Nutritional Evaluation of Instant Noodles from Wheat, Local Rice, and Water Yam Composite Flours

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ABSTRACT

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Aims: This study was carried out to investigate the influence of incorporating local rice (Oryza sativa L.) flour and water yam (Dioscorea alata) flour on wheat (Triticum aestivum) flour at different concentrations on the proximate composition, mineral, and water soluble vitamin contents of instant noodles samples..

Study design Mixture D-Optimal Design for three variables was used to get ten different combinations. The statistical software package was used get the design with 10 as the total number (N) of experiments. The minimum and maximum values for component proportions for the flour blends are given as: $20 <= X_1 <= 100$, $0 <= X_2 <= 50$, $0 <= X_3 <= 30$. Where X_1 = content of hard wheat flour (%), X_2 = content of rice flour (%), and X_3 = water yam flour

Place and Duration of Study: The study took place at the Department of Food Technology, Abia State Polytechnic, Aba between January 2021 and December 2023.

Methodology: local rice (*Oryza sativa* L.) and water yam (*Dioscorea alata*) were processed into flours and used to substitute wheat (*Triticum aestivum*) flour as composite flours at different proportions of 100:0:0 (Wheat); 75:25:0 (Wheat: Rice); 75:0:25 (Wheat:Water yam); proportions of 100:0:0 (Wheat); 75:25:25 (Wheat: Rice: Water yam); 75:25 (Wheat: Rice); 50:50 (Wheat: Rice); 50:25:25 (Wheat:Rice:Water yam); The formulated blends were used to produce 50:0:50 (Wheat:Water yam); 83.33: 8.33: 8.33 (Wheat:Rice:Water yam); 58.33: 33.33: 8.33 (Wheat:Rice:Water yam); 58.33: 8.33: 33.33 (Wheat:Rice:Water yam); 66.67: 16.67: 16.67 (Wheat:Rice:Water yam). The formulated blends were used to produce instant noodles. The proximate, mineral, and water soluble vitamin analysis were carried out on the noodle samples.

Results: The moisture contents of the instant noodle samples ranged from 11.29 to 12.49 % but their moisture contents were not significantly different (P>.05). However, varying the component proportions of the flours significantly (P<.05) affected the protein contents (3.07 to 7.42 %), the fat contents (18.24 to 21.50 %), the ash contents (1.37 to 6.15 %), the fibre contents (0.25 to 0.46 %), and the carbohydrate contents which ranged from 58.12 to 63.11 %. Inclusion of the water yam component of the blended flour sample caused decrease in the protein content in the instant noodles. Significant differences (P<.05) were observed the Phosphorus contents (4.3 to 77.00 mg/100g), Calcium contents (1.5 to 6.1 mg/100g), and Magnesium contents (0.70 to 4.20 mg/100g). However, Iron content (3.95 to 4.26 mg/ 100g) was not significantly (P>.05) different. The values of the water soluble vitamins ranged from 0.170 to 0.175 mg/100g in Vitamin B_1, 0.015 to 0.022 mg/100g in Vitamin B_2, 0.78 to 0.82 mg/100g in Vitamin B_3, and 15.50 to 16.50 mg/100g in Vitamin C. However, only vitamin B_2 varied significantly (P<.05).

Conclusion: Inclusion of local rice and water yam flours in the production of instant Noodles made significant changes in the proximate, mineral and water soluble vitamins contents. However, other foods rich in protein, fibre, vitamins, and mineral should be used to fortify instant noodles to enhance their nutritional and health benefits.

Keywords: *Proximate, Mineral, Water soluble vitamins, Faro 44, Component proportions*

1. INTRODUCTION

Instant noodles are considered a healthy food due to its low sodium content, produces a low glycemic response and provides good amounts of complex carbohydrates, proteins and vitamin, as well as have long shelf life [1]. They are widely consumed throughout the world and their global consumption is second only to bread [2]. The main ingredient of noodles is typically wheat (triticum aestivum) flour, water and some other ingredients to create a dough, which is then rolled out, shaped and cut into various forms. Among the noodles made from non-wheat flour, rice flour is one of the most used and it can be used to make vermicelli, as well as sheets and flat noodles [3]. The reason why rice flour is commonly used in gluten-free formulations is because of its bland taste, high digestibility and hypoallergenic properties [4], and is being employed in recent years in functional food, extruded products, coating agent, processing aid, emulsifiers, water binders, flavour carriers and fat replacer [5].

