# Quality Evaluation of Instant Noodles Substituted with Local Rice and Water Yam Flour Blends


**ABSTRACT**

**The study was done to evaluate the cooking and sensory quality of instant noodles produced from blends of local rice, water yam, and wheat composite flours. Mixture D-Optimal Design for three variables was used. The study took place at the Department of Food Technology, Abia State Polytechnic, Aba between January 2021 and December 2023.**

**The statistical software package was used to generate the experimental design matrix, analyze the experimental data and develop the regression model, and the total number of experiments N was= 10. 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. $X_1$ = content of hard wheat flour (%), $X_2$ = content of rice flour (%), and $X_3$ = content of water yam flour (%).**

**The cooking time of the instant noodles (5.25 - 7.05 min), cooked weight (3.08 - 3.99 g), and cooking loss (0.11 - 0.6 g/g) varied significantly (p<.05). The major factor that affected the cooking quality was the increase in the rice flour component of the mixture components. The protein content (3.07 - 7.42 %) decreased significantly with an increase in the water yam component of the blends. The mixture response surfaces of the sensory analysis depicted a progressive decrease in preference for appearance, flavor, mouthfeel, taste, and overall acceptability with increase in the rice and water yam components of the mixture. However, noodles made from 100:0:0 (wheat flour) was not statistically (p>.05) different from noodles made from 75:25 (wheat: rice) composite flour in all the sensory attributes except for the taste preference. The coefficients of the components implied that the local rice flour was a better substitute for wheat than water yam. Noodles made from 75:25 (wheat: rice) composite flour can be used to produce instant noodles that can compete with noodles in the market made from 100% wheat flour.**



**Noodles made from 75:25 (wheat: rice) composite flour can be used to produce instant noodles that can compete with noodles in the market made from 100% wheat flour.**



*Keywords: Instant noodles, cooking quality, rice noodles, sensory quality, Mixture Experimental Design*


## 1. INTRODUCTION

Instant noodles are widely consumed throughout the world and their global consumption is second after bread [1]. 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. However, Asian style noodles can be broadly grouped into two types - those made from wheat flour and those made from non-wheat flour [2]. Among the noodles made from non-wheat flour, rice flour is one of the most used and it can be used to make noodles, as well as sheets and flat noodles [3]. Rice flour is commonly used in gluten-free formulations because of its bland taste, high digestibility and hypoallergenic properties [4]. And in recent years, rice flour is being employed in functional food, extruded products, coating agent, processing aid, emulsifiers, water binders, flavour carriers and fat replacer [5].


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Nigeria's rice production has reached overwhelmingly high levels [6], and in recent years, Nigeria is the largest producer of rice in Africa followed by Egypt, Madagascar, and 13th in the world [7]. However, the Nigerian local rice is still highly underutilized as industrial raw material.

Water yam, is a seasonal, perishable, and underutilized crop. The expansion ratio of extruded water yam starches using a single screw extruder studied by [8] who 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.

In Nigeria, noodles consumption, second to bread, caused a dependency on massive imported wheat at the expense of hard earned foreign currency reserves. The consumption of these wheat-based products is related to the economy's performance and the purchasing power of consumers. And the high exchange rate of foreign currencies has caused serious rises in prices of wheat-based products like bread, noodles and other wheat-based products. One of the solutions to this problem is the substitution of wheat flour with Nigerian local rice and water yam flours in noodles production. This is expected to increase the demand for rice and water yam, and as well as reduce wheat importation. Therefore, the objective of this study is to evaluate the cooking and sensory quality of instant noodles produced from blends of gluten wheat, local rice, and water yam composite flours using optimal mixture design.

