ARID ZONE JOURNAL OF ENGINEERING, TECHNOLOGY & ENVIRONMENT
AZOJETE - CIGR Section VI Special Issue:
Innovation & Technologies for Sustainable Agricultural Production & Food Sufficiency
AZOJETE, December, 2018. Vol. 14(SP.i4): 74-85
Published by the Faculty of Engineering, University of Maidiguri, Maidiguri, Nigeria.

Print ISSN: 1596-2490, Electronic ISSN: 2545-5818
www.azojete.com.ng

ORIGINAL RESEARCH ARTICLE

SENSORY, TEXTURAL AND COOKING QUALITY OF INSTANT NOODLES PRODUCED FROM *MUSA SPP* - WHEAT COMPOSITE FLOURS

W. A. Adebayo[1], B. S. Ogunsina[2*] and K. A. Taiwo[1]

[1]*Dept. of Food Science and Technology, Obafemi Awolowo University, Ile Ife, Nigeria.*
[2]*Dept. of Agricultural and Environmental Engineering, Obafemi Awolowo University, Ile Ife, Nigeria.*

ARTICLE INFORMATION

Received: October, 2018
Accepted: December, 2018

Keywords:
Instant noddles
Musa spp
Cooking
Quality characteristic

ABSTRACT

Enormous post-harvest losses (35 - 60%) associated with banana and plantain products in Nigeria and other producing countries in the tropics culminate in great losses for farmers. In Nigeria, unripe plantain is normally processed into flour with limited consumption only as reconstituted dough in local food systems. Previous studies established that Nigerians have acquired taste for noodles and it is widely consumed across all strata of the economic divide. Information regarding the production of instant noodles from *Musa spp.* is rarely found in literature; hence in this study the quality characteristics of instant noodles produced from *Musa spp* – wheat composite flours was investigated. *Musa spp* – wheat composite flours in the ratios 0:100; 5:95; 10:90; 15:85; 20:80 and 25:75 were processed into instant noodles. The proximate composition, sensory, textural and cooking quality of the instant noodles were determined following standard procedures. The results showed a corresponding increase in the crude fat, ash and fibre contents of instant noodles as the percentage substitution with *Musa spp* flour in the instant noodle formulation increased. Significant differences ($p<0.05$) were observed in the taste, colour, flavor, texture and overall acceptability of the products. It was observed that cooking time and cooking loss decreased from 4.38 – 3.40 min and 7.61 – 5.51% as percentage substitution increased, respectively; whereas cooking gain, moisture and fat uptake increased as substitution level increased. The force–deformation curve of *Musa spp* - wheat instant noodle obeyed the Hooke's law showing a decrease in the strength characteristics of noodles as percentage substitution with *Musa spp* flour increased. The production of instant noodles from banana and plantain offers means of promoting and extending its utilization, thereby boosting the income obtainable from its production.

1.0 Introduction

Instant noodle has increasingly become an important food item globally, with annual production of 101,420 million packs in 2012, and a steady increase of 3% annually since 2010 (World Instant Noodle Association, 2013). Most instant noodles are made of wheat as the base material, thus instant noodle consumption led to dependency on massive importation of wheat in non-wheat producing countries Nigeria inclusive. Apart from high cost of wheat importation, excessive consumption of wheat has been associated with allergy, asthma, autoimmune response, or gluten sensitivity (Rosell *et al.*, 2013) in some parts of the world. Several works have been done on gluten-free noodle using different types of flour, although rice flour (Inglett *et al.*, 2005; Yadav *et al.*, 2011; Heo *et al.*, 2013) seems to be the best replacement for its small

*Corresponding Author Email: babsina@oauife.edu.ng

granule sizes to benefit noodle textural characteristics. Some other raw materials for gluten-free noodle include sorghum (Liu *et al*., 2012), and corn starch (Yuan *et al*., 2008; Yousif *et al*., 2012) or corn flour (Padalino *et al*., 2013). Lately, sweet potato starch (Silva *et al*., 2013), pseudo-cereal such as amaranth flour in combination with cassava starch (Fiorda *et al*., 2013) have also been used for the making of gluten-free pasta.

The absence of gluten in non-wheat noodle composition often adversely affects noodle quality; hence non-gluten noodle requires treatment to improve its textural quality. Several techniques commonly used for starch textural improvement are annealing, hydrothermal treatment (Hormdok and Noomhorm, 2007), gelatinization (Yousif *et al*., 2012) and fermentation (Yuan *et al*., 2008). In addition, the use of hydrocolloids such as carboxymethylcellulose (Choy *et al*., 2012), konjac glucomannan (Zhou *et al*., 2013), β-glucan (Inglett *et al*., 2005; Heo *et al*., 2013a), transglutaminase (Gan *et al*., 2009; Kim *et al*., 2014), and acetylated starch (Choy *et al*., 2012) have also been reported. However, in this work, the sensory, textural and cooking quality of instant noodles produced from *Musa spp* and wheat flours is investigated with the view to providing baseline information on the production of instant noodles from *Musa spp* fruits.

2.0 Materials

Source of material: Freshly harvested bunches of *Musa spp* fruits (Plate 1) were obtained from Obafemi Awolowo University Teaching and Research Farm, Ile-Ife. The extent of maturity was based on the stage one colour classification documented (Ahenkora *et al.,* 1997 and Dadzie and Orchard, 1997). Other materials such as white wheat flour (Dangote brand), iodized table salt (Dangote brand), potato starch, guar gum, potassium carbonate (food grade), sodium carbonate (food grade) and sodium tripolyphosphate (STTP, food grade) were bought from a local market in Ile-Ife, Osun State. The chemicals used for analysis were of analytical grade.

