EFFECT OF YELLOW TRIFOLIATE YAM FLOUR SUBSTITUTION ON THE COLOUR, CAROTENE AND COOKING PROPERTIES OF WHEAT NOODLES

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ABSTRACT

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This study evaluates the effect of yellow trifoliate yam flour substitution on the colour, carotene and cooking properties of wheat noodles. Trifoliate yam tubers were processed and added to wheat flour in ratio 10, 20, 30, 40 and 50% substitution to make noodles. The colour, carotene, lycopene and cooking quality of the noodles were determined. Colour of the noodles increased in yellowness with increased in yellow trifoliate yam substitution corresponding in increase inβ-carotene and lycopene. The control noodles had higher water absorption (168.40 %) and swelling index (2.49) values than the substituted noodles. The least cooking time (3.80 minutes) was observed in the sample substituted with 50 % trifoliate yam flour but the cooking loss increased with the level of substitution. There were no significant differences (p>0.05) between the control and samples substituted with 10 to 40 % level in cooking loss. Therefore, substitution of up to 40 % is desirable in the noodles.

Keywords: *Trifoliate yam, noodles, colour, cooking loss, lycopene, carotene*

INTRODUCTION

Wheat is the dominant crop in temperate countries used for human food and livestock feed (Shewry, 2009). Its advantages over other cereal crops are based on its adaptability, high yield potential and on the gluten protein fraction which confers the viscoelastic properties and makes it suitable in bread, pasta, noodles and other food products processing (Shewry, 2009). According to Taneya *et al.* (2014), noodles are long thin piece of food made from a mixture of flour, water and eggs usually cooked in soup or boiling water. However, noodle processing operations include mixing raw materials, dough sheeting, compounding, sheeting /rolling and slitting (Hou and Kruk, 1998). Consumption of noodle is increasing due to its convenience, accessibility and affordability (Dhiraj and Prabhasankar, 2013). Sanni *et al.* (2004) observed that substitution of wheat flour with flours from other sources is a possibility to increase the utilization of indigenous crops as well as contributing to lowering the cost of baked products (Sanni et al., 2004). Noodles have been made from different flour products such as rice berry flour, tilapia bone flour, cassava flour, protein concentrate and skim milk powder and improvement in the noodles nutrients and textures were reported (Baskaran *et al.*, 2011; Sirichokworrakit, 2014; Sirichokworrakit *et al*., 2015; Omeire *et al*., 2015). According to Oh *et al*. (1983), the quality of dry noodles is determined by its colour, cooking quality and texture. Addition of yellow trifoliate yam flour to wheat flour for noodle production could be a way of improving utilization of the yam and also reduction in the price of wheat flour used. Osagie (1992) reported that the yellow colouring in yellow trifoliate yam is made up of carotenoids. IITA (2008) equally reported that yellow trifoliate yam flour contain carotenoid. Carotenoid serves as precursor to vitamin A (provitamin A) and act as a powerful antioxidant that neutralizes free radicals and stimulates the genes that prevents cell from becoming cancerous (IITA, 2008). Deficiency of vitamin A is mainly due to inadequate dietary intake of vitamin A or its precursor. Chakravarty (2000) explained diet diversification as one of the alternative ways of combating vitamin A deficiency. Therefore, addition of yellow trifoliate yam flour to wheat flour for noodle production could improve the properties and nutrients of the product. This paper presents the effect of yellow trifoliate yam flour substitution on the colour, carotene and cooking properties of wheat noodles.

MATERIALS AND METHODS

Preparation of yellow trifoliate yam flour

Wheat flour, trifoliate yam tubers and other ingredients were obtained at a local market (Ganmo market) in Ilorin, Kwara State of Nigeria. Modified method of Abiodun and Akinoso (2014) were used for the production of the flour. The freshly harvested yam tubers were washed, drained and peeled. The peeled tubers were diced, blanched (60 ^oC) for 10 minutes in water bath and dried in the oven (at 60 ^oC) for 48 hours. The dried chips were milled into flour with hammer mill and sieved with 600 µm sieve size.

Preparation of the noodles

The noodle formula as shown in Table 1 consisted of 100 g of wheat flour, 55 ml of distilled water, 1 g of salt, egg and vegetable oil. Five noodle samples with a control were prepared by substituting wheat flour with 0 g, 10 g, 20 g, 30 g, 40 g and 50 g of yellow trifoliate yam flour. The different formulations were processed into noodles using a kitchen Aid Popeil automatic pasta maker. The noodles were dried in the oven and packaged.

