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Potentials of Trifoliate Yam (*Dioscorea dumetorum*) in Noodles Production

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Abstract

Trifoliate yam (*Dioscorea dumetorum)* is a high yielding but under exploited yam species. Potential of its flour in noodle production was investigated in this study. Trifoliate yam flour was produced and substituted for wheat flour at 20 -70% levels. Noodles were produced from the composite flour and evaluated for their proximate composition, functional properties, colour and cooking properties, using standard methods. Sensory attributes of the noodle were also determined using panelists. Data were analyzed using ANOVA at ($p<0.05$). The results showed that incorporation of trifoliate yam flour into wheat flour increased the moisture, crude fibre, ash and fat content of dried noodles. The moisture content ranges from 7.16 - 12.93%, crude fiber (0.72 - 1.30%), Ash (1.20 - 2.88%), fat (18.26 - 28.54%), protein (5.88 - 7.79%) and carbohydrate (51.18 - 62.77%). The water and oil absorption capacities of the noodles increased from 1.60 g to 2.03 g and 0.72 g to 1.21 g respectively, with increase in levels of trifoliate yam flour. Significant differences ($p<0.05$) exist between the colour of raw sheet noodles and the cooked noodles. The optimum cooking time and cooking loss were in the ranges (5.43 min to 7.06 min) and (9.31 - 15.09%) respectively. Sensory evaluation showed that the acceptability of uncooked and cooked dried noodles were at the moderate level. The substitution of different levels of trifoliate yam flour did not give significant ($p<0.05$) influence on sensory attributes except for the taste and color of dried noodles. Trifoliate yam has a good utilization potential in noodle production and could be used as substitute to wheat in human nutrition and in the food industries since they compare favorably in their nutritional compositions.

Keywords: Trifoliate yam; Noodles production; Sensory evaluation; Chemical composition

Introduction

Yam (*Dioscorea sp.*) is one of the most important staple food crops in West Africa especially Nigeria [1]. Yams are annual or perennial tuber–bearing and climbing plant with over 600 species, in which only few are cultivated for food and medicine [2]. Some yam varieties are widely used for food while others are underutilized. Trifoliate yam (*Dioscorea dumetorum*) is an under–exploited but high yielding yam species [3]. It has also been reported to be nutritionally superior to the commonly consumed yams with high protein and minerals [4]. It has starch grains that are smaller, more digestible than those of other yam species. Trifoliate yam tuber however, contains some anti-nutrient contents as a result of which slight bitterness may be experienced [5]. In addition, this yam species hardens few days after harvest leading to reduction in moisture and starch content and increase in sugar as well as structural polysaccharides [6]. Intensive processing like prolonged soaking and blanching are expected to eliminate these defects. Transforming its tubers into edible flour constitutes a means of conferring a long–term value onto it. Today, people's preference towards convenience food products has cumulated in many adverse consequences including hike in price and increase in the demand for importation of wheat. Noodles, which are convenient pasta products, are basically prepared from unleavened dough of durum wheat semolina and are only second to bread in popularity as staple food, globally [7]. They are nutritious and delicious, containing complex carbohydrates, which can provide long lasting energy and help to feel full for long periods. They are consumed in all five continents, with increased awareness of its nutritional benefits [8]. Noodles preparation by supplementations of wheat flour with other food materials have been documented; cassava [9], matured green banana and oat beta glucan [10], green banana [11], unripe plantain [12]. Better alternative usefulness of these materials is many; therefore involvement of underutilized materials like trifoliate yam could be more economically viable. Incorporation of its flour into wheat flour will reduce pressure on the latter while concomitantly promoting the industrial utilization of the former in pastry. Thus, this research work aimed at reducing food insecurity bane by promoting the utilization of trifoliate yam through substituting its flour in the noodle formulation.

Materials and Methods

Materials

Trifoliate yam (*Dioscorea dumentorum*), clean and free from bruises, was obtained from Malete, Ilorin, Kwara State. Sodium carbonate, potassium carbonate, gelatin, Iodized salt, ascorbic acid, Sodium phosphate (analytical grades), Eggs and edible oil and all the equipment used were supplied by the Department of Food Technology, University of Ibadan, Oyo state, Nigeria.