Preparation of *Musa spp* flour: About 10 kg of freshly harvested debunched *Musa spp* fruits were immersed in a plastic bowl containing potable water on individual variety basis for 5 min. The fruits were removed from the bowl and peeled with the aid of a stainless kitchen knife. The pulp was sliced into cylindrical discs with thickness of about 5 mm and dipped in citric acid (CIT) (1% w/v) for 1 min to prevent enzymatic browning reaction (Adeyemi and Oladigi, 2009). Accumulation of moisture on the sliced surface as a result of the pretreatment was drained with a cheese cloth before samples were transferred to dryer set at 70 °C (Adeniji *et al.,* 2010). The citric acid treated *Musa spp* fruit slices were dried in a convective air-oven at +70°C (±1°C) air velocity of 2.2 m/s (Adeyemi and Oladigi, 2009; Adeniji *et al.,* 2010). Prior to loading of the fruit slices, the dryer was run for 30 min to reach drying air temperature conditions. The sliced fruits were dried in thin layer for 48 h to constant weight at which the chips were considered to have attained its equilibrium moisture content. The chips were milled using laboratory milling machine (sieve size 500 μm aperture) and stored in an air tight bottle until the time of use. Figure 1 shows the flow chart for the production of pretreated *Musa spp* flour samples.

Plate 1: A freshly harvested matured plantain (*agbagba*) *Musa spp* fruits

Blend formulation of *Musa spp*-wheat composite flour: The processed *Musa spp* flour was blended with wheat flour at 0, 5, 10, 15 20 and 25% replacement (Arshad *et al.,* 2010) using a Kenwood food processor (Model 49074, Kenwood Ltd, Hants, UK) operated at full speed for 10 mins. The blends were stored in high density polyethylene bags (0.77 mm thick) prior to use.

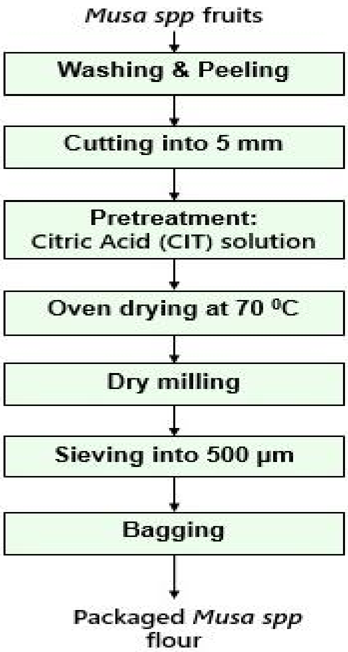

Figure 1: A flow chart showing production of *Musa spp* flours
Source: Adeniji *et al.* (2010)

***Musa spp* - wheat instant noodle production**: A laboratory model rotating single screw extruder was used to produce extrudate. The barrel diameter and length-diameter (L/D) ratio were 37 mm and 27:1, respectively with screw configuration standardized for processing flour-based products. The screw profile comprises self-wiping elements to improve mixing and apply shear to the material being extruded, while restricting flow and building up pressure. The exit diameter of the circular die is 1 mm. The extrusion of *Musa spp*-wheat flour composite dough was conducted at barrel temperature, 100 °C and screw speed, 85 rpm. The formulations and flow chart for the instant noodle production are shown in Table 1 and Figure 2, respectively; while Plate 2 shows samples of the instant noodles.

3.0 Methods

Proximate analysis: The proximate composition of instant noodles samples was determined according to AOAC (2002) method. The parameters investigated are: moisture content, crude protein, crude fat, ash, crude fibre and carbohydrate. All reagents used are of analytical grade (BDH Chemicals, Poole, UK).

Determination of optimum cooking time: The optimum cooking time was determined following the method of Widjaya *et al.* (2008). About 10 g of instant noodle was boiled in 1000 ml of boiling water and after each minute of cooking for the first 2 min, noddle was removed and squeezed between clear glass slides. This procedure was then repeated by removing the noodles every 15 s until the white core becomes unnoticeable. Therefore, the time taken for the white core to disappear when the noodle strand was boiled in the distilled water is taken as the optimum cooking time.

Determination of cooking weight and cooking loss: Cooking weight and cooking loss were determined by methods of Oh *et al.* (1985) and AACC International (2000) Approved Method 66 – 50, respectively. Ten grams (10 g) of instant noodle was cooked in 300 ml of distilled water in a beaker to their optimum cooking time, rinsed with distilled water, drained and left to cool for 5 min at room temperature. The noodles were weighed and % increase in weight was obtained by gravimetry. Residual water was removed by drying in the oven at 100 °C until there was no trace of water in the beaker. The samples were cooled and weighed

Table 1: Formulation of instant noodle from *Musa spp*-wheat composite flour

	Formulations					
Ingredients	0%NOD	5%NOD	10%NOD	15%NOD	20%NOD	25%NOD
Wheat flour, g	100	95	90	85	80	75
Musa spp flour, g	0	5	10	15	20	25
Water, ml	34	34	34	34	34	34
Salt, g	1.6	1.6	1.6	1.6	1.6	1.6
Potato starch, g	12	12	12	12	12	12
Guar gum, g	0.2	0.2	0.2	0.2	0.2	0.2
Potassium carbonate, g	0.12	0.12	0.12	0.12	0.12	0.12
Sodium carbonate, g	0.8	0.8	0.8	0.8	0.8	0.8
STTP, g	0.1	0.1	0.1	0.1	0.1	0.1