Table 1: Compositions of dough used in noodle production

Sample	Wheat flour (%)	Trifoliate yam flour (%)	Water (ml)	Egg (ml)	Salt (g)	Vegetable oil (ml)
AA	100	-	55	40	1	5
BB	90	10	55	40	1	5
CC	80	20	55	40	1	5
DD	70	30	55	40	1	5
EE	60	40	55	40	1	5
FF	50	50	55	40	1	5
CP	Commercial product					

Colour analyses

Pasta colour was evaluated by measuring L*, a*, b* parameters by means of a reflectance colorimeter (CR 300 Chroma-metter, Minolta, Japan). Colour was expressed in CIE-Lab parameters as L* (whiteness/darkness), a* (redness/greenness), and b* (yellowness/blueness). Ten measurements were performed on each sample and the mean value and standard deviation were calculated (Ugarcic-Hardi *et al*., 2007).

Carotene lycopene estimation

Beta-carotene and lycopene was determined from the dried methanolic extract according to Kumara *et al*. (2011) and Kumar *et al*. (2013). 100 mg of extract was mixed with 10 ml of acetone- hexane mixture (4.6) for 1 min and filtered. The absorbance was recorded at three different wave lengths (453, 505 and 663). The lycopene content was calculated by:

Beta- carotene (mg per 100ml) = $0.216 \times A_{66} - 0.304 \times A_{505} + 0.452 \times A_{453}$

Lycopene (mg per kg fresh wt) = A503 x 137.4

Cooking characteristics

Cooking time

About 10g of noodles was cooked in 300ml of deionised water in a covered 500ml beaker. Cooking time was determined by the removal of a piece of noodle every 2 minutes and pressing the noodle between 2 pieces of watch glasses. Optimum cooking was achieved when the center of the noodles became transparent or at the moment the noodle was fully hydrated. Cooking was stopped by rinsing briefly in deionised water (Sirichokworrakit *et al*., 2015).

Cooking loss

Approximately 10g noodles were cooked in 300mL of distilled water in a 500 mL beaker until the central opaque core in the noodle strand disappeared. Cooking loss (%) was measured by transferring the cook water to a pre-weighed beaker and evaporating the water in a conventional oven overnight at 100°C, then reweighing the beaker with left over solids. Cooking quality analysis was performed in triplicate (Sirichokworrakit *et al*., 2015).

Cooking Loss (%) = $\frac{\text{Dried residue in cooking water}}{\text{Noodle weight before cooking}} x\ 100$

Water absorption

Water absorption (%) is the difference between weight of cooked noodles and uncooked noodles, expressed as the percentage of the weight of uncooked noodles. Cooked noodles were rinsed with water and drained for 30 seconds then weighed to determine the gain in weight. This analysis indicates the amount of water absorbed by the noodles during cooking process.

Water absorption (%) = (weight of cooked−weight uncooked noodles × 100

Swelling index

Cooking loss was determined by boiling 5 g of cut noodles (2 cm long) for 6 minutes. The samples were then cooled in cold water and drained for 5 minutes and rapidly weighed (W1). The noodles were wiped with filter paper and kept in a petri dish. The cooked product was dried in an oven at 130°C to constant weight (W2).

Swelling index = $\frac{W1 - W2}{W2}$

Sensory evaluation

Sensory analysis of the noodle was carried out by selecting 20 panelists among the students of Department of Home Economics and Food Science, University of Ilorin, Kwara State. The panelists were requested to examine the noodle and score according to their degree of likeness with a 9-point hedonic scale ranging from 1 (disliked extremely) to 9 (liked extremely). The parameters evaluated were the taste, appearance, aroma, softness, elasticity and overall acceptability.

Statistical analysis

All analyses were carried out in triplicates. The mean and SD of the data obtained were calculated. The data were evaluated for significant differences in their means with Analysis of Variance (ANOVA) ($p < 0.05$). Differences between the means were separated using turkey test as packaged by SPSS software (version 17.0).