Nigeria is the largest producer of rice in Africa, but the Nigerian local rice is still highly underutilized as industrial raw material. The Nigerian Government is currently making efforts to improve the productivity of agriculture by improving yield per ha, processing and value addition [6]. These efforts if sustained will soon make Nigeria self-sufficient in rice production, and consumers will certainly start going for high quality rice.

Water yam, is a seasonal, perishable, and underutilized crop. Water yam (*Dioscorea alata*) is a staple starchy food that is highly economical and desirable for the diabetic due to its low sugar content [7]. It is an energy rich tuber and provides protein three times more superior than the one of cassava and sweet potato [8]. The expansion ratio of extruded water yam starches using a single screw extruder studied by [9] demonstrated that water yam has great potential as a food ingredient in extruded products and can be successfully used in the preparation of snacks, pre-gelatinized flours and breakfast cereals.

The objective of this study was to evaluate the proximate composition, mineral, vitamin contents of instant noodles produced from wheat-local rice-water yam blends. This study underscores the potential to develop healthier, sustainable alternatives in the instant noodle industry, benefiting both consumers and local economies. And the findings will contribute to the growing body of knowledge on the use of composite flours in addressing nutritional deficiencies, promoting food security, and encouraging the industrial utilization of indigenous crops.

2. MATERIAL AND METHODS

2.1 Source of Materials

Polished rice of FARO 44 variety used for this study was obtained from Abakaliki rice mill in Ebonyi State, Nigeria. The hard wheat flour used for this study was obtained from a Noodles manufacturing industry located in Uturu, Abia State, Nigeria. The tubers of watery yam Dioscorea alata was obtained from the farm of National Root Crop Research Institute (NRCRI).

2.2 Production of Rice and Water Yam Flours

Rice flour used for the instant noodle samples production was prepared according to the method used [10]. Rice grains were cleaned, sorted and washed. They were then steeped in water for 12 h, drained and dried at 60^0C in a hot air oven. Milling of the dried rice grains was done using attrition mill make and the milled grains sieved using a 300-µm mesh size sieve to obtain fine flour. The water yam was hand-peeled and sliced into sizes of 2 to 3cm thickness, dried at 60^0C in an oven, and pulverized with a hammer mill. Flour mixture of processed wheat, rice, water yam flours were prepared to fit into the experimental design as shown in Table 1. The flours were then thoroughly mixed to obtain a homogenous blend.

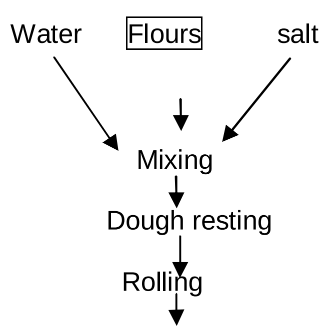
2.3 Production of Instant Noodles

The method of [11] was employed with some modifications. All ingredients were weighed out in their right proportions. A single stage mixing was used in all cases. The alkali mixture i.e. guargum, iodized salt, sodium phosphate, potassium carbonate and water mixed in a mixer with constant stirring for about 20 min. They were then added one after the other to avoid lumps formation.The flow diagram for the noodles production is shown in Figure.1.

Table.1: Mixture D-Optimal Design with three variables for Noodles formulation

Run	**Wheat flour** (X_1) **%**	**Rice flour** (X_2) **%**	**Water yam flour** (X_3) **%**	**Guargum (%)**	**Iodized Salt (%)**	**Sodium phosphate (%)**	K_2CO_3 **(%)**
1	60.00	25.00	15.00	2	0.7	2	0.9
2	45.00	25.00	30.00	2	0.7	2	0.9
3	47.50	37.50	15.00	2	0.7	2	0.9
4	75.00	25.00	00.00	2	0.7	2	0.9
5	70.00	0.00	30.00	2	0.7	2	0.9
6	50.00	50.00	00.00	2	0.7	2	0.9
7	35.00	50.00	15.00	2	0.7	2	0.9
8	80.00	12.50	7.50	2	0.7	2	0.9
9	100.00	00.00	00.00	2	0.7	2	0.9
10	20.00	50.00	30.00	2	0.7	2	0.9

H_2O added= 30-33% by volume



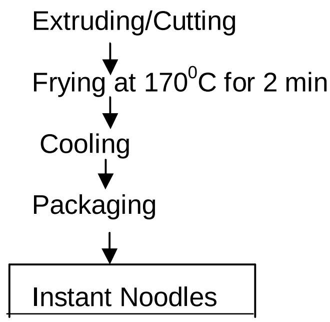


Fig 1: Flow chart for instant noodles production

2.1 PROXIMATE COMPOSITION

Proximate composition of the samples was determined using the [12] method.