0%NOD (Control) =100% wheat flour; 5%NOD = 95% wheat+ 5% *Musa spp* flour; 10%NOD = 90% wheat+ 10% *Musa spp* flour; 15%NOD = 85% wheat+ 15% *Musa spp* flour; 20%NOD = 80% wheat+ 20% *Musa spp* flour and 25%NOD = 75% wheat+ 25% *Musa spp* flour (Hou *et al.,* 1997)

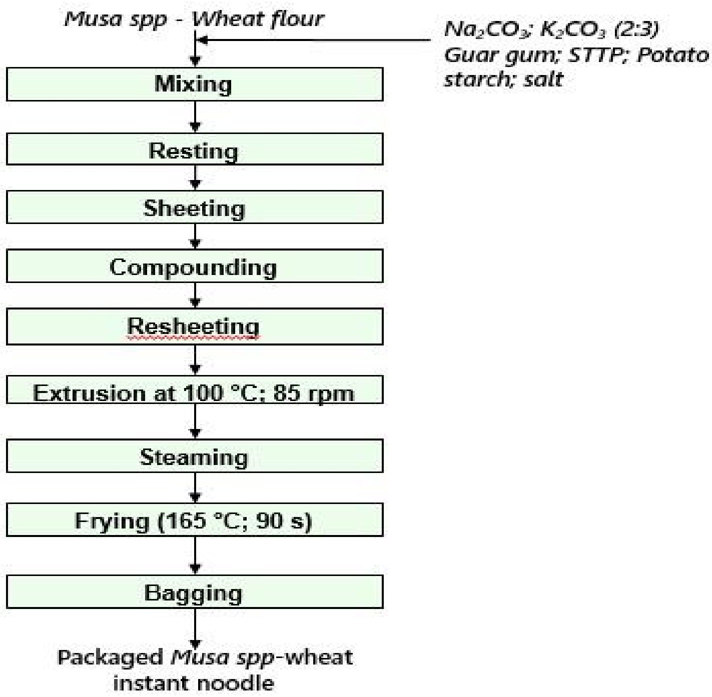

Figure 2: A schematic diagram showing production of fried instant noodle

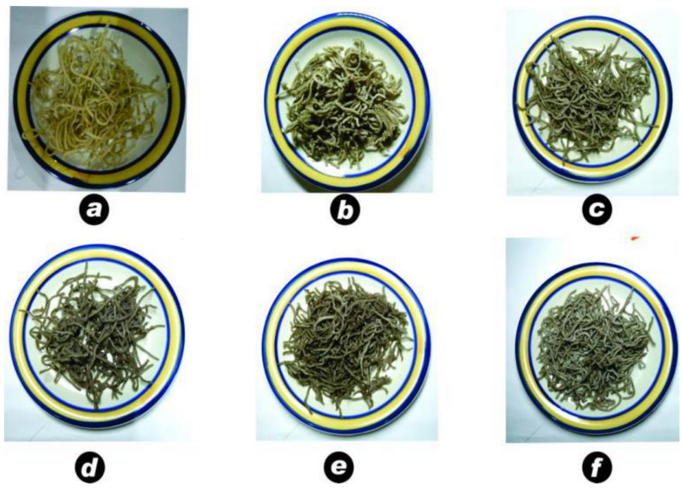

Plate 2: Fried instant noodles produced from *Musa spp*-wheat flours

(a)100% wheat flour instant noodle; (b) 5% *Musa spp* flour + 95% wheat flour instant noodle; (c) 10% *Musa spp* flour + 90% wheat flour instant noodle; (d) 15% *Musa spp* flour + 85% wheat flour instant noodle; (e) 20% *Musa spp* flour + 80% wheat flour instant noodle; (f) 25% *Musa spp* flour + 75% wheat flour instant noodle again.

The percentage weight loss during cooking was obtained by gravimetric method. Values reported are average of five replications.

$$C_w = \frac{W_C - W_D}{W_D} \times 100 \qquad (1)$$

Where: C_W = Cooking weight (%); W_C = Weight of cooked instant noodle, g and W_D = Weight of dried instant noodle, g.

$$C_L = \frac{W_L}{W_D} \times 100 \qquad (2)$$

Where: C_L = Cooking loss, %; W_L = Weight of loss solid, g

Determination of crude fat: Ground instant noodle (3 g) was subjected to soxhlet extraction with n-hexane for about 6 h. The was desolventized by flash evaporation and further drying in a hot-air oven at 100 °C for 30 min. to remove residual organic solvent and moisture. The oil was allowed to cool in a dessicator and weighed. The quantity of oil obtained was expressed as percentage of the original sample weight used.

$$\%CF = \frac{W_{oil}}{W_{sample}} \times 100 \qquad (3)$$

Where: $\mathrm{CF} = \text{Crude fat content ,\%}$; $\mathrm{W_{oil}} = \text{Weight of extracted oil, g}$; $\mathrm{W_{sample}} = \text{Weight of sample, g}$

