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Functional Properties of Bitter Yam (*Dioscorea dumetorum*) as Influenced by Soaking Prior to Oven-drying

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ABSTRACT

Processing method influences the functional compositions and utilization of foods. This study investigated the effect of soaking in water over time prior to the traditional method of drying and milling on some functional properties of bitter yam flour. Four equal parts of cleaned, peeled and sliced bitter yam tubers were respectively soaked in clean water for 6, 12, 18 and 24 h, dewatered, oven-dried at 50°C and milled, using standard procedures. The peak effect was recorded in the sample soaked for 24 h which increased respectively to 0.55±0.00 and 6.12±0.01% for bulk density and pH value. This represented a relative increase by 1.85 and 2.68%, respectively. Sample soaked for 24 h recorded a decrease in the water absorption capacity (3.01±0.01^{d}%), oil absorption capacity (1.39±1.20^{d}%), swelling index (3.20±0.01^{d}%) and foam capacity (16.48±0.09^{d}%). This represented a relative decrease of 4.14, 35.94, 1.23 and 6.09%, respectively. The observation, apart from that on the bulk density, was significant ($p<0.05$) and time dependent, indicating that soaking in water modified these properties of the bitter yam flour irrespective of the soaking time. The study provides insight on the possible application of soaking in clean water to optimize the studied functional compositions of bitter yam flour.

Key words: *Dioscorea dumetorum*, oil absorption capacity, bulk density, swelling index, pH value

INTRODUCTION

Yam (*Dioscorea* spp.) is a food with economic and socio-cultural importance in many tropical countries (Jova *et al*., 2005). Bitter yam (*Dioscorea dumetorum*) belongs to the genus *Dioscorea* and family Dioscoreacae (Bai and Ekanayake, 1998). Other common names for bitter yam include African bitter yam, wild yellow yam, trifoliate (three-leaved) yam and cluster yam. Bitter yam is known as 'ji una' or 'ji ona' in Ojoto and many Igbo speaking area in the south-eastern Nigeria, where it is regarded as food for the adult. In the area, bitter yam serves as food of choice for the diabetic patients and as herb for the treatment of various ailments. In the south-western Nigeria, bitter yam is utilized in the treatment of malaria (Dike *et al*., 2012), suggesting a widespread ethno-medicinal importance of bitter yam. Bitter yam is rich in phyto-nutrients, including proteins

(Medoua *et al.*, 2005; Alozie *et al.*, 2009), yet it remains an underutilized tropical tuber (Owuamanam *et al.*, 2013). Even with the potential of using bitter yam in bakery and pharmaceutical industries, it has no industrial application (Ukpabi, 2010; Onuegbu *et al.*, 2011).

The problem of inadequate food supply in sub-saharan African and the attendant malnutrition problem (Musieba *et al.*, 2013) necessitated researches aimed at finding alternative food supply from available but less utilized food sources (Enujiugha and Ayodele-Oni, 2003). The reasons for the limited use of bitter yam include, the unpalatable bitter taste and high post harvest hardening of the tubers (Medoua *et al.*, 2005). To prevent the high post harvest hardening, the tubers were dried and milled into flour. In this regard, there is need for further simple processing method(s) that may improve on the traditional method of drying and milling. Simple processing measures may stop further biologic activities that cause post harvest food spoilage but may affect the food compositions (Novak and Haslberger, 2000). Recently, Ezeocha *et al.* (2012) reported that increased cooking duration improved the nutritional and phytochemical properties of the bitter yam. These warranted this study aimed at investigating the effect of soaking in water over time prior to oven-drying (50°C) on some functional properties of resultant bitter yam flour. The result from this study may provide basis for further studies aimed at improving the physicochemical properties and possibly the taste as well as the keeping quality of bitter yam flour.

MATERIALS AND METHODS

Source and preparation of materials: Bitter yam tubers were purchased randomly from retail sellers at Owerri relief market in Imo State, south-eastern Nigeria. The equipment used including milling machine, weighing balance thermometer, shaker and centrifuge machine, were obtained from the laboratory of Food Science and Technology Department, Federal Polytechnic Nekede Owerri, Imo State. All the chemicals used were of analytical grades.

