



Influence of Soaking Method on the Chemical and Functional Properties of Trifoliolate Yam (*Dioscorea dumetorum*) Flours

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Abstract

The effect of soaking method on the chemical and functional properties of trifoliolate yam flour was evaluated in Nigeria. The freshly harvested trifoliolate yam tubers (white and yellow cultivars) were divided into two portions. Portion A was washed, drained, peeled, sliced, dried, milled and sieved to obtain the raw flour while portion B was washed, peeled and soaked in warm water (60 °C) for 10 minutes and then left in hot water for 12 h, sliced, dried, milled and sieved. Alkaloid and carotenoid profiles, pasting and functional properties of the flours were evaluated. Raw white trifoliolate yam flour had higher peak viscosity (210.21 RVU), holding strength (155.50 RVU) and final viscosity (236.09 RVU). The viscosities were drastically reduced in the soaked flours. The major carotenoid in yellow trifoliolate yam flour was carotene followed by β -cryptoxanthin. Total carotenoid contents of the flour ranged from 94.95 to 102.57 mg 100g⁻¹. The major alkaloid in trifoliolate yam was dioscorine followed by dihydrodioscorine. Total alkaloid was higher (0.58 mg 100g⁻¹) in the raw white trifoliolate flour but these values were lower in the processed flours. Raw yellow trifoliolate yam flour had higher bulk density (0.88 g cm⁻³) while the least values was observed in the soaked yellow flour (0.73 g cm⁻³). The soaked flours had higher swelling power and water absorption capacities. Raw and soaked trifoliolate yam flour could be used in food industry for baking and stiff dough production.

Key words: *Dioscorea dumetorum*, soaking, viscosity, holding strength, alkaloid, carotenoid, dioscorine

Introduction

Yam belonging to the genus *Dioscorea* (Family *Dioscoreaceae*) is an important food in many tropical countries particularly in West Africa, South Asia and the Caribbean, where it also has social and cultural importance for about 300 million people throughout the world (Manuel et al., 2005; Ettien et al., 2009). The genus *Dioscorea* includes about 600 species, of which only six species are cultivated and consumed in Nigeria (Craufurd et al., 2001; Akinwande et al., 2007). The cultivated species in Nigeria are *D. rotundata* (white guinea yam), *D. cayenensis* (yellow guinea yam), *D. dumetorum* (trifoliolate yam), *D. bulbifera* (aerial yam), *D. esculenta*

(Chinese yam) and *D. alata* (water yam) (Amusa et al., 2003).

Among the *Dioscorea* species, trifoliolate yam (*D. dumetorum*) is a lesser known yam and is underutilized. The tuber is known as three leaved yam, bitter yam and cluster yam and the plant is easily identifiable by its trifoliolate compound leaf, which twines in anti-clockwise direction (Onwueme, 1982). The tubers are usually boiled with peel and eaten as boiled yam. The presence of alkaloid and post-harvest hardening of the tuber limit their production and utilization (Afoakwa and Sefa-Dedeh, 2001). The tubers are left in the soil and harvested when needed for food. Although, the chemical, textural and

anti-nutritional contents of the tuber had been studied (Treche and Agbor-Egbe, 1996; Afoakwa and Sefa-Dedeh, 2001; Medoua et al., 2005), there are few reports on the effect of pre-treatment methods on the quality of trifoliate yam flour. Processing of the tuber into flour would encourage the utilization and improve the economic value of the tuber. Therefore, this paper presents the effect of soaking method on the chemical and functional properties of trifoliate yam (*Dioscorea dumetorum*) flours.

Materials and Methods

The white and yellow trifoliate yam tubers were obtained from a farm at Osogbo, Osun State, Nigeria.

Preparation of raw flour

The freshly harvested yam tubers were washed, drained and peeled. The peeled tubers were sliced and dried in the hot air oven at 60 °C for 48 h. The dried chips were milled into flour with hammer mill and sieved with 600 µm mesh sieve. The flour samples were sealed in polythene bag.