Sensory Evaluation of Produced Instant Noodle: A semi-trained twenty-six panelist was used from the Department of Agricultural and Environmental Engineering of Obafemi Awolowo University, Ile-Ife, South-Western Nigeria (McWatter *et al.,* 2008). Criteria for selection are that panelists are 18 and above years of age; regular consumers of noodles; and not allergic to any food. The panelists filled a consent form approved by the University Institutional Review Board and received instructions on how to use the sensory booth signal lights to communicate with the server. They were instructed to evaluate appearance and colour first and taste each sample afterwards to evaluate flavour, texture and overall liking. A rating scale of l – 7 points (1 = dislike very much; 7 = like very much) was used (McWatter *et al.*, 2008). The formulated products were evaluated 3 h after production. Water and unsalted crackers were provided to panelists to cleanse their palates between samples and covered expectoration cups if they did not wish to swallow the samples. Samples were identified with 3 - digit code numbers and presented in a random sequence. Panelists were also asked if they would buy the product if it were commercially available and how much they would be willing to pay (lower, same, or higher price) compared with similar commercial products. They were also asked to comment freely on the samples. Evaluation was conducted in a climate-controlled sensory evaluation laboratory equipped with individual partitioned booths without special lighting

Determination of textural quality: Compression test was conducted using a Universal Testing Machine (Instron Electromechanical Testing Systems, Model 3369, 50 kN, Instron Corporation, USA) at Centre for Energy Research Development, Obafemi Awolowo University, Ile Ife. The samples were discreetly loaded at the rate of 10 mm/min. The test results and graphs were automatically generated. The data obtained included compressive load at yield, compressive strain at yield, compressive stress at yield and energy at yield. The experiment was replicated fifteen times.

4.0 Results and Discussion

The proximate composition values of *Musa spp*-wheat instant noodle were expressed on dry basis (Table 2). The carbohydrate content of the *Musa spp*-wheat instant noodle samples ranged from 73.67 – 76.32 % with samples 25%NOD and 0%NOD having the minimum and maximum values, respectively. There is significant difference ($p < 0.05$) in the carbohydrate content of all the noodle samples, with all the instant noodle samples being of high calorie values. The carbohydrate content of *Musa spp*-wheat instant noodle compared favourably with 64.6 – 79.1%; 70.39- 73.80% and 68.30% reported for cassava instant noodle (Sanni *et al.*, 2004), sweet potato-wheat instant noodle (Taneya *et al.,* 2014) and corn-tapioca-wheat instant noodle

(Pakhare *et al.,* 2016). The crude protein content values of *Musa spp*-wheat instant noodle samples ranged from 9.46 to 11.86% with samples 25%NOD and 0%NOD having minimum and maximum values, respectively, indicating significant differences at $p<0.05$. This implies that substitution of wheat flour with *Musa spp* flour reduced the crude protein content of the instant noodles. The crude protein values compared favourably with 5.8 – 12.4% and 11.66 – 12.51% reported for cassava-wheat instant noodle (Sanni *et al.,* 2004) and sweet potato-wheat instant noodles (Taneya *et al*., 2014), but lower than 14.29% and 14.9% reported by Pakhare *et al.* (2016) for defatted rice bran-soybean-wheat noodle, respectively. The crude fat, crude fibre and ash values of *Musa spp*-wheat instant noodles ranged from 10.35 – 14.74%; 0.40 – 0.88% and 1.09 – 1.17%, respectively.

Increased addition of *Musa spp* flour as replacement for wheat in instant noodle production affected the crude fat, fibre and ash contents of the products significantly ($p< 0.05$). The improved crude fat content may be as a result of the absorption of fat during frying. The crude fat results compared favourably with 11.1 – 18.4% documented by Sanni *et al.* (2004) for cassava-wheat instant noodle but higher compared with 5.3 – 6.25% and 4.98% documented by Taneya *et al.* (2014) for sweet potato-wheat instant noodle and Pakhare *et al.* (2016) for corn-tapioca-wheat instant noodle. In addition, the crude fiber results compared favourably with 0.2 - 0.8% and 0.54 – 0.58% documented by Sanni *et al.* (2004) for cassava-wheat instant noodle and Taneya *et al.* (2014) for sweet potato-wheat instant noodle, respectively; although, Pakhare *et al.* (2016) reported a higher crude fibre value (4.02) for corn-tapioca-wheat instant noodle. The ash content also compared favourably with 0.6 – 1.2% and 1.54% documented by Sanni *et al.* (2004) for cassava-wheat instant noodle and Pakhare *et al.* (2016) for corn-tapioca-wheat instant noodle but lower compared with 2.21- 2.44% documented by Taneya *et al.* (2014) for sweet potato-wheat instant noodle.

Table 2: Proximate composition of *Musa spp*-wheat instant noodle

Sample	Moisture content, d.b (%)	Crude fat (%)	Crude fibre (%)	Ash (%)	Crude protein (%)	Carbohydrate (%)
0%NOD	$3.72^{a}\pm0.32$	$10.35^{f}\pm0.27$	$0.40^{f}\pm0.02$	$1.09^{c}\pm0.01$	$11.86^{a}\pm0.02$	$76.30^{a}\pm 0.25$
5%NOD	$3.78^{a}\pm0.41$	$10.79^{e}\pm0.24$	$0.44^{e}\pm0.02$	$1.09^{c}\pm0.01$	$11.37^{b}\pm0.12$	$76.32^{a}\pm0.14$
10%NOD	$3.88^{a}\pm0.38$	$11.13^{d}\pm0.10$	$0.55^{d}\pm0.01$	$1.12^{b}\pm0.01$	$10.81^{c}\pm0.03$	$76.20^{a}\pm0.50$
15%NOD	$3.95^{a}\pm0.26$	$12.82^{c}\pm0.06$	$0.70^{c}\pm0.02$	$1.13^{b}\pm0.01$	$10.43^{d}\pm0.01$	$74.92^{b}\pm0.10$
20%NOD	$4.02^{a}\pm0.35$	$13.97^{b}\pm0.07$	$0.83^{b}\pm0.02$	$1.15^{a}\pm0.00$	$9.96^{e}\pm0.08$	$74.08^{c}\pm0.14$
25%NOD	$4.05^{a}\pm0.29$	$14.74^{a}\pm0.05$	$0.88^{a}\pm0.01$	$1.17^{a}\pm0.01$	$9.46^{f}\pm0.05$	$73.67^{c}\pm0.09$