Methods

Production of trifoliate yam flour (TYF): Trifoliate yam tubers were processed into flour according to procedure of Abiodun et al. [13] as shown in Figure 1.

Preparation of noodles: Noodles were prepared following the procedures of Nagao [14] as shown in Figure 2. Noodles produced from six different blends of trifoliate yam flour and wheat flour with their codes was shown in Table 1. Basic ingredients and combinations were presented in Table 2.

Functional properties

Determination of bulk density: Bulk density and oil absorption capacity were determined by adopting the method of Udensi and Okaka [15]. 3 g of each sample was weighed into 10 ml graduated cylinders and tapping ten times against the palm of hand. The volume

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Trifoliate yam tubers
↓
Cleaning and sorting
↓
Peeling
↓
Washing
↓
Slicing
↓
Soaking (12 hrs)
↓
Blanching (60°C for 10 min)
↓
Draining/cooling (20 min)
↓
Oven Drying (80°C for 72 hrs)
↓
Milling (hammer mill)
↓
Cooling
↓
Sieving (250 µm)
↓
Packaging

Figure 1: Production of trifoliate yam flour [13].

Code	TYF: WF
Y_0W_{100}	00:100
$Y_{20}W_{80}$	20:80
$Y_{30}W_{70}$	30:70
$Y_{50}W_{50}$	50:50
$Y_{70}W_{30}$	70:30
$Y_{100}W_0$	100:00

Table 1: Sample codes and blend ratios of trifoliate yam-wheat noodles.

Ingredients Mixing
↓
Kneading
↓
Resting (20 mins)
↓
Sheeting
↓
Rolling
↓
Cutting in sizes
↓
Drying (39°C for 6-8 hours)
↓
Dried Noodles

Figure 2: Production of trifoliate yam flour into noodles [14].

of sample was recorded after tapping was recorded and bulk density was expressed as g/ml.

Determination of water absorption capacity: Water binding capacity of noodles was determined according to the method of AACC [16]. Aqueous suspension of noodles was made by dissolving 2 g (dry weight) of noodle in 40 ml of distilled water. The suspension was agitated for 1 hour on a Griffin flask shaker and centrifuged at 2200 rpm for 10 minutes. The free water (supernatant) was decanted from the wet sample, drained for 10 minutes and the wet sample was then weighed. The water absorption capacity was calculated by difference using equation 1.

$$\%Water\ absorption\ capacity = \frac{Weight\ of\ bound\ water}{Weight\ of\ sample} \times 100 \tag{1}$$

Oil absorption capacity: The method of Kinsella JE and Melachouris [17] was used. One gram meal that was mixed with 10 ml refined vegetable oil (Gino) in a weighted 25 ml centrifuge tube was thoroughly stirred for 2 min and then centrifuge at 4000 rpm for 20 min. the supernatant was discarded, the adhering free oil was removed and the tube and content was re-weighed. Oil absorption capacity as expressed as weight of oil bound by 100g meal.

Determination of solubility index and swelling capacity: Solubility and Swelling power determinations were carried out based on a modification of the method of Iwuoha [18]. One gram of noodle was dissolved with distilled water to a total volume of 40 ml using a weighed 50 ml graduated centrifuge tube. The suspension was stirred just sufficiently and uniformly avoiding excessive speed since it might cause fragmentation of the starch granules. The slurry in the tube was heated at 85°C in a thermostatically regulated temperature water bath for 30 minutes with constant gentle stirring. The tube was then removed, wiped dry on the outside and cooled to room temperature. It was then centrifuged at 2200 rpm for 15 minutes. The supernatant was decanted into a pre-weighed moisture can. The solubility was determined by evaporating the supernatant in thermostatically controlled drying oven at 105°C and weighing the residue (Equation 2). The sediment paste was weighed and swelling capacity was calculated as the weight of sediment paste per gram of noodle used (Equation 3).