RESULTS AND DISCUSSION

Colours of uncooked and cooked noodles are shown in Table 2. Lightness values ranged from 52.23 to 64.20 and 50.19 to 64.53 in uncooked and cooked noodles respectively. Samples EE and FF were significantly different ($p>0.05$) from CP, BB and CC in the L* values of uncooked noodles. The a* values of the uncooked noodles ranged between 2.57 to 3.95. Samples with yellow trifoliate yam flour were slightly reddish than the cooked noodles which ranged between -0.78 to 0.29. There were reductions in the a* values in the cooked noodles as a result of leaching into the cooking medium. No significant differences ($p<0.05$) were observed in the values of DD, EE and FF in b* values of uncooked noodles. Likewise, there were no significant differences ($p<0.05$) in CP, AA, BB and CC in b* values. In the cooked noodles, the b* values increased with increase in yellow trifoliate yam substitution. Cooked noodles with 50% yellow trifoliate yam flour had higher b* value which was significantly different (p<005) from other noodles. The results obtained in the samples were comparable to that of the commercial product. The changes noticed in the colours of the cooked noodles compared to the uncooked noodles could be as a result of the cooking effect on the noodles. During cooking, chemical changes (gelatinization, hydrolysis, protein denaturation, flavor development etc.) and leaching of some components occurred in the noodles which led to colour change. The colours of the noodles were affected by the natural colour of the yellow trifoliate yam flour. Color is one of the most important factors in determining consumer acceptance of noodles (Sirichokworrakit *et al*., 2015).

Table 2: Effect of yellow trifoliate yam substitution and cooking colour of uncooked noodles

Sample	Uncooked Noodles			Cooked Noodles		
	L*	a*	b*	L*	a*	b*
CP	52.23±0.23b	2.57±0.22b	10.14±0.98b	50.19±0.12c	-0.78±0.42b	11.12±2.02e
AA	61.30±5.14ab	2.84±0.71b	12.30±1.33b	55.21±2.74abc	-0.20±0.57ab	8.98±1.41f
BB	53.64±3.97b	3.17±0.58ab	8.61±3.85b	51.12±7.94bc	0.29±0.76a	12.17±0.55e
CC	57.95±3.04b	3.06±0.30ab	12.90±2.30b	62.47±4.00a	0.16±0.52a	15.19±0.15d
DD	61.20±2.40ab	3.96±0.12a	20.65±1.93a	61.15±1.51abc	0.29±0.35a	17.84±0.77c
EE	63.52±8.28a	3.66±0.47ab	20.94±4.16a	64.53±1.49a	0.01±0.18ab	20.44±0.77b
FF	64.20±7.89a	3.58±0.25ab	21.28±3.30a	61.89±1.87ab	0.24±0.20a	22.75±0.28a

Value with the same letter in the column are not significantly different ($p<0.05$)

Table 3 showed the β-carotene and lycopene contents of noodles. β-carotene contents ranged from 27.20 to 54.30 $mgkg^{-1}$. β-carotene contents of the noodles increased with trifoliate yam flour substitution. There were no significant differences ($p<0.05$) in the control and samples substituted with 10 % trifoliate yam in β-carotene contents. Sample substituted with 50 % trifoliate yam was not significantly different ($p>0.05$) from sample with 40% trifoliate yam flour but was significantly different ($p<0.05$) from control and other samples in β-carotene. Addition of higher levels of yellow trifoliate yam increased the carotene level of the noodles. Likewise, lycopene increased with increase in yellow trifoliate yam substitution. The highest value (11.2 mg kg^{-1}) was in sample substituted with 50% trifoliate yam flour while the least (5.30 $mgkg^{-1}$) was in the control (AA). FF was significantly different ($p<0.05$) from control and sample with 10 % of trifoliate yam flour substitution in lycopene contents. The β-carotene values obtained for the substituted noodles were higher than the value (26.2 mg kg^{-1}) obtained by Rustanti *et al.* (2015) for pumpkin enriched noodles. CODEX (2006) recommended maximum limit of synthetic β-carotene in noodle to be 1200 mg kg^{-1} while the maximum limit for natural β-carotene was 1000$mgkg^{-1}$. β-carotene and lycopene are carotenoids that serve as vitamin A precursor and antioxidant.

Table 3: β-carotene and lycopene contents of noodles

Sample	β-carotene (mg kg^{-1})	Lycopene (mg kg^{-1})
AA	27.20±0.41c	5.30±0.20b
BB	29.70±0.25c	5.80±0.13b
CC	38.50±0.05b	7.60±0.06ab
DD	39.30±0.18b	7.80±0.08ab
EE	47.60±0.26ab	8.10±0.11ab
FF	54.30±0.70a	11.20±0.33a

Value with the same letter in the column are not significantly different ($p<0.05$)