Values are mean ± standard deviation of triplicate. Values followed by the same letter in the same column are not significantly different ($p< 0.05$), 0%NOD = 100% wheat flour instant noodle; 5%NOD = 5% *Musa spp* flour + 95% wheat flour instant noodle; 10%NOD = 10% *Musa spp* flour + 90% wheat flour instant noodle; 15%NOD = 15% *Musa spp* flour + 85% wheat flour instant noodle; 20%NOD = 20% *Musa spp* flour + 80% wheat flour instant noodle; 25%NOD = 25% *Musa spp* flour + 75% wheat flour instant noodle

Cooking properties: The cooking time ranged from 3.40 – 4.38 min for the instant noodle samples with sample 25%NOD and 0%NOD having minimum and maximum values, respectively (Table 3). The values showed that as percentage of substitution of glutten-rich (wheat) flour with non-gluten (*Musa spp*) flour, there is reduction in cooking time of the instant noodle. This may be attributed to discontinuity within the gluten matrix, which resulted in weak dough properties (Manthey *et al*., 2004; Omeire *et al*., 2015). There is significant difference ($p < 0.05$) in the instant noodles cooking time at all levels of substitution. The cooking time values of *Musa spp*-wheat instant noodle compared favourably with 3.11 – 4.77 min for breadfruit-konjac-pumpkin-wheat instant noodle; 4.5 – 8.29 min for plantain-wheat instant noodle and 4.3 – 5.41 min for corn-tapioca-wheat instant noodles (Purwandari *et al*., 2014; Ojure and Quadri, 2012; Pato *et al*., 2016) but lower than 5.6 – 6.6 min reported by Ritika *et al.* (2016) for malted and fermented cowpea-wheat instant noodle; 7.33 – 8.67 min for sago starch-wheat instant noodle (Purwani *et al*., 2006); 7.30 min for defatted rice bran-soy- wheat instant noodle (Pakhare *et al*., 2016) and 7.16 – 9.36 min reported for raw jackfruit-wheat instant noodle (Kumari and Divakar, 2017). The cooking gain values ranged from 168.11 – 183.55% with samples 25%NOD and 0%NOD having the minimum and maximum values, respectively. There is significant difference ($p<0.05$) among the instant noodles' cooking gain.

The results obtained compared favourably with 120.7 – 160.3% reported by Ritika *et al.* (2016) for malted-fermented cowpea-wheat instant noodle but lower than 252 – 379% and 287 – 362% reported by Purwani *et al.* (2006) for sago starch-wheat instant noodle and Foo *et al.* (2011) for soy protein isolate-wheat instant noodle respectively. Cooking loss values ranged from 5.51 – 7.65 with samples 0%NOD and 20%NOD having lowest and highest values, respectively. The optimum solution (cooking loss of 7.03%) is found at barrel temperature of 100 °C and 85 rpm conveying shaft speed. The cooking loss results obtained compared favourably with 6.39 – 10.40% reported by Ojure and Quadri (2012) for cassava-wheat instant noodle but higher than 0.93 – 1.63% and 2.01 – 6.19% reported by Ritika *et al.* (2016) for malted-fermented cowpea-wheat instant noodle and Purwani *et al.* (2006) for sago starch-wheat instant noodle, respectively. Purwandari *et al.* (2014) reported that cooking loss of instant noodles from blends of breadfruit, konjac, pumpkin and wheat flours, ranged from 12.45 – 17.04%. These results are in the agreement with the study of Martinez *et al.* (2007) 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. The high cooking loss recorded by *Musa spp*-wheat instant noodle as substitution increases could be due to a weakening of the protein network by the presence of *Musa spp* (non-gluten protein) flour which allows more solids to be leached out from the noodles into the cooking water (Yu and Ngadi, 2004; Wu *et al.,* 2006). The moisture uptake ranged from 9.79 – 12.01% with samples 0%NOD and 25%NOD having minimum and maximum values, respectively. The fat uptake values ranged from 9.37 – 12.82% with samples 0%NOD and 25%NOD having lowest and highest values, respectively.