$$\%Solubility = \frac{Weight\ of\ soluble}{Weight\ of\ sample} \times 100 \tag{2}$$

$$Swelling\ capacity = \frac{Weight\ of\ sediment}{Sample\ weight - Weight\ of soluble} \tag{3}$$

Cooking time: Optimal cooking time was evaluated by observing the time of disappearance of the core of the noodle strand during cooking (every 30 s) by squeezing the noodles between two transparent glass slides. About 10g of noodles was cooked in 300 ml of distilled water in a covered 500 ml beaker. Cooking time was determined by the removal of a strand of noodle every 30 seconds and pressing the noodle between two pieces of watch glasses. Optimum cooking was achieved when the center of the noodles became transparent. Cooking was stopped by rinsing with distilled water.

Cooking loss: The cooking loss was determined by measuring the amount of solid substance lost to cooking water. A 10 g sample of noodles was placed into 300 ml of boiling distilled water in a 500 ml beaker. Cooking water was collected in an aluminum vessel which was placed in an air oven at 105°C and evaporated to dryness. The residue was weighed and reported as a percentage of the starting material. For each optimal cooking time and cooking loss value, five determinations were performed to obtain the mean values (Equation 4)

$$Cooking\ loss\,(\%) = \frac{Dried\ residue\ in\ cooking\ water}{Noodle\ weight\ before\ cooking} \times 100 \quad (4)$$

Water uptake: The water uptake was determined by the ratio of the weight of cooked noodle to the weight of noodle before cooking (Equation 5)

$$Water\ uptake\,(\%) = \frac{Weight\ of\ cooked\ noodle}{Weight\ of\ noodle\ before\ cooking} \quad (5)$$

Determination of colour: The color of the dried noodle sheets and the optimally cooked noodle samples were measured with a Chroma-meter (Minolta, Tokyo, Japan) equipped with a D65 illuminant using the CIE L*a*b* system. The L*, a* and b* readings were obtained directly from the instrument and provided measures of lightness, redness and yellowness, respectively. All measurements were performed in triplicate and mean value recorded.

Sensory evaluation: Cooked samples were evaluated for appearance, flavor, taste, texture, colour and overall acceptability by 30 untrained panelists using nine-point hedonic scales, where 9 and 1 were extremely like dislike respectively.

Statistical analysis: Means of triplicate data were recorded. There were subjected to one-way analysis of variance (ANOVA), means were separated using Duncan multiple range test at 0.05 significance level using SPSS software.