Preparation of soaked flour samples

The freshly harvested yam tubers were washed, drained and peeled. The peeled tubers weighing 151.27-189.32 g were steeped in hot water (60°C) for 10 minutes and left in the water for 12 h. The tubers were sliced and dried in the hot air oven at 60 °C for 48 h. The dried chips were milled into flour with hammer mill and sieved with 600 µm mesh sieve.

Analyses

Alkaloid extraction and analysis was carried out as described by Wink (1993) while carotenoid contents were determined using the method of Takagi (1985). Swelling power, water absorption capacity and bulk density were determined using methods of Peroni et al. (2006), Iwuoha (2004) and Udensi and Okaka (2000) respectively. Pasting properties was analyzed using Rapid Visco Analyzer (Newport Scientific, Australia)

Statistical analysis

The mean and standard deviation of the data obtained from three replicates were calculated. The data were evaluated for significant differences in their means with Analysis of Variance (ANOVA) ($p \leq 0.05$).

Results and Discussion

The pasting properties of trifoliate yam flour are presented in Table 1. Peak viscosity ranged from 84.54 to 210.21 RVU. Raw white trifoliate yam flour had higher values for peak viscosity, holding strength, breakdown, final and setback viscosities and was significantly different ($p < 0.05$) from other flours. The raw white trifoliate yam flour had the ability to withstand hot condition and form viscous gel after cooling. There were reductions in the values of soaked trifoliate yam flours which may be due to leaching of the amylose components in the processing medium. Amylose had been reported to be water soluble and plays a major role in gel firmness (Beta et al., 2000). There was no significant difference ($p > 0.05$) in the pasting

Table 1. Pasting properties of trifoliate yam flour

Cultivar	Sample	Peak viscosity (RVU)	Holding strength (RVU)	Breakdown (RVU)	Final viscosity (RVU)	Setback (RVU)	Pasting time (min)	Pasting temperature (°C)
White	Raw	210.21 ± 1.95a	155.50 ± 2.12a	54.71 ± 2.30a	236.09 ± 0.12a	80.59 ± 2.00a	4.88 ± 0.02b	48.61 ± 0.21a
	Soaked	88.88 ± 1.89c	86.83 ± 0.47c	2.04 ± 0.41b	152.25 ± 0.78c	65.42 ± 1.29b	6.52 ± 0.37a	48.71 ± 0.64a
Yellow	Raw	172.88 ± 1.31b	124.55 ± 1.77b	48.33 ± 1.54a	185.30 ± 1.83b	60.75 ± 0.06b	4.89 ± 0.04b	49.11 ± 0.05a
	Soaked	84.54 ± 0.65c	81.63 ± 0.53c	2.92 ± 0.12b	128.08 ± 0.71d	46.46 ± 0.18c	5.96 ± 1.43a	48.53 ± 0.10a

Mean values with the same superscripts within the column are not significantly different ($p \leq 0.05$)

time of the raw flours and likewise the soaked flours. Raw yellow trifoliolate yam flour had higher pasting temperature (49.1°C) but was not significantly different ($p > 0.05$) from other flours.

The major carotenoids in the yellow yam were carotene and β -cryptoxanthin (Table 2). Raw yellow trifoliolate yam had higher carotenoid values (102.57 mg100g⁻¹) than the soaked flour (94.95mg100g⁻¹). Akin-Idowu et al. (2009) reported carotenoid contents of 3.40-10.86 $\mu\text{g g}^{-1}$ in tuber and boiled yellow yam. Decrease in pre-treated samples was in agreement with the findings of Akin-Idowu et al. (2009). Decrease in the total carotenoid contents was observed in the boiled and pounded yellow yam due to oxidation and degradation upon exposure to heat, light, acids, metals and enzymes. Carotenoid stability in food during processing is essential to achieve products with desirable color and nutritional quality (Hagenimana et al., 1999). Carotenoids act as a powerful antioxidant that neutralizes free radicals and stimulates the genes that prevents cell from becoming cancerous (IITA, 2008).