2.2 MINERAL DETERMINATION

The mineral contents (Phosphorus (P), Calcuim (Ca), Magnesuim (Mg), and Iron (Fe were analyzed by the procedure of [13] using an Atomic Absorption Spectrophotometer. Mineral) composition of instant noodles were estimated using wet digestion with nitric and perchloric acid. About 1.0 g of each of the samples was first digested with 20 mL of acidic mixture (650 mL conc HNO_3; 80 ml perchloric acid (PCA); 20 ml conc H_2SO_4) and aliquots of the diluted clear digest used for atomic absorption spectrophotometry using filters that match the different elements. The values were then read in Atomic Absorption Spectrophotometer.

2.3 DETERMINATION OF WATER SOLUBLE VITAMIN

The vitamin B1, B2 were determined by the methods described by [14].

2.3.1 Determination of thiamine

The samples were treated with dilute HCL to extract the thiamine complex which was then treated with phosphatase to liberate free thiamine. It was purified by passing through base-exchange silicate alkaline column to remove interfering compounds. The column was eluted with ferricyanide to oxidise thiamine to thiochrome which was measured flourometrically.

2.3.2 Determination of riboflavin

Riboflavin was extracted with dilute acids and after removing the interfering substances by treatment with KMnO4, it was determined in a fluorimeter at 450 - 500 nm wavelength. The intensity of the fluorescent is proportional to the concentration. Niacin content were estimated according to the method of [15], while the vitamin C content of the samples was determined by the method described by [16]. All analyses were performed in duplicates.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Instant Noodles from Wheat-Rice-Water Yam Composite Flours.

Table 2 depicts the proximate composition of instant noodles produced from blends of wheat, rice, and water yam flours.

3.1.1 Moisture content

The moisture contents of the instant noodles ranged from 11.29 to 12.49 % but their moisture contents were not significantly different ($p>0.05$). Low moisture content favours long shelf life.

3.1.2 Protein content

The percentage protein content of the instant noodles significantly ($p<0.05$) ranged from 3.07 to 7.42 %. The results were relatively lower when compared with the protein content values (10.15 to 10.86%) obtained from the noodle samples made by [17]. The difference might have arisen from the differences in the fat contents of the samples from both studies. Sample WRY (50:50:0) had the highest protein content, followed by sample WRY (100:0:0). The sample with the least protein content was made from 20% wheat, 50% rice, and 30% water yam composite flours (WRY 20:50:30) Among the three components used for this study, water yam flour had the least protein content (Table 3). Thus, increasing the water yam component of the blended flour sample may have resulted in the decrease of the protein content in the instant noodles. This followed the same pattern with the works of [11] in which the least protein was observed in the noodle samples made from composite flours with the highest cassava component. Cassava and water yam are carbohydrate rich tubers.

3.1.3 Crude fat

The fat content ranged from 18.24 to 21.50 % in the instant noodle samples. This range is much higher when compared with the fat contents (1.95 to 3.61%) of noodles samples produced by [18]. The noodles samples from their study were not fried and that made them low in fat contents. According to [19], oil in instant noodles contains about 20 % of its total weight. The general high fat content of the instant noodle samples is as a result of absorption of oil during frying. The fat content of all the instant noodle samples were not significantly different ($p>0.05$) except sample WRY (47.5:37.5:15) which had the least fat content of 18.24 %. This implies that variations in the mixture components did not significantly affect the fat content of the noodle samples.