Preparation of the bitter yam flour samples: Damaged tubers could result in loss of nutrients (Adeyeye and Otokiti, 1999). Therefore, wholesome bitter yam tubers were sorted out, cleaned, peeled, sliced with a chipping machine and weighed. The chips were shared into five equal parts, based on weight. One part was not soaked in water and served as the control. Four parts were respectively soaked in clean water for 6, 12, 18 and 24 h and drained. All (the five parts) were separately dried to a constant weight in a moisture extraction oven (Gallenkamp 1H-100) set at 50°C, cooled for 30 min and milled (in a laboratory mill, Thomas Wiley mill model ED-5) into flour. The separate samples flour was packaged in a properly labeled airtight container prior to analysis as shown in Fig. 1.

Functional analysis: The bulk density, oil absorption capacity and water absorption capacity were determined by the methods of Okaka and Potter (1979). The foam capacity was determined by the method of Narayana and Narasinga Rao (1982). The swelling index was determined by the method of Takashi and Sieb (1988) while the pH value was read from a pH meter.

Statistical analysis: Collected data were subjected to statistical Analysis of Variance (ANOVA) with the Statistical Package for Social Sciences (SPSS) for Windows version 16. The Bonferroni *post hoc* test was used to identify the means that differ significantly at $p<0.05$. Results were expressed as Mean±Standard deviation (SD).

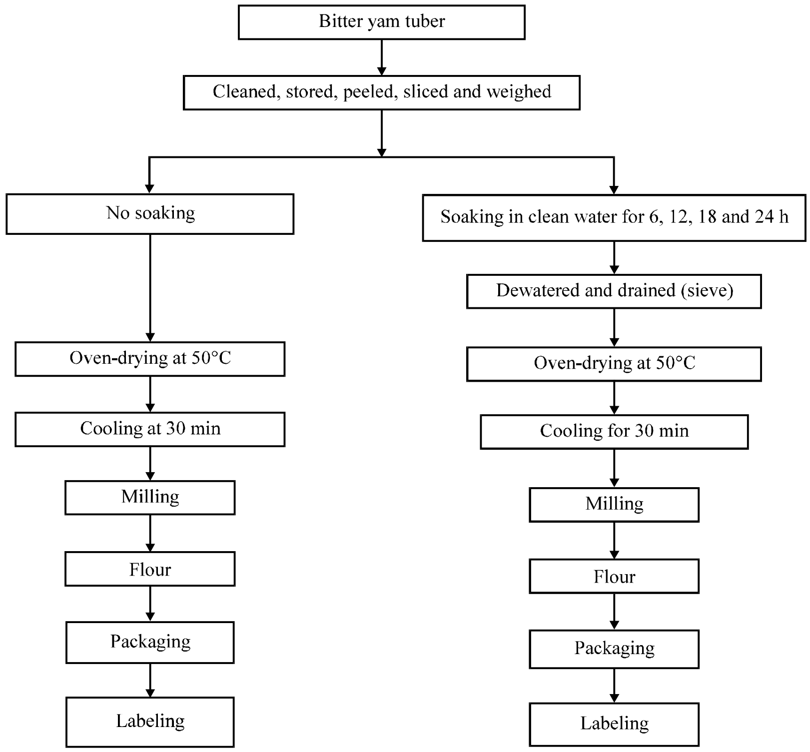

Fig. 1: Schematic diagram for the control and soaked bitter yam flour

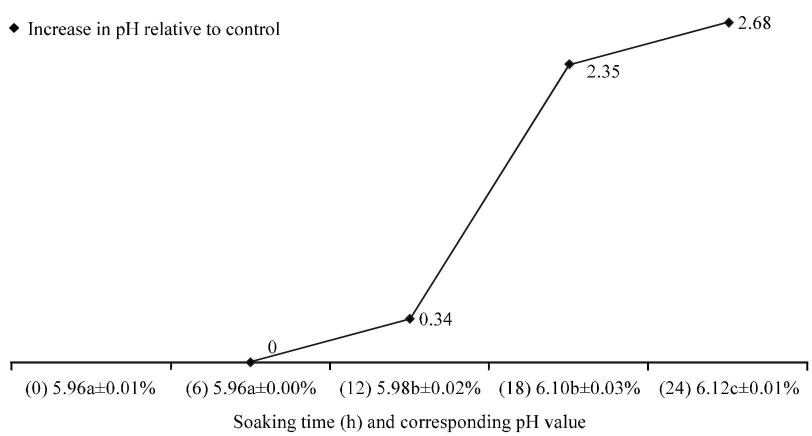

Fig. 2: pH value of soaked bitter yam flour

RESULTS

Results showed peak effect in the sample soaked in water for 24 h which increased respectively to 0.55±0.00 and 6.12±0.01% for bulk density and pH value. This represented an increase by 1.85 and 2.68%, respectively for bulk density and pH value relative to control. The observation however was neither significant ($p>0.05$) nor time dependent for the bulk density (Fig. 2 and 3).