Table 4 showed the cooking quality of substituted noodles. Water absorption capacity (WAC) of the control sample had higher value which was significantly different (p<0.05) from the substituted noodles. Among the substituted noodles sample EE had higher value (153.70%) but was not significantly different (p>0.05) from DD and FF. There were reductions in the water absorption capacities of the substituted noodles. This may be as result of decrease in the gluten contents of the noodles due to the substitution leading to less water retention. Sirichokworrakit *et al.* (2015) also observed reduction in the WAC of noodles enriched with riceberry flour. The control noodle had higher swelling index (2.69) than other samples. There were no significant differences (p>0.05) in swelling index of the control noodle and sample DD and EE. Cooking time also varied with level of yellow trifoliate yam substitution. The cooking time decreased with increase in trifoliate yam substitution. Sirichokworrakit *et al.* (2015) explained that short cooking time with less soluble solid are the desirable quality of a good noodle. Control noodle had lower cooking loss (7.00%) while sample FF had higher cooking loss (9.60%) which was significantly different (p>0.05) from the control and other substituted noodles. The cooking losses observed in the noodles were low when compared to other products reported by Smatanová and Lacko-Bartošová (2014) for whole grain wheat flour noodles (11.66-16.62%) and Ojure and Quadri (2012) for plantain-wheat noodles (10.40%). Cooking loss is a measure of resistance to disintegration upon prolonged boiling (Galvez *et al.*, 1994).

Table 4: Effect of yellow trifoliate yam flour on cooking qualities of substituted noodles

Sample	WAC %	Swelling Index	Cooking time	Cooking loss (%)
AA	169.40±0.21a	2.69±0.92a	5.23±0.01a	7.00±0.01c
BB	144.00±283c	2.36±0.20c	5.43±0.01a	7.40±0.03bc
CC	144.80±3.11c	2.45±0.16bc	5.08±0.06a	7.80±0.03bc
DD	146.35±3.39bc	2.59±0.17ab	4.26±0.36bc	8.20±0.01bc
EE	153.70±1.84b	2.52±0.02abc	4.41±0.01b	8.80±0.01bc
FF	147.40±5.09bc	2.47±0.25bc	3.80±0.30c	9.60±0.02a

Value with the same letter in the column are not significantly different (p<0.05)

The sensory properties of substituted noodles are shown in Table 5. Taste of CP and AA were significantly different (p<0.05) from other noodles. The taste likeness of the noodles diminished with increase in yellow trifoliate yam substitution. This indicated that addition of more than 10% trifoliate yam flour impacted undesirable taste to the noodles. Appearance of CP (7.67), AA (7.50) and FF (7.17) were not significantly different (p<005) from each other according to the panelist rating. Noodles with 10% trifoliate yam flour exhibited higher softness value (7.67) but not significantly different from CP, BB, DD and FF. Commercial noodles were more elastic but was not significantly different (p>0.05) from AA and sample substituted with 10 to 30 % yellow trifoliate yam flour. Noodles with 100% wheat flour were the most preferred followed by noodle with 10% yellow trifoliate yam flour substitution. Noodle with 50% yellow trifoliate yam had the least value in acceptability. Addition of yellow trifoliate yam flour brought a significant change in the sensory properties of the product.

Table 5: Effect of yellow trifoliate yam substitution on sensory properties of substituted noodles

Sample	Taste	Appearance	Softness	Aroma	Elasticity	Acceptability
CP	7.33±1.21a	7.67±1.03a	7.33±1.03ab	7.33±1.37a	7.33±0.82a	8.00±1.10a
AA	7.17±0.75a	7.50±0.55a	7.67±0.52a	6.83±0.98a	7.00±0.89ab	7.00±0.89b
BB	6.17±0.75b	6.67±1.03bc	6.67±1.03ab	6.50±0.84a	6.00±0.89ab	6.33±2.10c
CC	5.67±1.63c	5.83±1.83c	5.83±1.72b	6.50±1.22a	6.67±1.21ab	6.67±1.21c
DD	6.00±1.67b	6.33±1.75c	6.83±0.98ab	6.17±1.32a	6.67±0.82ab	6.50±1.05cd
EE	5.83±1.72bc	7.00±1.41b	6.00±1.41b	6.67±0.82a	5.67±1.03b	6.67±1.03c
FF	5.69±1.51c	7.17±1.60ab	6.67±1.21ab	6.67±1.21a	5.50±1.87b	6.00±1.03d

Value with the same letter in the column are not significantly different (p<0.05)

CONCLUSIONS

This study determined the effect of yellow trifoliate yam flour substitution on the colour, carotene and cooking properties of wheat noodles. Addition of yellow trifoliate yam flour to wheat flour for noodle production increased the yellowish colouration of the substituted noodles, which are indication of increased β-carotene and lycopene contents of the products. However, substitution with trifoliate yam flour decreased the water absorption capacity, swelling index and the cooking time but increased cooking loss. Replacement of noodles with yellow trifoliate yam flour is recommended as it improved the carotenoid contents and improved cooking qualities of the noodles. Substitution up to 10 % with trifoliate yam could be used in noodles with the desired properties.

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