3.1.4 Ash

The ash contents varied significantly ($p<0.05$) from 1.37 to 6.15 % as shown in Table 2, and were comparable with ash contents results of [18] which ranged from 1.84 to 3.67%. Sample WRY (60:25:15) had the highest ash content of 6.15 %, while sample WRY (50:50:0) had the least ash content of 1.37 %. This difference might be as a result of relative high ash content in water yam flour when compared with wheat and rice flours (Table 1). Ash content can be used to indicate mineral elements present in a food sample. 1.84 to 3.67

3.1.5 Fibre

The fibre contents of the instant noodle samples were significantly different ($p<0.05$), and ranged from 0.25 to 0.46 %. The instant noodle sample WRY (20:50:30) had the highest fibre content and was not significantly different ($P>0.05$) with noodle samples WRY (70:0:30). The sample WRY (100:0:0) had the least fibre content (0.25) but not significantly different with the fibre content in sample WRY (75:25:0). The inclusion of water yam flour in the mixture component might have significantly ($P<0.05$) increased the fibre content of the instant noodle samples. From ref [20], the crude fibre contents ranged from 2.0 to 2.33 % in the varieties of water yam they analysed. These are significantly higher than the crude fibre contents of the instant noodle samples from this study.

3.1.6 Carbohydrate

The carbohydrate contents of the instant noodles were generally high, and ranged from 58.12 to 63.11 %. The high carbohydrate content in the instant noodle was expected because the three blended flour sample of wheat, rice, water yam are classified as carbohydrate foods.

Table 2 Proximate Composition of Instant Noodles Made From Blended Wheat-Rice-Water Yam Composite Flours

Codes	**M.C (%)**	**Crude Protein (%)**	**Fat (%)**	**Ash (%)**	**Fibre (%)**	**CHO (%)**
WRY (60:25:15)	11.72±0.57	3.85^{f}±0.14	18.93^{ab}±0.81	3.15^{a}±0.21	0.35^{e}±0.01	62.01^{ab}±0.33
WRY (45:25:30)	11.71±0.18	3.23^{g}±0.09	20.55^{ab} ±0.07	3.28^{a}±0.13	0.43^{bc}±0.01	60.81^{abc}±0.33
WRY(47.5:37.5:15)	12.49±0.37	3.15^{g}±0.06	18.24^{b}±1.36	2.63^{c}±0.09	0.40^{cd}±0.01	63.11^{a}±1.75
WRY (75:25:0)	12.14±0.27	5.02^{cd}±0.11	20.15^{ab} ±0.07	2.02^{de}±0.02	0.27^{g}±0.01	60.41^{abc}±0.06
WRY (70:0:30)	11.41±0.35	6.20^{b}±0.14	20.35^{ab} ±0.21	2.31^{cd}±0.06	0.45^{ab}±0.01	59.29^{bc}±0.49
WRY (50:50:0)	11.29±0.14	7.42^{a} ±0.03	21.50^{a}±0.14	1.37^{f}±0.01	0.30^{f}±0.00	58.12^{c}±0.24
WRY (35:50:15)	11.85±0.36	4.44^{e}±0.08	19.70^{ab} ±1.56	2.70^{c}±0.14	0.38^{e}±0.01	60.95^{abc}±1.97
WRY (80:12.5:7.5)	11.31±0.33	4.77^{de}±0.19	20.57^{ab} ±0.04	2.51^{cd}±0.21	0.35^{e}±0.00	60.50^{abc}±0.11
WRY (100:0:0)	12.10±0.49	7.41^{a}±0.25	20.35^{ab} ±0.07	1.65^{ef}±0.28	0.25^{g}±0.01	58.26^{bc}±0.09
WRY (20:50:30)	11.65±0.13	3.07^{g}±0.09	20.50^{ab} ±0.14	2.03^{de}±0.04	0.46^{a}±0.01	62.30^{ab}±0.07
LSD	NS	0.585	3.26	0.595	0.035	3.49

However, the carbohydrate content of the sample WRY (47.5:37.5:15) with the highest carbohydrate is significantly different from the sample WRY (70:0:30) that recorded the least carbohydrate content. This might be due to the absence of rice flour component in the mixture which had the least carbohydrate content (Table 2).

3.2 Mineral Contents of Instant Noodles

The mineral composition of instant noodles made from wheat, rice, water yam composite flours was presented in Table 3The mineral content of instant noodles produced in this study were significantly different ($p<.05$).

3.2.1. Phosphorus

The phosphorus (P) content varied from 4.30 to 7.70 mg/10g. The sample made from 20:50:30 WRY had the least phosphorus, while sample WRY (47.5:37.5:15) had the highest P content. However, varying the blending proportion of the flour components did not significantly ($p>.05$) affect the phosphorus content of the instant noodle samples.