## 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 by [9]. Rice grains were cleaned, sorted and washed. They were then steeped in water for 12 h, drained and dried at 60 $^0$C 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$^0$C in an oven for 8 h, 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. The flow diagram for the noodles production is shown in Figure 1

**Table 1: Noodles Formulation**

| Run | Wheat flour ($X_1$) % | Rice flour ($X_2$) % | Water yam flour ($X_3$) % | Guargum (%) | Iodized Salt (%) | Sodium phosphate (%) | $KCO_3$ (%) |
|---|---|---|---|---|---|---|---|
| 1 | 100.00 | 0.00 | 0.00 | 2 | 0.7 | 2 | 0.9 |
| 2 | 60.00 | 25.00 | 15.00 | 2 | 0.7 | 2 | 0.9 |
| 3 | 50.00 | 50.00 | 00.00 | 2 | 0.7 | 2 | 0.9 |
| 4 | 35.00 | 50.00 | 15.00 | 2 | 0.7 | 2 | 0.9 |
| 5 | 70.00 | 0.00 | 30.00 | 2 | 0.7 | 2 | 0.9 |
| 6 | 20.00 | 50.00 | 30.00 | 2 | 0.7 | 2 | 0.9 |
| 7 | 85.00 | 0.00 | 15.00 | 2 | 0.7 | 2 | 0.9 |
| 8 | 45.00 | 25.00 | 30.00 | 2 | 0.7 | 2 | 0.9 |
| 9 | 47.50 | 37.50 | 15.00 | 2 | 0.7 | 2 | 0.9 |
| 10 | 75.00 | 25.00 | 0.00 | 2 | 0.7 | 2 | 0.9 |

D-Optimal Design, range: $20<=X_1<=100$, $0<=X_2<=50$, $0<=X_3<=30$. $H_2O$ added= 30-33% by volume.

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#### 2.3 Production of Instant Noodles

The method of [10] 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.

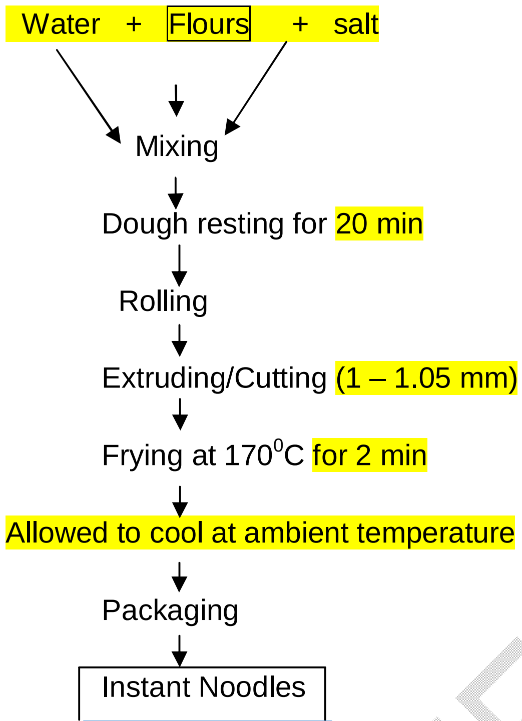


**Fig 1: Flow chart for instant noodles production**

The component proportions by volume of wheat, rice, and water yam flours were measured in a measuring cylinder and introduced into the blender and the alkali mixture ingredients added in a blender, and thoroughly mixed. The formed dough, after thorough manual mixing, was allowed to rest for 20 min, then kneaded and rolled with a rolling pin to form sheets. The sheets were then moved to the kneading section of the Marcato paster machine for further kneading before moving to the slitting section of the same machine where the slitter cuts the kneaded dough into strands having the thickness of 1 – 1.05 mm each. Palm oil used for frying was bleached at 150$^0$C for 15 min in an automated deep fryer. The slitted dough was then fried in the automatic deep fryer for about 2 minutes at the temperature of 170$^0$C. The fried instant noodles were removed, allowed to cool, and then packed in an air tight container at room temperature till used.