Table 3: Cooking properties of *Musa spp*-wheat instant noodle

Sample	Cooking time, min	Cooking gain, %	Cooking loss, %	Moisture uptake, %	Fat uptake, %
0%NOD	4.38±0.01	183.55±2.11	5.51±0.01	9.79±0.55	9.37±0.32
5%NOD	4.17±0.01	173.78±1.78	6.31±0.01	10.27±0.81	9.94±0.51
10%NOD	4.06±0.02	173.68±1.83	6.31±0.01	10.7±1.09	10.01±0.23
15%NOD	4.09±0.01	173.45±1.21	7.19±0.02	11.16±0.95	11.17±0.64
20%NOD	3.48±0.01	169.68±1.56	7.65±0.02	11.59±0.27	12.47±1.02

25%NOD	3.40±0.01	168.11±1.97	7.61±0.01	12.01±1.02	12.82±1.17

Values are mean ± standard deviation of triplicate analysis, Values followed by the same letter in the same column are not significantly different ($p < 0.05$), 0%NOD =100% wheat flour instant noodle; 5%NOD= 5% *Musa spp* flour + 95% wheat flour instant noodle; 10%NOD = 10% *Musa spp* flour + 90% wheat flour instant noodle; 15%NOD = 15% *Musa spp* flour + 85% wheat flour instant noodle; 20%NOD = 20% *Musa spp* flour + 80% wheat flour instant noodle; 25%NOD = 25% *Musa spp* flour + 75% wheat flour instant noodle

Sensory evaluation

The values of sensory attributes of *Musa spp*-wheat instant noodle are presented in Table 4. Overall acceptability of the instant noodle products ranged from 1.15 – 5.96% with products 0%NOD and 25%NOD having minimum and maximum values, respectively on a 7-point hedonic scale. There is decline in overall acceptability of the instant noodle from like moderately to dislike very much as percentage of substitution of wheat flour was increased in the formulation. The products 5%NOD and 10%NOD were slightly liked by the panelists but further decline in wheat flour percentage proportion in the formulation beyond 10% (w/w) led to dislike of the products by the panelists. The taste, colour and texture values of the *Musa spp*-wheat instant noodles ranged from 2.42 – 6.15%, 1.19 – 6.15% and 3.77 – 6.23%, respectively. The taste values showed that as the proportion of wheat substitution increased, the panelists' assessment of taste changed from being like moderately to dislike moderately. The panelists liked the taste of the instant noodle as the proportion of wheat flour replacement is not beyond 10% (w/w). Another important organoleptic property in instant noodle is colour because it influences purchasing decisions of its consumers. The panelists assessed the colour of the product 0%NOD as like moderately but as the inclusion of *Musa spp* flour into the instant noodle formulation increased, the panelists' assessment of the instant noodle changed to dislike very much. This showed that the colour of *Musa spp*-wheat instant noodle was not acceptable to the panelists. The instant noodle flavour was liked moderately by the panelists till 10% (w/w) substitution of wheat flour with *Musa spp* flour. Further increase in percentage proportion of *Musa spp* flour in the formulation made the panelists to dislike very much the instant noodle flavour.

Table 4: Sensory evaluation score of *Musa spp*-wheat composite flour instant noodle

Products	Taste	Colour	Flavor	Texture	Overall acceptability
0%NOD	6.15^{a}±0.77	6.15^{a}±0.72	5.58^{a}±0.49	6.23^{a}±0.69	5.96^{a}±0.71
5%NOD	5.73^{b}±0.59	2.38^{b}±0.49	5.15^{b}±0.53	5.42^{b}±0.68	4.69^{b}±0.77
10%NOD	5.31^{c}±0.67	2.42^{b}±0.49	5.42^{ab}±0.68	5.27^{b}±0.81	4.39^{b}±0.49
15%NOD	4.23^{d}±0.57	1.62^{c}±0.48	3.50^{c}±0.50	3.96^{c}±0.71	2.08^{c}±0.73
20%NOD	3.19^{e}±0.62	1.50^{c}±0.50	3.39^{c}±0.49	3.62^{c}±0.56	1.58^{d}±0.49
25%NOD	2.42^{f}±0.49	1.19^{d}±0.39	1.73^{d}±0.59	3.77^{c}±0.42	1.15^{e}±0.36

Values are mean ± standard deviation of triplicate, Values followed by the same letter in the same column are not significantly different ($p< 0.05$), 0%NOD = 100% wheat flour instant noodle; 5%NOD = 5% *Musa spp* flour + 95% wheat flour instant noodle; 10%NOD = 10% *Musa spp* flour + 90% wheat flour instant noodle; 15%NOD = 15% *Musa spp* flour + 85% wheat flour instant noodle; 20%NOD = 20% *Musa spp* flour + 80% wheat flour instant noodle; 25%NOD = 25% *Musa spp* flour + 75% wheat flour instant noodle