3.2.2 Calcium (Ca)

The calcium contents of the instant noodles samples ranged from 1.50 to 6.10 mg/10g and significantly differed (*P*<.05) from each other. The range were comparable with the calcium contents of noodle samples obtained from [18]. The instant noodles made from 50 % wheat and 50 % rice flour (sample no 6) had the highest calcium contents (6.10mg/10g), followed by sample WRY (70:0:30) which is not significantly different from sample no 3, 4, 9, and 10. The calcium content was not significantly different by the blending proportions of the flour components of the mixtures.

Table 3. Mineral Composition of Instant Noodles

S/no	Code	P mg/1000g	Ca mg/10g	Mg mg/10g	Fe mg/10g
1	WRY (60:25:15)	13.80^{f}±0.03	1.70^{de}±0.01	1.30^{bc}±0.01	3.97±0.23
2	WRY (45:25:30)	44.90^{d}±0.05	2.90^{cde}±0.01	1.30^{bc}±0.00	4.01±0.16
3	WRY (47.5:37.5:15)	77.00^{a}±0.14	3.90^{bc}±0.01	0.90^{c}±0.01	3.98±0.03
4	WRY (75:25:0)	57.60^{c}±0.08	3.40^{bcd}±0.02	1.30^{bc}±0.01	4.12±0.03
5	WRY (70:0:30)	68.60^{b}±0.08	5.00^{ab}±0.02	0.70^{c}±0.00	4.00±0.06
6	WRY (50:50:0)	69.60^{b}±0.06	6.10^{a}±0.01	1.90^{bc}±0.01	3.95±0.21
7	WRY (35:50:15)	13.80^{f}±0.04	1.50^{e}±0.01	1.50^{bc}±0.00	4.00±0.14
8	WRY (80:12.5:7.5)	14.60^{ef}±0.06	2.60^{cde}±0.00	2.70^{ab}±0.00	3.95±0.07
9	WRY (100:0:0)	15.80^{e}±0.03	3.90^{bc}±0.01	3.90^{a}±0.01	3.98±0.25
10	WRY (20:50:30)	4.30^{g}±0.01	4.10^{bc}±0.01	4.20^{a}±0.03	4.26±0.06
	LSD	7.40	0.55	0.40	NS

3.2.3 Magnesium (Mg)

The magnesium (mg) content of the instant noodle samples ranged from 0.7.00 - 4.2 mg/10g in sample no 5 (WRY: 70:0:30) and sample 10 (WRY: 20:50:30) respectively, and were significantly different (*P*<.05). However, the magnesium content of sample no 10 was not significantly different (*P*>0.05) from sample no 9 and no 8, while that of sample no 8 which is instant noodles made from 80 % wheat, 12.5 % rice, and 7.5 % water yam flour was not significantly different from sample 7, 5, 4, 2, 1, 9, and 10. This indicates close magnesium contents of the noodle samples.

3.3.4 Iron (Fe)

The iron (Fe) contents of instant noodles samples varied from 3.95 to 4.26 mg/10g, but the Fe values of the samples were not significantly different (*P*>.05). The iron contents of the instant noodles were comparable with the iron content (3.07-6.14mg/100g) of homemade noodles reported by [13].

3.4 The Composition of Water Soluble Vitamin (Thiamin, Riboflavin, Niacin and Vitamin C) of the samples

Table.4 shows the composition of B-complex vitamin (thiamin, riboflavin, and niacin) and vitamin C and of the instant noodles samples. The B vitamin are widely found in foods, and their influence is felt in many parts of the body. They generally function as co-enzymes that help the body obtain energy from food.

3.4.1 Vitamin B1 (Thiamin)

Vitamin B1 composition in the instant noodles samples ranged from 0.170 to 0.175 mg/100g, and varying the component proportions of the flours did not significantly (*P*>.05) affect their thiamin composition. This range of values was comparable with the composition of thiamin (0.160 mg/100g) noted in dried wheat and potato noodles studied by [21], but below the Recommended Dietary Allowance for thiamin (1.2mg/day for adult males and 1.1 mg/day for adult females). Though thiamin is found in whole grains, milling and polishing of rice is reported to destroy 67% of Vitamin B3, 80% of Vitamin B1, 90% of Vitamin B6 and some other micro nutrients [22]. White (milled) rice and wheat was used for this study. Enrichment process adds back the nutrients lost during processing. Another factor that could lead to losses in thiamin is cooking. Cooking of fortified noodles was reported to be high with the highest losses ranging from 66-80% [23].