### 2.4 Cooking Time, Cooked Weight, and Cooking Loss Determination.

The samples were cooked separately by immersion in boiling water and stopwatch started immediately. Different times taken for each of the samples to get cooked were recorded as cooking time using stopwatch. This was done in triplicates. Optimally cooked noodles should have a chewy, resilient bite without surface stickiness [11]. Cooked weight and cooking loss was determined by the method employed by [12]. The loss of dispersed solids in the cooking water is widely used as an indicator of cooking quality of noodles, considering that the low solids loss is an indicative of high cooking quality [13]. Five grams of each of the fried instant noodle samples was boiled in 150 ml distilled water for 4 min, drained for 5 min, and then weighed. Cooking water was evaporated and dried at 105$^0$ C to a constant weight. Cooking loss was expressed as a percentage of dry matter lost during cooking to dry sample weight. The water absorption was the percentage of weight increase in cooked noodles samples compared to dried samples.

### 2.5 Sensory Evaluation

The cooked noodles samples were presented in disposable plastic containers to a panel of 20 tasters who are noodles consumers. The attributes assessed include appearance, flavour, texture, and overall acceptability. These were scored using a 9 point- Hedonic scale which ranged from 1=dislike extremely to 9=like extremely, with 5=Neither like nor dislike

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and the results tested for significant difference using the analysis of variance and differences amongst means compared using the Duncan multiple range test at 5% level of significance as described by [14].

## 2.6 Statistical Analysis

The statistical software package Design-Expert 13 was used to generate the Mixture D-Optimal Design for three variables, analyze the experimental data and develop the regression model. Ten different combinations was generated.

## 3. RESULTS AND DISCUSSION

## 3.1 Cooking Quality of Noodles

The cooking quality of the instant noodle samples made from wheat, rice, water yam composite flour is presented in Table 2. The parameters used to indicate the cooking quality of noodles in this study include cooking time, cooked weight, and cooking loss.

### 3.1.1 Cooking time

The cooking time of the instant noodle samples as shown in Table 2 varied from 5.50 to 6.95 min, and were significantly (P>.05) different. This range of cooking time is lower than the cooking time range (6.20 to 11.23 min) reported by [15]. The relative shorter cooking time of noodle samples as observed in this study might be due to pre-frying of the noodle samples before cooking. The noodle sample made from 100 % wheat flour had the shortest cooking time of 5.50 min and significantly (*P*>.05) different from other samples. The longest cooking time (6.95 min), was recorded in noodle sample made from 35 % wheat, 50 % local rice and 15 % water yam composite flour, and was not significantly (*P*>.05) different from noodle samples produced from flour components of WRY (60:25:15) and WRY (50:50:0). The differences observed in the cooking time of noodles might be due to differences in gelatinization temperature of respective starches in the three flour samples. Another factor is that the packed bulk density (0.82) of the local rice flour used for this work is significantly higher than that of wheat and water yam flour [16], as this may lead to the reduction of the rate of moisture penetration during cooking of the dried noodles. This might have contributed to the increase in cooking time as the rice flour component increased in the flour mixture used in making of the noodle samples.

**Table 2: Cooking Quality of Instant Noodles**

| s/no | Wheat : Rice : Water yam flour | Cooking time (min) | Cooked weight (g) | Cooking loss (g/g) |
|---|---|---|---|---|
| 1 | 100:00:00 | $5.50^{c}\pm0.35$ | $3.09^{b}\pm0.01$ | $0.11^{f}\pm0.02$ |
| 2 | 20:50:30 | $6.05^{b}\pm0.07$ | $3.99^{a}\pm0.01$ | $0.60^{a}\pm0.03$ |
| 3 | 60:25:15 | $6.85^{a}\pm0.07$ | $3.59^{ab}\pm0.02$ | $0.30^{c}\pm0.02$ |
| 4 | 50:50:00 | $6.85^{a}\pm0.07$ | $3.48^{ab}\pm0.04$ | $0.44^{b}\pm0.01$ |
| 5 | 35:50:15 | $6.95^{a}\pm0.14$ | $3.98^{a}\pm0.01$ | $0.46^{b}\pm0.01$ |
| 6 | 70:00:30 | $6.05^{b}\pm0.07$ | $3.20^{ab}\pm0.01$ | $0.20^{d}\pm0.01$ |
| 7 | 85:00:15 | $6.00^{b}\pm0.07$ | $3.09^{b}\pm0.03$ | $0.12^{ef}\pm0.01$ |
| 8 | 45:25:30 | $6.05^{b}\pm0.07$ | $3.85^{ab}\pm0.01$ | $0.45^{b}\pm0.01$ |
| 9 | 47.5:37.5:15 | $6.00^{b}\pm0.14$ | $3.81^{ab}\pm.05$ | $0.43^{b}\pm0.01$ |
| 10 | 75:25:00 | $6.05^{b}\pm0.21$ | $3.18^{ab}\pm0.04$ | $0.14^{ef}\pm0.01$ |
| | LSD | 0.45 | 0.90 | 0.065 |