Results and Discussions

Proximate compositions

Substitution of TYF for Wheat flour significantly ($p<0.05$) influenced the proximate composition of noodles, (Table 3). The moisture content ranged between (9.09 - 12.16%) for 20 - 70% levels. Noodle sample $Y_{100}W_0$ had highest mineral content of (12.93%) db, while (control) Y_0W_{100} had the least (8.50%). The higher moisture content found in $Y_{100}W_0$ might be due to water holding capacity of fibers and polysaccharides in trifoliate yam flour during the dough formation. The results of moisture content were close to a safe moisture level (≤10%) for long term storage of flour. The capabilities of yam flours to hold more water are related to the higher fiber content compared with other flours [19]. Crude Protein ranged (5.88 - 7.79%) were significantly ($p<0.05$) reduced with substitution levels of TYF. This result was closer to (7 - 8%) minimum recommended for prevention of PEM (protein-energy malnutrition) by UNO/WHO [20]. Yap and Chen [21] similarly reported a decreased in protein content in the wet noodles when substitution proportion were raised. Crude Ash content ranged 1.20 - 2.88% and decreased when the trifoliate yam flour amount in some noodles increased and also increased in some noodles. Noodle prepared from $Y_{30}W_{70}$ has the highest ash content of 2.88% and was reduced to 2.57% at $Y_{70}W_{30}$. The ash content depends on the quality of the flour and thus corresponds to the higher mineral content, especially potassium. $Y_{100}W_0$ noodle has the lowest ash content of 1.20%. These values were still closer to 3% for maximum ash content in first quality dried noodle and higher than 0.012 - 0.030% ash content reported by Chang and Wu [22] in seaweeds powders substitution. However, $Y_{20}W_{80}$ and $Y_{70}W_{30}$ noodles showed no significant different ($p \leq 0.05$) with Y_0W_{100} noodle. Ash content is a reflection of mineral status, though contamination can indicate a high concentration in a sample. Crude Fat content was at the range between 18.43 - 28.54%, and significantly higher ($p<0.05$) than 3.3% fat content recommended by the Ministry of Health on the wet noodle [23]. This might be due to higher oil absorption capacity of TYF than the WF in the control formulation. The results were in disagreement with Wang et al. [24] whose fat content of noodles decreases as the substitution level of green banana flour increases. This result was however similar to Senthil et al. [25] and lower than 13.37 - 21.50%, reported by Gabriel and Faith [26] in similar studies. The lipid components will contribute to the texture, flavor and aroma of foods, thereby prolonging satiety and facilitate the absorption of lipid-soluble vitamins [27]. Crude fibre contents of noodles incorporated with trifoliate yam flours were between 0.72 and 1.30%. $Y_{30}W_{70}$ noodle had higher fibre content than the Y_0W_{100} noodles i.e., control (0.99%). Fibre is important for the removal of waste from the body thereby preventing constipation and many health disorders [28]. Carbohydrate content, varies between (51.18 - 62.77%) and decreases with increased trifoliate yam flour addition. There were significant differences ($p<0.05$) between dried noodle control and noodle made from trifoliate yam flour substitution. Similar result was documented by Wirjatmadi et al. [29]. The Ministry of Health required not less than 14% of carbohydrate content on wet noodles [30].

Functional properties of trifoliate–wheat noodles

Functional properties are characteristics of a substance that affect its behavior and that of products to which it is added during food processing [31]. Results of functional Properties of Trifoliate–Wheat Noodles were presented in (Table 4). Control sample (Y_0W_{100}) had the highest degree of bulkiness (0.72) and bulkiness ranged between (0.61-0.72). Bulk density was significantly decreased with addition of TYF to Wheat flour. Bulk density is a measure of heaviness of a flour sample. Incorporated of TYF significantly increased ($p<0.05$) the WAC with increase in substitution level and ranged between (1.60 g to 2.03 g), with Y_0W_{100} the least and $Y_{100}W_0$ the highest. High water binding capacities

Ingredients (g)	Y_0W_{100}	$Y_{20}W_{80}$	$Y_{30}W_{70}$	$Y_{50}W_{50}$	$Y_{70}W_{30}$	$Y_{100}W_0$
WF	200	160	140	100	60	-
TYF	-	40	60	100	140	200
Sodium carbonates (g)	1.5	1.5	1.5	1.5	1.5	1.5
Potassium carbonates (g)	0.2	0.2	0.2	0.2	0.2	0.2
Sodium phosphate (g)	0.2	0.2	0.2	0.2	0.2	0.2
Gelatin (g)	6.0	6.0	6.0	6.0	6.0	6.0
Ascorbic acid	1.0	1.0	1.0	1.0	1.0	1.0
Iodized salt (g)	3.0	3.0	3.0	3.0	3.0	3.0
Egg (ml)	0.6	0.6	0.6	0.6	0.6	0.6
Edible oil (ml)	5.0	5.0	5.0	5.0	5.0	5.0
Water (ml)	130	130	130	130	130	130
WF: Wheat Flour; TYF: Trifoliate Yam Flour						

Table 2: Recipe for trifoliate yam–wheat noodles.