Mechanical Properties of *Musa spp*-Wheat Instant Noodle

The force – deformation characteristics exhibited by *Musa spp*-wheat instant noodles at different levels of substitution under compressive loading is presented in Figure 2. For all levels of substitution, the deformation of *Musa spp*-wheat uncooked instant noodle increased with an increase in compressive force. Deformation decreased after rupture occurred in the samples and the compressive at this point was denoted as the bio-yield point or load at break (Gupta and Das, 2000). The force beyond the bio-yield point represented the force required to crush the instant noodle after rupture had occurred (Poulsen, 1978; Gupta and Das, 2000). As the levels of substitution increased, there was a fall in force – deformation characteristics curves of *Musa spp*-wheat instant noodles. The fall in force – deformation characteristics curves of the instant noodle correlate well with its yield stress of *Musa spp*-wheat dough. The fall in force – deformation curves of *Musa spp*- wheat instant noodle may be attributed to the weakening of the protein network by the presence of *Musa spp* (non-gluten protein) flour (Yu and Ngadi, 2004; Wu *et al.,* 2006). The texture parameters obtained from the force – deformation curves of *Musa spp*-wheat instant noodles thereafter investigated were bio-yield point or load at break, energy at break, tensile stress at break and maximum tensile stress. Figure 3 showed the texture parameters of *Musa spp*-wheat instant noodle. The bio-yield point or load at break ranged from 0.747 – 4.21 N. The values showed that as percentage of substitution increased, there was reduction in load at break due to the weakening of the protein network by the presence of *Musa spp* (non-gluten protein) flour (Yu and Ngadi, 2004; Wu *et al.,* 2006). The load at break is an indication of how the instant noodle strands resist breakdown (Seib *et al.,* 2000). It also gives an indication on how the noodles bind together during cooking reflecting the cooking tolerance and quality (Bhattacharya *et al.,* 1999). The energy at break of the instant noodle values ranged from 0.00054 - 0.0068 J. The values followed similar trend as bio-yied point values. It showed that as percentage of substitution increased, there was reduction in energy at break of *Musa spp*-wheat instant noodle. The values showed that as percentage of substitution increased, less energy would be required by the noodle strands to resist breakdown. This is as a result of weakening of protein network by the presence of *Musa spp* flour in the instant noodle (Seib *et al.,* 2000). The energy at maximum tensile stress values ranged from 0.02 – 1.3 J. The values also followed energy at break pattern showing that increase in percentage of substitution reduced the energy at maximum tensile stress of the instant noodles. The tensile stress at break of the instant noodle values ranged from 0.130 – 1.81 MPa. The values also followed a similar pattern with bio-yield points and energy at break. The values showed that as percentage of substitution increased, there was corresponding decrease in tensile stress of the noodles. The tensile stress of the instant noodle correlated well with cooking loss of the noodle. The result obtained compared favourably with 0.113 – 0.158 MPa reported by Chen *et al.* (2002) for sweet potato-wheat noodles.

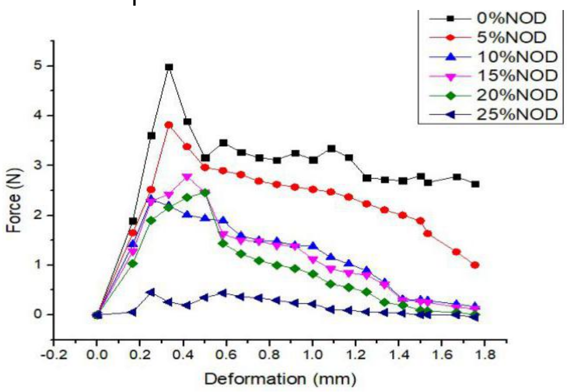

Figure 2: The force-deformation curve of uncooked *Musa spp*-wheat instant noodles

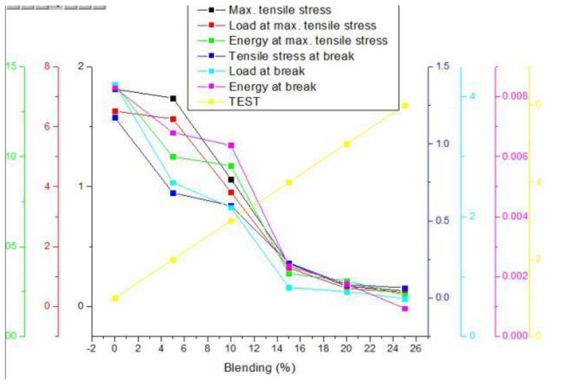

Figure 3: Mechanical properties of uncooked *Musa spp*-wheat instant noodle

5.0 Conclusions

The proximate and cooking properties of *Musa spp*-wheat instant noodle decreased as percentage of substitution with *Musa spp* flour increased. All the sensory attributes of *Musa spp*-wheat instant noodle were assessed above average except colour. Colour being one of the major factor for consumers' choice affect panelists' acceptability of the instant noodle. The optimum percentage of substitution in *Musa spp*-wheat instant noodle is 10% as further increase in substitution affected panelist acceptability. The production of a *Musa spp* based food product like instant noodle promises value addition to the crop while abating the associated post harvest losses.

References

Adeniji, TA., Tenkouano, A., Ezurike, JN., Ariyo, CO. and Vroh-Bi, I. 2010. Value adding post-harvest processing of cooking bananas (*Musa spp*. AAB and ABB genome groups), *African Journal of Biotechnology,* 9 (54): 9135-9141.

Adesina, A. 2015. Agricultural Transformation Agenda: 2014 Report Scorecard, Federal Ministry of Agriculture and Rural Development, Abuja. Nigeria, pp. 1 – 23.

Adeyemi, OS. and Oladigi, AT. 2009. Compositional changes in banana (*Musa spp*.) fruits during ripening. *African Journal of Biotechnology*, 8: 858 – 859.

Ahenkora, K., Kyei, MA., Marfo, EK. and Banful, B. 1997. Nutritional composition of false horn *Apantu pa* plantain during ripening and processing. *African Crop Science Journal*, 5(2): 243-248 AOAC. 2002. Official Methods of Analysis. Association of Analytical Chemists. Gaithersburg, Maryland, USA.

Arshad, MU., Anjum, FM. and Zahoor, T. 2007. Nutritional assessment of cookies supplemented with defatted wheat germ. *Food Chemistry*, 102: 123-128.

Aurand, WL. 1987. Food composition and analysis of food, Von Nostrand Reinhold, New York, pp.135-138.

Bhattacharya, M., Zee, SY. and Corke, H. 1999. Physicochemical properties related to quality of rice noodles. *Cereal Chemistry,* 76(6): 861-867.