The mixture response surface in Figure 2 indicates an increase in cooking time with increase in the rice component of the mixture, while increasing the water yam component of the flour showed a quadratic curve which indicates an initial increase and later reduction in cooking time with further addition of the water yam component.

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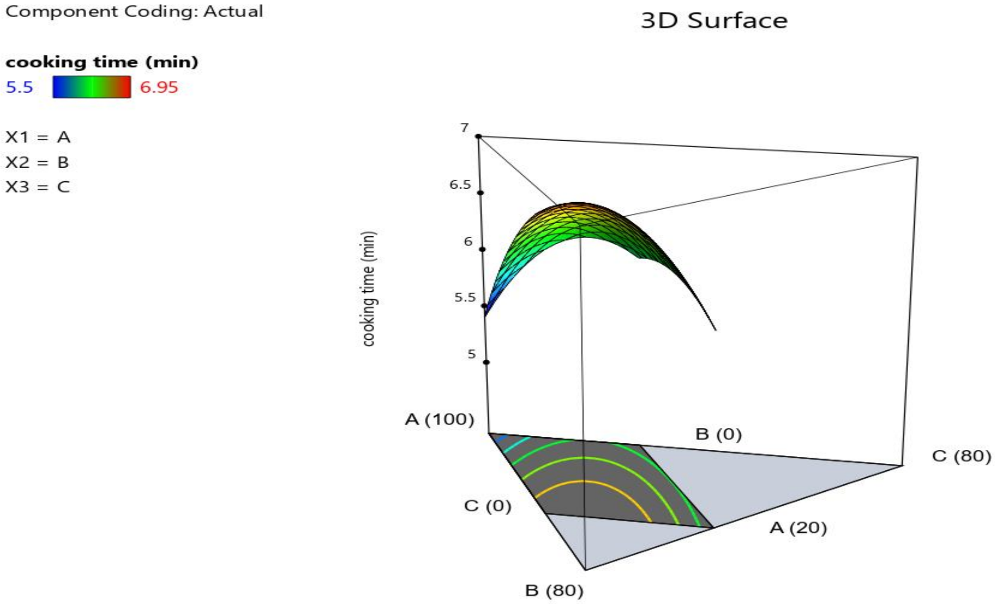


**Figure 2: Effect of wheat substitution with local rice and water yam flour on the cooking time of instant noodles**

The substitution of wheat flour with water yam flour could reduce the cooking time of noodles by enhancing moisture penetration due to discontinuity in gluten network [15]. Lower cooking time in noodles is preferable.

### 3.1.2 Cooked weight

The cooked weight of the samples varied from 3.09 to 3.99g, with sample WRY (20:50:30) having the highest cooked weight (3.99 g) (Table 2). The instant noodle sample with the least weight (3.09 g) was made from 100 % wheat flour and from the sample with the component ratio of WRY (85:0:15). The mixture response surface in Figure 3. depicts a linear increase in the cooked weight of the instant noodle samples as the component of wheat flour was substituted with rice flour, but no significant change as the component of water yam flour increased.