The predominant alkaloids in trifoliolate yam flours were dioscorine and dihydrodioscorine with values ranging from 0.06-0.33 mg100g⁻¹ and 0.03-0.15 mg100g⁻¹ respectively (Table 3). Raw trifoliolate yam flour had higher values than the soaked flour. There was no significant difference ($p > 0.05$) in the dioscorine and dihydrodioscorine contents of the raw flour and the soaked flour. Total alkaloids ranged from 0.13-0.58 mg 100g⁻¹. The levels of these alkaloids in white trifoliolate yam flour were higher than that in yellow trifoliolate yam flour. The total alkaloid content of the raw white trifoliolate yam flour was higher and significantly different ($p < 0.05$) from other flours. These values were greatly reduced by soaking method. Higher alkaloid contents were reported in trifoliolate yam flour which ranged between 0.89-3.08% (Okwu and Ndu, 2006; Ogbuagu, 2008). Poornima and Ravishankar (2009) reported alkaloid content of 0.68 mg100g⁻¹ in wild yam *Dioscorea belophylla*. Alkaloid poisoning was reported to cause general paralysis of the central nervous system, which can also result in seizures and convulsion (Oke, 1985). Alkaloid contents of the trifoliolate yam were low and hence may not cause health problems to the consumer.

The swelling power, water absorption capacity and bulk density ranged from 1.47 to 2.30, 2.15 to 2.94 ml H₂O g⁻¹ and 0.73 to 0.88 g cm⁻³ respectively. Higher swelling power and water absorption capacity values were observed in the soaked flours with the highest values in white cultivar. The soaked flours were significantly different ($p < 0.05$) from the raw flours. Swelling power is an indication of the water absorption index of the granules during heating and reflects the extent of the associative forces within the granules (Loos et al., 1981; Moorthy and Ramanujam, 1986). Water absorption capacity depends

Table 2. Carotenoid contents (mg100g⁻¹) of yellow trifoliolate yam

Cultivar	Sample	Carotene	β -cryptoxanthin	Total carotenoid
Yellow	Raw	49.95 ± 0.02	35.21 ± 0.01	102.57 ± 0.05
	Soaked	46.91 ± 0.01	32.06 ± 0.01	94.95 ± 0.03

Table 3. Alkaloid profiles and functional properties of trifoliolate yam flours

Cultivar	Treatment	Dioscorine (mg 100g ⁻¹)	Dihydro- dioscorine (mg 100g ⁻¹)	Total alkaloid (mg 100g ⁻¹)	Swelling power (g g ⁻¹)	Water absorption capacity (ml H ₂ O g ⁻¹)	Bulk density (g cm ⁻³)
White	Raw	0.33 ± 0.10a	0.15 ± 0.09a	0.58 ± 0.10a	1.98 ± 0.08 b	2.42 ± 0.02b	0.84 ± 0.04a
	Soaked	0.10 ± 0.02b	0.05 ± 0.11b	0.18 ± 0.12c	2.29 ± 0.02 a	2.94 ± 0.01a	0.76 ± 0.03b
Yellow	Raw	0.28 ± 0.15a	0.13 ± 0.05a	0.46 ± 0.09b	1.47 ± 0.09c	2.15 ± 0.18c	0.88 ± 0.06a
	Soaked	0.06 ± 0.10b	0.03 ± 0.08b	0.13 ± 0.10d	2.30 ± 0.04a	2.77 ± 0.04a	0.73 ± 0.04b

Mean values with the same superscripts within the column are not significantly different ($p \leq 0.05$)

on the associative forces among starch components and weak inter associative forces result in high water binding capacity (Aryee et al., 2006; Riley et al., 2006). Raw flours had higher bulk densities than the soaked flours. The density of the flour is important in determining the packaging requirement and material handling (Ezeocha et al., 2011).

Conclusion

Trifoliate yam is one of the cultivated species with high nutritional potential. Soaking method improved the functional properties and reduced the anti-nutritional properties of trifoliate yam flour. Raw and soaked trifoliate yam flours could be used in food industry for baking and stiff dough production.

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