Chen, Z., Legger, A., Hassen, JPH., Schols, HA. and Voragen, AGJ. 2002. Evaluation of starch noodles made from three typical chinese sweet-potato starches. *Journal of Food Science,* 67(9): 3342 – 3347.

Choy, AL., Morrison, PD., Hughes, JG., Marriott, PJ. and Small, DM. 2013. Quality and antioxidant properties of instant noodles enhanced with common buckwheat flour. *Journal of Cereal Science*, 57: 281-287.

Fiorda, FA., Soares Jr., MS., da Silva, F., Grosmann, MVE. and Souto, LRF. 2013. Microstructure, texture and colour of gluten-free pasta made with amaranth flour, cassava starch and cassva bagasse. *LWT-Food Science and Technology,* 54: 132-138.

Heo, S., Lee, SM., Shin, JH., Yoo, SH. and Lee, S. 2013. Effect of dry- and wet-milled rice flours on the quality attributes of gluten-free dough and noodles. *Journal of Food Engineering,* 118: 213-217.

Hormdok, R. and Noomhorm, A. 2007. Hydrothermal treatments of rice starch for improvement of rice noodle quality. *LWT-Food Science and Technology,* 40: 1723-1731.

Liu, L., Herald, TJ., Wang, D., Wilson, JD., Bean, SR. and Aramouni, FM. 2012. characterization of sorghum grain and evaluation of sorghum flour in a Chinese egg noodle system. *Journal of Cereal Science*, 55: 31-36.

Mashayekh, M., Mahmordi, MR. and Entezari, MH. 2008. Effect of fortification of defatted soy flour on sensory and rheological properties of wheat bread. *International Journal Food Science and Technology*, 48: 1693 – 1698.

McWatters, KH., Quedraogo, JB., Resurreccion, VA., Hung, YC. and Phillips, RD. 2008. Physical and sensory characteristics of sugar cookies containing mixture of wheat, fonio (*Digitaria* *exillus*) and cowpea (*Vigna unguiculata*) flours. *International Journal of Food Science and Technology*. 38: 403-410.

Oh, NH., Seib, PA. and Chung, DS. 1985. Noodles: Effects of processing variables on quality characteristics of dry noodles, *Cereal Chemistry*, 62(6), 437- 440.

Olomola, AS. 2015. Understanding the Framework for Intergovernmental Interactions in the Implementation of Nigeria's Agricultural Transformation Agenda, Nigeria National Strategy Support Programme II, Working Paper Series, No. 27. International Food Policy Research Institute (IFPRI). Nigeria, pp. 14 – 36.

Padalino, L., Mastromatteo, M., Lecce, L., Cozzolini, F. and Del Nobile, MA. 2013. Manufacture and characterization of gluten-free spaghetti enriched with vegetable flour. *Journal of Cereal Science,* 57: 333-342.

Pakhare, KN., Dagadkhair, AC., Udachan, IS. and Andhale, RA. 2016. Studies on preparation and quality of nutritious noodles by incorporation of deffated rice bran and soy flour. *Journal of Food Processing and Technology*, 7 (10): 629 – 633.

Prinyanka, K., Aparna, K. and Lakshmi, DN. 2012. Development and evaluation of ready to eat (RTE) extruded snack using egg albumin powder and cheese powder. *Agricultural Engineering International: CIGR Journal,* 14(4): 179-187.

Rosell, CM., Barro, F., Sousa, C. and Mena, MC. 2013. Cereals for developing gluten-free products and analytical tools for gluten detection. *Journal of Cereal Science*, http://dx.doi.org/10.1016/j.jcs.2013.10.001. In press

Sanni, LO., Bamgbose, CA. and Sanni, SA. 2004. Production of Instant cassava noodle from cassava. *Journal of Food Technology*, 2(2): 83 – 89.

Seib, PA., Liang, X., Guan, F., Liang, FT. and Yang HC. 2000. Comparison of Asian noodles from some hard white and hard red wheat flours. *Cereal Chemistry,* 77(6): 816 - 822.

Taneya, MLJ., Biswas, MMH. and Shams-Ud-Din, M. 2014. The studies on the preparation of instant noodle from wheat flour supplementing with sweet potato flour. *Journal of Bangladesh Agriculture University*, 12(1): 135 – 142.

World Instant Noodle Association. 2013. Expanding market. instantnoodles.org/noodles/expanding-market.html. Accessed on 11/03/2018.

Wu, J., Aluko, RE. and Corke, H. 2006. Partial least-squares regression study of the effects of wheat flour composition, protein and starch quality characteristics on oil content of steamed and fried instant noodles. *Journal of Cereal Science*, 44: 117 – 126.

Yadav, BS., Yadav, RB. and Kumar, M. 2011. Suitability of pigeoan pea and rice starches and their blends for noodle making. *LWT-Food Science and Technology,* 44: 1415 - 1421.

Yousif, EI., Gadallah, MGE. and Sorour, AM. 2012. Physico-chemical and rheological properties of modified corn starches and its effect on noodle quality. *Annals of Agricultural Science*, 57 (1): 19-27.

Yu, LJ. and Ngadi, MO. 2004. Textural and other quality properties of instant fried noodles as affected by some ingredients. *Cereal Chemistry*, 81(6): 772-776.

Yuan, ML., Lu, ZH., Cheng, YQ. and Li, LT. 2008. Effects of spontaneous fermentation on the physical properties of corn starch and rheological characteristics of corn starch noodle. *Journal of Food Engineering,* 85: 12-17.