Soaking prior to oven drying caused a time dependent and significant decrease ($p<0.05$) in the water absorption capacity (3.01±0.01^{d}%), oil absorption capacity (1.39±1.20^{d}%), swelling index

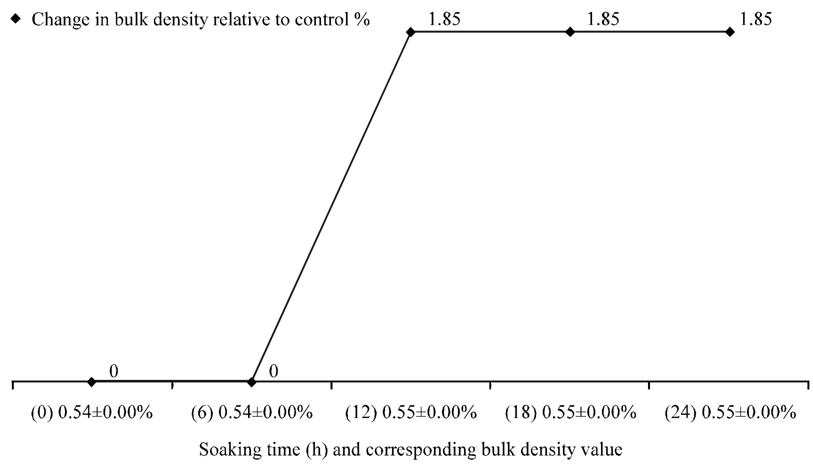

Fig. 3: Bulk density value of soaked bitter yam flour

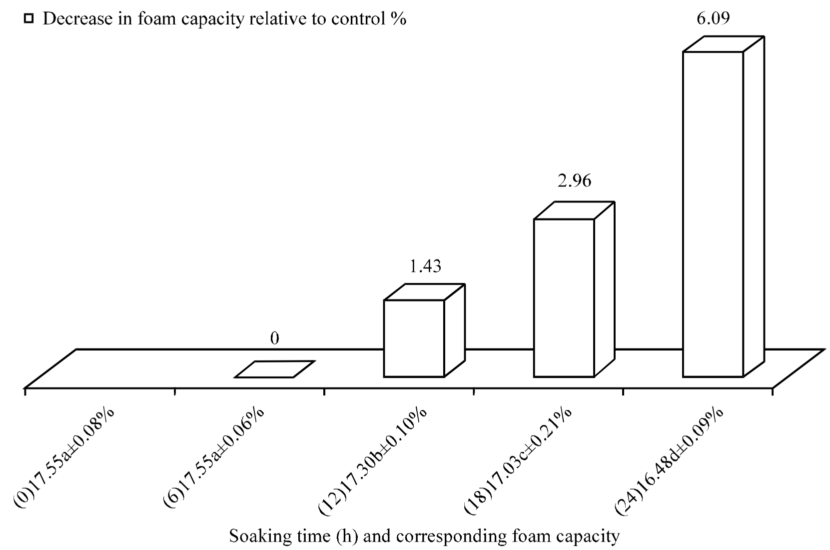

Fig. 4: Foam capacity value of soaked bitter yam flour

Table 1: Water absorption, oil absorption, swelling index and foam capacity of soaked bitter yam flour

Soaking time (h)	Water absorption (%)	Relative decrease (%)	Oil absorption (%)	Relative decrease (%)	Swelling index (%)	Relative decrease (%)
0	3.14±0.00^a		2.17±0.01^a		3.24±0.02^a	
6	3.14±0.00^a	0.00	2.17±0.01^a	0.00	3.24±0.01^a	0.00
12	3.12±0.00^b	0.64	2.13±0.00^b	1.84	3.23±0.01^b	0.31
18	3.10±0.00^c	1.27	2.10±0.00^c	3.23	3.21±0.01^c	0.93
24	3.01±0.01^d	4.14	1.39±1.20^d	35.94	3.20±0.01^d	1.23

Values are mean±standard deviation of triplicate determinations. Values on the same column with different superscripts means that the difference is statistically significant ($p<0.05$)

(3.20±0.01^d%) (Table 1) and foam capacity (16.48±0.09^d%) (Fig. 4). This represented a relative decrease of 4.14, 35.94, 1.23 and 6.09%, respectively in the water absorption capacity, oil absorption capacity, swelling index and foam capacity.

