{g}	0.14^{g}	5.37^{c}
Sun	TDr206	3.76^{b}	2.52^{c}	4.63^{a}	1.02^{c}	6.09^{a}
Oven	TDr206	1.93^{f}	1.87^{e}	3.76^{c}	1.34^{a}	5.34^{c}
Sun	TDa247	2.45^{d}	2.44^{d}	3.98^{b}	0.88^{d}	5.68^{b}
Oven	TDa247	1.12^{g}	1.26^{g}	2.48^{g}	0.21^{f}	5.21^{d}

References

Akingbala, J.O., Oguntimein, G. B. and Sobande, A. O. (1995). Physico-chemical properties and acceptability of yam flour substituted with soy flour. *Plant Food Human. Nutrition*., 48:73-80.

Akissoe, N., Hounhouigan, D. J., Bricas, N., Vernier, P., Nago, C. M. and Olorunda, A. (2001). *Physical, chemical and sensory evaluation of dried yam (Dioscorea rotundata) tubers, flour and amala a flour derived product*. *Trop. Sci*., 41: 151-155.

AOAC (1995). *Official Methods of Analysis. 18th Edn. Association of Official Analytical Chemists*, Washington, DC., USA.

Bricas, N., Vernier, P., Ategbo, E., Hounhoiugan, J. D., Mitchkpe, E., N'Kpenu, K. E. and Orkwor, G. (1997). The development of pounded machine in West Africa. *J. Res. Dev*., 44: 100-114.

Dugler, H., Arik, M., Sekeroglu, M. K., Tarakeiglu M., Noyan, T. and Cesur, Y. (2002). Proinflammatory cytokines in Turkish children with Protein Energy Malnutrition. *Mediators Inflamm*., 11:363 – 365.

Eklou, S.A., Ines, M. S., Francis, N., Moussa, S., Ayoni, O. A., Kayode, S. and Daniel, T. O. (2006). Comparative study of drying methods on seed quality of interspecies NERICA rice varieties (*Oryza glaberimax, Oryza sativa*) and their parents. *Afr. J. Biotechnol*., 5: 1618-1624.

Emperatriz, P.D., Ronald, M., Elevina, P. and Mily, S. (2008). Production and characterization of unripe plantain (*Musa paradisiacal L.*) flours. *Intercienca*,33:90-296.

Habou, D., Asere, A. A. and Alhassan, A. M. (2003). Comparative study of the drying rate of tomatoes and pepper using forced and natural convection solar dryers. *Nig. J. Renew. Energy,* 14: 36-40.

Hassan, S.W., Umar, R. A., Maishanu, H. M., Matazu, I. K., Faruk, U. Z. and Sani, A. A. (2007). The effect of drying method on the nutrients and non-nutrients composition of leaves of *Gynandropsis gynandra* (*Capparaceae*). *Asian J.Biochem.,* 2:349-353.

Hayata, M., Alpaslan, M. and Bayer, A.D. (2006). Effect of drying on functional properties of Tarhana. *International Journal of Food Science and Technology*, 29:457- 462.

Hounhouigan, D.J., Kayode, A. P., Bricas, N. and Nago, C. M. (2003). Desirable culinary and sensory characteristics of yams in urban Benin. *Benin J. Agric. Sci*., 21: 2815-2820.

Houson, P. and Ayenor, G.S. (2002). Appropriate Processing and food functional properties of Maize flour. *African Journal of Science and Technology*, 3: 121-126.

James, C.S. (1995). *Analytical chemistry of foods Chapman and Hall* New York, Pp. 76-86.

Ladan, M.J., Abubakar, M. G. and Lawal, M. (1997). Effect of solar drying on the nutrient composition of tomatoes. *Nig. J. Renew. Energy*, 5: 67-69.

Leach, H.W., McCowan, L.D. and Schoch, T.J. (1959). Swelling and solubility patterns of various starches. *Cereal Chem*., 36:534 - 544

Matazu, I.K. and Haroun, A. A. (2004). The effect of drying method on the nutrients and non- nutrients composition of the fruit of *Hibiscus esculentus* (Okra). *Nig. J. Renew. Energy*, 11: 9-13.

Morris, A., A. Barnett and O. Burrows, (2004). *Effect of processing on nutrient content of foods. Cajarticles*, 37: 160-164.

Ojinnaka, M., Odimegwu, E. and Ilechukwu, R. (2016). Functional properties of flour and starch from two cultivars of aerial yam (*Dioscorea bulbifera*) in South East Nigeria. *Journal of Agriculture and Veterinary Science*, 9 (8): 22-25.

Onwuka, G. I. and Ihuma, C. (2007). Physicochemical composition and product behaviour of flour and chips from two yam spp. (Dioscorea rotundata and Dioscorea alata). *Res. Journal of Applied.Science*.2:35–38.

Riley, C. K., Wheatley, A.O. and Asemota, H. N. (2006). Isolation and Characteristics of Starches from Eight *Dioscorea alata* cultivars grown in Jamaica. *African Journal of Biotechnology,* 5(17): 1528-15.