are desirable as they increase the unit yield of products. It stabilizes starches against effects such as seneresis, which sometimes occurs during retorting and freezing [32-34]. Similar trend was observed on OAC, with $Y_{100}W_0$ being the highest (1.21 g) and control noodle, the least (0.72 g). This result disagrees with Siddaraju et al. [35]. Oil absorption is an important property in food formulations because fats improve the flavour and mouth feel of foods [17]. Water binding capacity is also an important functional characteristic in the development of ready-to-eat foods since high water absorption capacity may assure product cohesiveness [36]. Swelling capacity of noodles reduces with substitution levels and ranged between (3.33 g to 5.11 g). $Y_{100}W_0$ had the least value (3.33 g) and Y_0W_{100} the highest (5.11 g). Variation in the Swelling power can be traced to differences in their associative forces. This may explain its hard and waxy texture as revealed from sensory evaluation. Solubility indices of noodles varied significantly ($p<0.05$) and ranged (8.01 - 11.07%). There was no significant difference between the control sample and noodles from TYF/WF blends up to 30% substitution level. Riley et al. [30] reported that solubility increased with decreasing amylose content. The observation for the noodles is similar with the result obtained from of Soni et al. [37] who associated high solubility with high amylose content. The difference could be attributed to differences in granule sizes and their arrangement within their cells.

Colour of trifoliate yam–wheat noodles

Colour characteristics of raw sheet and optimally cooked noodles prepared from different levels of trifoliate yam flour substituted with wheat flour are shown in Table 5. The results indicated that, as the amount of trifoliate yam flour increased, the appearance of the raw sheet and the cooked noodles grew darker. The darkness is likely a product of the Maillard reaction between reducing sugars and proteins [38]. The redness (a*) also increased, while yellowness (b*) decreased with increased addition of TYF. These changes in colour can also be attributed to the higher amount of oxidized phenol compounds in TYF noodles. Similar results have been reported for crackers incorporated green banana flour [24] and yeast leavened banana-bread [38]. Color is a key quality trait [39] because of the visual impact at the point of sale. It provides some indication of the quality of the starting materials and, in some cases, the age of the product.

Cooking properties of trifoliate yam–wheat noodles

Inclusion of TYF in noodles production significantly ($p<0.05$) influenced the cooking properties. Cooking times of all noodle samples increased with increase in TYF and ranged from 5.43 min to 7.06 min, with Y_0W_{100} and $Y_{100}W_0$ being the least and highest respectively (Table 6). Similar trend was observed with cooking loss. The cooking loss is the amount of dry matter in the cooking water of optimally cooked noodles. An increase in the cooking loss with noodles substitute with TYF may have been due to weakening of the protein network by the presence of trifoliate yam flour. This may allow more solids to be leached out from the noodles into the cooking water [40]. These results are in the agreement with Ovando- Martinez et al. [41] who reported that partial or complete substitution of durum wheat semolina with fibre material can result in negative changes to pasta quality, including increased cooking loss. Water uptake and cooking weight also increases as the level of TFY in the noodle increases. $Y_{30}W_{70}$ has the lowest water uptake and cooking weight and is not significantly ($p<0.05$) different with that of control. The water uptake and cooking weight were observed to increase as TYF addition increases, with 100% having the highest in

Noodles Sample	Moisture (%)	Crude Ash (%)	Crude Fat (%)	Crude fibre (%)	Crude protein (%)	Carbohydrate (%)
Y_0W_{100}	8.50 ± 0.14^{a}	2.50 ± 0.03^{a}	18.43 ± 0.15^{f}	0.99 ± 0.00^{a}	7.79 ± 0.02^{c}	62.77 ± 0.34^{a}
$Y_{20}W_{80}$	9.09 ± 0.13^{b}	2.41 ± 0.07^{ab}	20.15 ± 0.12^{e}	0.97 ± 0.01^{ab}	7.21 ± 0.01^{b}	62.11 ± 0.06^{c}
$Y_{30}W_{70}$	9.77 ± 0.01^{c}	2.88 ± 0.00^{c}	23.73 ± 0.04^{a}	1.30 ± 0.01^{d}	6.94 ± 0.05^{e}	56.68 ± 0.10^{b}
$Y_{50}W_{50}$	11.69 ± 0.07^{d}	2.29 ± 0.08^{b}	28.54 ± 0.01^{b}	0.72 ± 0.01^{c}	6.30 ± 0.01^{a}	51.18 ± 0.14^{d}
$Y_{70}W_{30}$	12.16 ± 0.02^{e}	2.57 ± 0.07^{a}	21.89 ± 0.00^{c}	0.76 ± 0.03^{c}	6.72 ± 0.01^{f}	61.67 ± 0.09^{c}
$Y_{100}W_0$	12.93 ± 0.01^{f}	1.20 ± 0.00	26.26 ± 0.04^{d}	0.93 ± 0.00^{b}	5.88 ± 0.02^{d}	53.23 ± 0.07^{e}
Significant differences is indicated by different letters within the same rom. ($p \leq 0.05$)						