DISCUSSION AND CONCLUSION

Processing method influences the functional compositions, hence quality, acceptability and utilization of foods. This study investigated the effect of soaking in water over time prior to the traditional method of drying and milling on some functional properties of bitter yam flour. Generally, the swelling index indicates the degree of exposure of the internal structure of starch present in food to the action of water. As shown in Table 1, the swelling index of the soaked bitter yam flour decreased ($p<0.05$), suggesting saturation effect following increasing exposure of the samples to the action of water. Owuamanam *et al.* (2013) reported a significant ($p<0.05$) increase in the swelling index of bitter yam flour but the processing method were steeping and boiling in varying concentration of trona solution. Increase in the swelling index of flours with increasing time was attributed to the increasing heat (Ikegwu and Ekwu, 2009), hence, the converse may explain the present observation. Therefore, processing by soaking in water is not recommended when the target is to increase the swelling index of the resultant bitter yam flour. The increase in the pH value of the samples soaked in water suggests their low acidic value or small amount of free fatty acids, hence, their reduced extent of decomposition and possible storage advantage. This observation may be due to vaporization of the volatile fatty acids over time. Vaporization of volatile fatty acids even at room temperature have been reported (Onabolu, 1988). Similar result was reported by Owuamanam *et al.* (2013). As deduced from Fig. 2, sample soaked for 18 h had the highest marginal increase in pH value (2.01%), suggesting optimum soaking time to achieve efficient pH value for the resultant bitter yam flour.

Bulk density, the ratio of the mass per unit volume of a substance, indicates the porosity, package size, mouth feel and flavor of a product and is generally affected by the particle size (Unuigbe and Ozekhome, 2009). The bulk density value of the sample soaked for 6 h did not differ from that of the control but increased in the sample soaked for 12 h and remained constant thereafter (Fig. 3). The implication of this is that soaking time is very critical to the achievement of optimum bulk density for the bitter yam flour. However, the variation in the bulk density of the bitter yam flour obtained by soaking in clean water over time was neither significant ($p<0.05$) nor time dependent, implying that soaking in water over time did not modify the particle size, hence the bulk density of bitter yam flour. The decreasing ($p<0.05$) value in foam capacity with increasing soaking time of the bitter yam flour probably was due to reduction in the acidic content. Adejumo *et al.* (2013) attributed the decrease in foam capacity to a reduction in the acidic content. This does appear to support the present result on pH value that increased ($p<0.05$), implying a reduction in the acidic content, with increasing soaking time.

Fine particle size was associated with higher water absorption capacity (Unuigbe and Ozekhome, 2009). A decrease in the water absorption capacity was recorded in the samples obtained by soaking in water, suggesting coarse particle size. Water absorption capacity of flour obtained from the bitter yam ranged from 3.14 ± 0.00^{a} to 3.01 ± 0.01^{d} (raw to highest soaking time). Heat related processing increased oil absorption capacity of cowpea (Padmashree *et al.*, 1987). Thus for soaking, a non heat process, the decrease (2.17 ± 0.01^{a} to 1.39 ± 1.20^{d}) in oil absorption capacity was expected. Owuamanam *et al.* (2013) reported a significant ($p<0.05$) increase in the water absorption capacity and a decrease in the oil absorption capacity in bitter yam flour processed by steeping and boiling in varying concentration of trona solution. The ability of food to absorb water and oil may help to enhance sensory properties such as flavor retention and mouth feel (Kinsella, 1976; Hutton and Campbell, 1981; Udensi and Iwe, 2009). Therefore, soaking bitter yam tubers in water is recommended when the target is to increase the oil absorption capacity (but not the water absorption capacity) of bitter yam flour.

This study demonstrated a time dependent and significant ($p<0.05$) effect on most of the studied functional properties of the bitter yam flour. This is an indication that soaking in water modified the content value of these properties of the bitter yam flour irrespective of the soaking time. The study provides insight on the possible application of soaking in clean water to optimize the studied functional compositions of bitter yam flour.

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