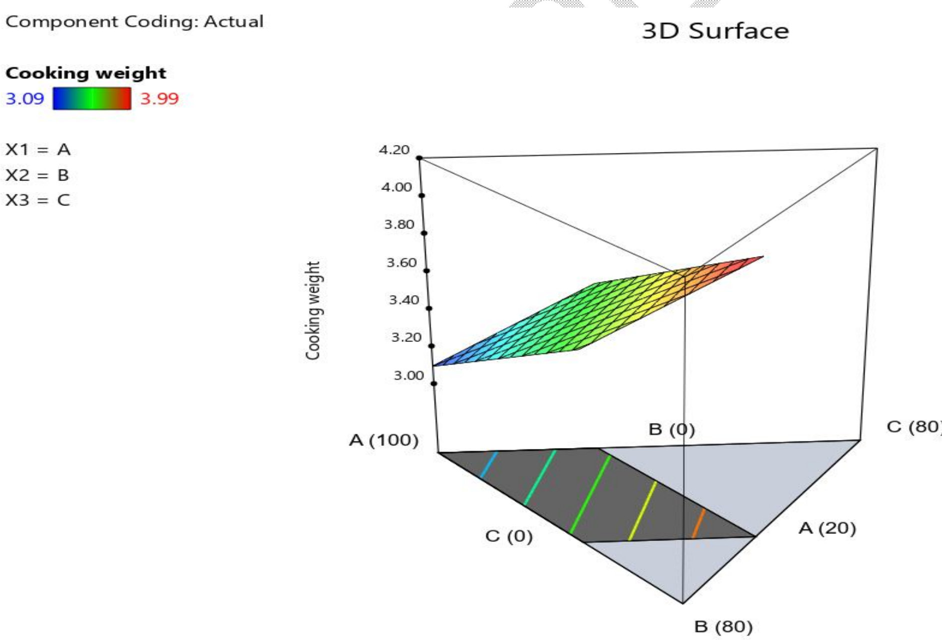


**Figure 3: Effect of wheat substitution with local rice and water yam flour on the cooked weight of instant noodles**

Higher protein (gluten) concentration in the product results in decreased cooked weight due to reduction in the starch tendency to imbibe water [15]. Thus, decrease in the protein (gluten) content of the mixture by substituting wheat flour with local rice flour might have resulted to increase in the cooked weight. The local rice flour had the highest bulk density when compared with the bulk densities of wheat flour and water yam flours [16], and this might have contributed to the increase in cooked weight of the product sample with increase in rice component of the flour mixture. The estimated regression coefficient in Table 4. showed that water yam imparted the highest cooked weight effect of 3.93 rice flour imparted the highest cooked effect of 3.93, followed by water yam flour (3.25), while the least (3.1) was imparted from wheat.

### 3.1.3 Cooking loss

The values of cooking loss varied significantly (P<.05) from 0.11 to 0.60 g/g (Table 2), with the minimum cooking loss observed in noodles made from 100 % wheat flour, while the highest loss of 0.6 g/g was observed in noodles made from composite flour WRY (20:50:30). There was a significant (P<.05) (Table 3) linear increase in cooking loss of the samples with increase in the substitution of wheat flour with rice flour in the mixture. The significant lack of fit is not significant (p>.05) (Table 3). These indicate that the variations in the mixture components have significant effect on the cooking loss of the instant noodle samples, and is suitable for formulating a predictive regression model. Noodles should have minimal loss of solids in the cooking water, higher cooking loss results to unwanted characteristics such as high starch solubility and poor cooking resistance or tolerance that causes stickiness in texture of noodles [17].