Table 4. Vitamin Composition of Instant Noodles Samples

S/no	W:R:Y	VIT B_1 mg/100g	VIT B_2 mg/100g	VIT B_3 mg/100g	VIT C mg/100g
1	(100: 0: 0)	0.173±0.00	0.015^{b}±0.00	0.79±0.22	15.50±0.50
2	(75: 25: 0)	0.175±0.01	0.022^{a}±0.00	0.80±0.21	16.00±0.50
3	(75: 0: 25)	0.170±0.01	0.016^{b}±0.00	0.82±0.12	16.00±1.00
4	(50: 50: 0)	0.174±0.01	0.022^{a}±0.00	0.81±0.11	15.50±0.50
5	(50: 25: 25)	0.170±0.01	0.021^{a}±0.00	0.80±0.15	15.00±0.00
6	(50: 0: 50)	0.170±0.01	0.016^{b}±0.01	0.82±0.13	16.50±0.00
7	(83.33: 8.33: 8.33)	0.171±0.01	0.017^{b}±0.00	0.78±0.21	16.00±0.00
8	(58.33: 33.33: 8.33)	0.172±0.01	0.020^{ab}±0.00	0.79±0.22	15.00±0.30
9	(58.33: 8.33: 33.33)	0.170±0.01	0.020^{ab}±0.00	0.81±0.21	15.50±0.40
10	(66.67: 16.67: 16.67)	0.171±0.01	0.018^{ab}±0.0O	0.81±0.24	15.50±0.50
	LSD	NS	0.04	NS	NS

3.4.2 Vitamin B2 (Riboflavin)

The vitamin B2 contents of the noodles samples ranged from 0.015 to 0.022 mg/100g but their differences are significantly different (*P*<.05). As shown in Table 4, noodles sample (no 4) made from 50 % wheat and 50% rice composite had the highest riboflavin content (0.022 mg/100g) but not significantly different with samples of no 3, 6, 7, 8, 9, and 10. The least (0.015 mg/100g) was observed with the sample no 1 made from 100% wheat flour but not significantly different from the noodles samples in no 2, 4, 5, 8, 9, and 10. The range of values of riboflavin in this study was similar with that (0.02-0.06 mg/100g) reported from milled rice in the review work done by [22], but quite lower when compared with the range (0.10-0.14mg/100g) from dried wheat and potato noodles in the work of [21]. The variations in values might be due the fact that water soluble vitamin are easily destroyed or washed out during food storage or preparation. This range is far below the Recommended Dietary Allowance for thiamin which is 1.3mg/day for adult males and 1.1 mg/day for adult females [24].

3.4.3 Vitamin B3 (Niacin)

Vitamin B3 contents of the samples ranged from 0.79 to 0.82 mg/100g, but their variations are not significantly different (*P*>.05). This range of niacin values is lower than niacin content of 1.3 to 2.5 mg/100g noted in milled rice. This lower range might come from losses in niacin content during preparation, frying, and storage. The RDA for niacin is 16 mg/day for adult males and 14 mg/day for adult females [24]. Keeping food products away from strong light and refrigerating reduce losses of water soluble vitamin.

3.4.4 Ascorbic Acid (Vitamin C)

The ascorbic acid of the noodles samples ranged from 15.50 – 18.95 mg/100g, but their differences were not significantly different (*P*>.05). When compared with the vitamin C contents of the fresh and dried wheat and potato noodles from the study of [21], this range was about 50 % lower, but higher when compared with the values (2.1 - 2.2 mg/100g) obtained from noodle samples produced by [25]. The relative higher vitamin C content in the study mentioned might have come from the water yam used to substitute wheat. The heat from frying might have also destroyed some vitamin C in this study. Major sources of ascorbic acid are fresh fruits (e.g. citrus) and vegetables.

4. CONCLUSION

The proximate composition, mineral, and water soluble vitamins contents of the instant noodles samples varied significantly (*P*<.05) as the components of the blends varied. This revealed that substituting some level of wheat flour with local rice and water yam flour composite flours, for instant noodles production, could enhance nutritional quality of instant noodles. However, the values showed that the contents of protein, fibre, minerals and water soluble vitamins including vitamin C of all the samples fall below the Recommended Dietary Allowance. This indicates that instant noodles should be fortified with protein, mineral and vitamins to improve their nutritional value. For instance, instant noodles can be eaten with fresh fruits and vegetables to increase the fibre and vitamin contents.

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