Table 3: Proximate composition of trifoliate–wheat noodles.

Noodles Sample	Bulk Density g/ml	WAC (g)	OAC (g)	Swelling Capacity(g)	Solubility Index (%)
Y_0W_{100}	0.72 ± 0.00^{a}	1.60 ± 0.01^{b}	0.72 ± 0.01^{e}	5.11 ± 0.10^{a}	9.94 ± 0.05^{a}
$Y_{20}W_{80}$	0.67 ± 0.00^{b}	1.91 ± 0.01^{a}	0.75 ± 0.00^{d}	4.26 ± 0.01^{c}	9.96 ± 0.01^{a}
$Y_{30}W_{70}$	0.63 ± 0.00^{d}	1.61 ± 0.01^{bc}	0.87 ± 0.00^{c}	4.95 ± 0.02^{b}	9.92 ± 0.01^{a}
$Y_{50}W_{50}$	0.61 ± 0.00^{e}	1.71 ± 0.00^{e}	0.99 ± 0.00^{a}	3.54 ± 0.01^{d}	8.01 ± 0.02^{b}
$Y_{70}W_{30}$	0.66 ± 0.01^{bc}	1.63 ± 0.00^{c}	0.93 ± 0.01^{b}	3.50 ± 0.01^{de}	8.13 ± 0.02^{c}
$Y_{100}W_0$	0.63 ± 0.00^{d}	2.03 ± 0.01^{d}	1.21 ± 0.01^{f}	3.33 ± 0.03^{e}	11.07 ± 0.02^{d}
Significant differences is indicated by different letters within the same rom. ($p \leq 0.05$)					

Table 4: Functional properties of trifoliate–wheat noodles.

Noodles Sample	L* Raw Sheet Noodle	a* Raw Sheet Noodle	b* Raw Sheet Noodle	L* Optimally Cooked Noodle	a* Optimally Cooked Noodle	b* Optimally Cooked Noodle
Y_0W_{100}	84.53 ± 0.01^{f}	-1.44 ± 0.01^{c}	19.77 ± 0.01^{a}	73.46 ± 0.01^{f}	-2.11 ± 0.01^{a}	20.07 ± 0.21^{d}
$Y_{20}W_{80}$	69.66 ± 0.01^{e}	2.24 ± 0.01^{a}	21.72 ± 0.03^{b}	53.03 ± 0.01^{e}	3.86 ± 0.01^{b}	15.53 ± 0.01^{c}
$Y_{30}W_{70}$	72.19 ± 0.01^{d}	2.26 ± 0.00^{ab}	19.42 ± 0.10^{c}	48.04 ± 0.01^{d}	3.24 ± 0.01^{c}	12.59 ± 0.01^{a}
$Y_{50}W_{50}$	68.03 ± 0.01^{c}	2.28 ± 0.01^{b}	18.53 ± 0.01^{d}	45.68 ± 0.01^{c}	4.77 ± 0.01^{d}	14.63 ± 0.01^{b}
$Y_{70}W_{30}$	71.95 ± 0.07^{b}	1.32 ± 0.01^{d}	18.31 ± 0.01^{e}	47.21 ± 0.01^{b}	3.88 ± 0.01^{b}	12.78 ± 0.01^{a}
$Y_{100}W_0$	66.82 ± 0.08^{a}	3.02 ± 0.01^{e}	18.83 ± 0.03^{f}	45.26 ± 0.01^{a}	4.86 ± 0.01^{e}	14.55 ± 0.01^{b}
Significant differences is indicated by different letters within the same rom. ($p \leq 0.05$)						

Table 5: Colour characteristics of raw and optimally cooked noodles.