The mixture response surface in Figure 4 shows a progressive increase in cooking loss as the rice component of the mixture substitutes the wheat component. The wheat starch granules and gluten matrix form a strong network by acting as filler particles and this enables dough to form a very unique cohesive and viscoelastic texture, which aids bread making and other food applications such as pasta, biscuits, noodles, cakes, soups etc. [5]. The discontinuity in the gluten network coupled with the medium amylose content of the rice flour used to replace wheat flour component of the mixture might have caused the increase in cooking loss as the rice component of the composite flour increased. Loss of gluten network in flour leads to reduced elasticity of the noodles, and cooking loss of noodles in cooking water. Hardness of rice flour gel is a dominant factor in rice noodle quality [12], coupled with absence of gluten network. From Table 4 the linear model is as stated in equations in equation 3.1 as follows:

**Cooking Loss = $0.0385X_1+0.6165X_2+0.5363X_3$ …………………….. 3.1**

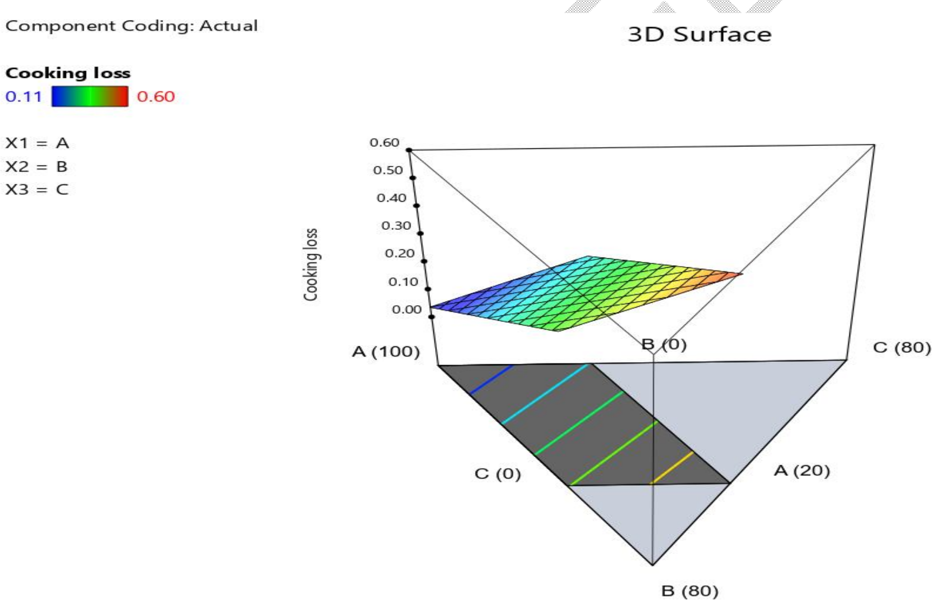


**Figure 4: Effect of Wheat Substitution with Native Rice and Water Yam Flour on the Cooking Loss of Instant Noodles**

**Table 3: Estimated regression coefficient for cooking loss of wheat-rice-water yam instant noodles.**

| Source | Component | Coefficient Estimate | df | Standard Error | p-value |
|---|---|---|---|---|---|
| | A-Wheat | 0.0385 | 1 | 0.0299 | |
| | B-Rice | 0.6165 | 1 | 0.0458 | |
| | C-Water yam | 0.5363 | 1 | 0.0845 | |
| Model | | | | | 0.0001 significant |
| Lack of Fit | | | | | 0.0835 not significant |

### 3.2 Sensory Evaluation of the Instant Noodles Samples

The results of the sensory evaluation of wheat-rice-water yam noodles are shown in Table 4. Varying the components of the composite flour significantly (p<.05) affected the scores of all the sensory parameters.

#### 3.2.1 Appearance

The scores, in terms of appearance, ranged from 3.20 to 8.60 as shown in Table 4. The noodle sample with the highest score (8.60) was made from 100% wheat flour, followed by score (8.20) obtained from sample (no 4) made from 75% wheat and 25% rice flours and they were not significantly (p>.05) different. This implies that partial replacement of wheat flour, with 25 % local rice (Faro 44) flour in noodles production, does not have any significant effect on the appearance. The second best noodle sample with the score (6.77) was made from 85% wheat, and 15% water yam flour components. The product sample with the least panelists' score (3.20) was obtained from noodles made from 20% wheat flour, 50% rice, and 30% water yam composite flour .

The three dimensional graph (Fig.5) depicts a significant quadratic decrease in preference for appearance as the components of both rice flour and water yam flours increased in the raw material.

**Table 4. Sensory Scores For the Instant Noodles Samples**

| Codes | Appearance | Flavour | Mouthfeel | Taste | Overall Accept. |
|---|---|---|---|---|---|
| WRY (60:25:15) | $5.73^{cd} \pm 0.78$ | $5.53^{cde} \pm 1.61$ | $6.27^{bc} \pm 1.17$ | $6.63^{bc} \pm 0.85$ | $6.04^{cd} \pm 0.63$ |
| WRY (45:25:30) | $4.50^{e} \pm 1.33$ | $5.93^{cde} \pm 1.01$ | $5.33^{cd} \pm 1.18$ | $5.43^{de} \pm 1.68$ | $5.30^{d} \pm 1.10$ |
| WRY(47.5:37.5:15) | $6.00^{bc} \pm 1.02$ | $5.20^{de} \pm 1.56$ | $5.60^{c} \pm 1.94$ | $6.30^{cd} \pm 1.29$ | $5.78^{cd} \pm 1.11$ |
| WRY (75:25:0) | $8.20^{a} \pm 0.76$ | $7.50^{ab} \pm 1.04$ | $7.30^{ab} \pm 1.12$ | $7.40^{b} \pm 0.81$ | $7.60^{b} \pm 0.74$ |
| WRY (70:0:30) | $6.20^{bc} \pm 1.81$ | $6.20^{cd} \pm 0.89$ | $6.30^{bc} \pm 1.02$ | $5.90^{cd} \pm 0.84$ | $6.15^{cd} \pm 0.87$ |
| WRY (50:50:0) | $4.80^{de} \pm 1.00$ | $3.60^{f} \pm 1.65$ | $3.60^{e} \pm 1.65$ | $3.90^{fg} \pm 1.90$ | $3.98^{e} \pm 1.32$ |
| WRY (35:50:15) | $3.30^{f} \pm 1.76$ | $4.90^{e} \pm 0.96$ | $4.40^{de} \pm 1.45$ | $4.60^{ef} \pm 1.89$ | $4.30^{e} \pm 1.22$ |
| WRY (85:0:15) | $6.77^{b} \pm 1.45$ | $6.50^{bc} \pm 1.41$ | $6.27^{bc} \pm 1.44$ | $6.97^{bc} \pm 1.19$ | $6.63^{c} \pm 1.28$ |
| WRY (100:0:0) | $8.60^{a} \pm 0.50$ | $8.53^{a} \pm 0.73$ | $8.23^{a} \pm 1.01$ | $8.67^{a} \pm 0.48$ | $8.51^{a} \pm 0.54$ |
| WRY (20:50:30) | $3.20^{f} \pm 1.35$ | $2.70^{f} \pm 1.37$ | $3.30^{e} \pm 1.29$ | $3.10^{g} \pm 1.54$ | $3.08^{f} \pm 1.34$ |
| LSD | 1.03 | 1.30 | 1.20 | 1.00 | 0.90 |

The response surface further depicts a significant reduction in preference for appearance as the component of rice exceeded certain amount (25%) in the mixture. This reduction could be attributed to the fact that the hard wheat flour obtained from the industry which appeared whitish had been replaced with less whitish rice component. This implies that

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the noodles whiteness decreased with substitution of wheat flour with components of rice and water yam flours. Appearance is a very important attribute of noodles. Wheat flour from the endosperm portion of the kernel which gives rise to white flour, and the products made from this white flour are considered to have milder flavor, and smoother texture. High-quality wheat flour with white color is required for production of noodles with good appearance **(Li *et a*l., 2015).** And any replacement of the white flour will reduce the attractive whitish appearance.

The coefficient of the mixture components of wheat, rice, and water yam are 5.95, -1.23, and -1.49 respectively (Table 5). These negative values indicate that both rice and water yam components generally had antagonistic effects on the appearance of the final noodle samples. However, the major significant (p>.05) component responsible for the reduction in the preference of the noodles was the addition of water yam flour.