Noodles Sample	Cooking Time (mins)	Cooking loss (%)	Water uptake (g)	Cooking weight (%)
Y_0W_{100}	5.43 ± 0.02[a]	9.36 ± 0.01[b]	1.62 ± 0.01[c]	162 ± 0.82[c]
$Y_{20}W_{80}$	6.36 ± 0.01[b]	9.31 ± 0.01[b]	1.93 ± 0.02[a]	193 ± 1.63[a]
$Y_{30}W_{70}$	6.27 ± 0.01[b]	11.19 ± 0.01[a]	1.61 ± 0.01[c]	161 ± 0.82[c]
$Y_{50}W_{50}$	6.92 ± 0.10[c]	13.06 ± 0.25[c]	1.71 ± 0.01[b]	171 ± 1.25[b]
$Y_{70}W_{30}$	5.45 ± 0.04[a]	15.09 ± 0.07[d]	1.64 ± 0.01[c]	164 ± 0.47[c]
$Y_{100}W_0$	7.06 ± 0.08[c]	12.46 ± 0.03[e]	2.04 ± 0.01[d]	204 ± 0.94[d]
Significant difference is indicated by different letters within the same rom. ($p \le 0.05$)				

Table 6: Cooking properties of trifoliate yam–wheat noodle.

Noodles Sample	Colour	Taste	Flavor	Texture	Over all acceptability
Y_0W_{100}	7.41 ± 2.12[b]	6.81 ± 2.44[a]	7.32 ± 1.64[a]	6.92 ± 1.20[b]	7.09 ± 1.83[a]
$Y_{20}W_{80}$	4.61 ± 0.00[c]	5.01 ± 1.70[b]	5.11 ± 1.37[b]	6.21 ± 2.30[a]	6.26 ± 2.05[b]
$Y_{30}W_{70}$	6.90 ± 2.47[a]	5.31 ± 2.71[c]	5.61 ± 1.71[c]	6.20 ± 2.39[a]	6.32 ± 2.28[b]
$Y_{50}W_{50}$	5.30 ± 1.89[e]	4.90 ± 2.23[d]	5.90 ± 2.08[d]	4.90 ± 2.23[c]	5.92 ± 1.44[c]
$Y_{70}W_{30}$	6.10 ± 2.81[f]	4.63 ± 2.63[e]	4.30 ± 2.36[e]	4.20 ± 2.15[c]	4.83 ± 2.82[d]
$Y_{100}W_0$	4.49 ± 1.16[d]	4.10 ± 2.25[f]	4.80 ± 1.55[f]	4.11 ± 1.73[d]	5.52 ± 2.75[e]
Significant difference is indicated by different letters within the same rom. ($p \le 0.05$)					

Table 7: Sensory evaluation of trifoliate yam–wheat noodles.

both cases.

Sensory properties of trifoliate yam–wheat noodles

According to Alozie et al. [3] five on a scale of 9 is adjudged as acceptable. From Table 7 most panelists adjudged the optimally cooked noodles substituted with 20 - 50% trifoliate yam flour to be as acceptable as the control noodles, although there were significant differences ($p<0.05$) among some sensory attributes. Virtually all noodle samples were accepted, as no outright rejection was observed for any of the sensory parameters.

Conclusion

Noodles of comparable nutritional and sensory standards were produced from blends of trifoliate yam flour and wheat flour. Outcome of this study, if put into commercialization could reduce increase in the demand for importation of wheat for flour emanating from its exclusive utilization in bakery/pastry and also make it available for other useful purposes and thereby promoting food security. Anti-oxidant potential, microbial and shelf-life characteristics of these noodles are recommended for further studies.

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