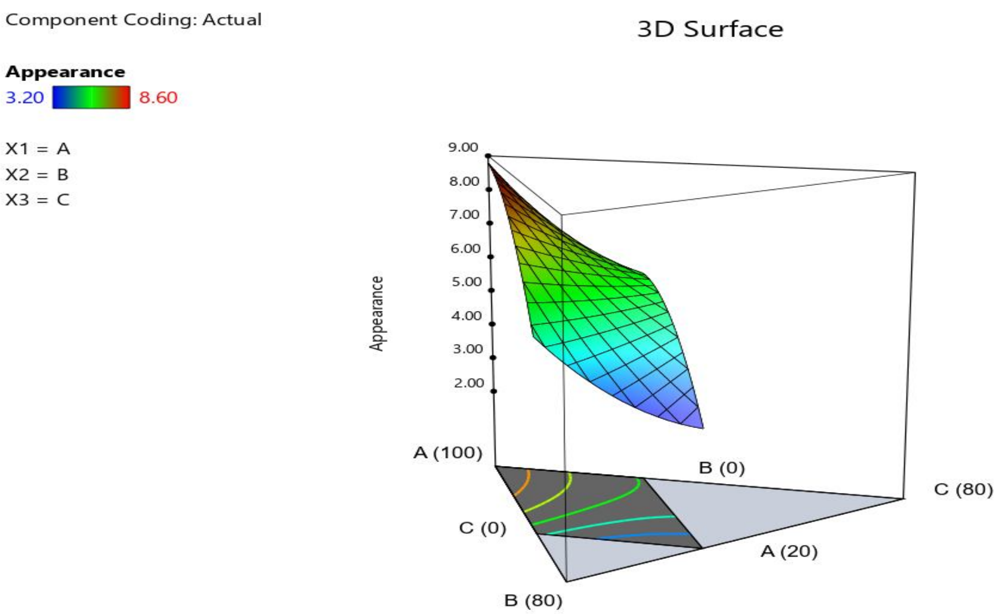


**Figure 5: Effects of Mixture components on the Appearance of Instant Noodles.**

**Table 5. Estimated regression coefficient for appearance of wheat-rice-water yam instant noodles.**

| Source | Component | Coefficient Estimate | DF | Standard Error | Prob > F |
|---|---|---|---|---|---|
| | A-Wheat | 5.95 | 1 | 0.65 | |
| | B-Rice | -1.23 | 1 | 0.57 | |
| | C-Water yam | -1.49 | 1 | 0.45 | |
| | AB | 6.20 | 1 | 4.89 | 0.1065 |
| | AC | -14.66 | 1 | 14.11 | 0.2788 |
| | BC | -10.87 | 1 | 13.30 | 0.8825 |
| Model | | | | | 0.0026 significant |
| Linear Mixture | | | | | 0.0005 significant |
| Lack of fit | | | | | 0.0002 significant |

**3.2.2 Flavour**

The scores for flavour ranged from 2.70 to 8.53 (Table 4.). The effect of replacement of wheat flour with rice and water yam on the flavour of the noodle product sample is similar to what was obtained in the appearance. The preference in terms of flavour in noodle samples made from 100% wheat and that produced from wheat and rice in the ratio of 75:25 are not statistically (p>.05) different. Similarly, the next most acceptable noodles (sample no 8), in terms of flavour, made from wheat-rice-water yam flours in the ratio of 85:0:15, was not different statistically from noodles produced from 75% wheat and 25% rice flour components.

The response surface in Figure 6 indicates a significant quadratic decrease in the preference for flavour as rice and water yam flour components increase in the mixture. White wheat flour is made from the endosperm portion of the kernel which makes up about 80% of the volume of the whole grain, and is desirable because the products made from this white flour are often considered to have milder flavour, smoother texture, and, in the case of bread, greater volume [19]. This might be responsible for the positive flavour effect of wheat on the noodle samples since white wheat flour was used for the study.

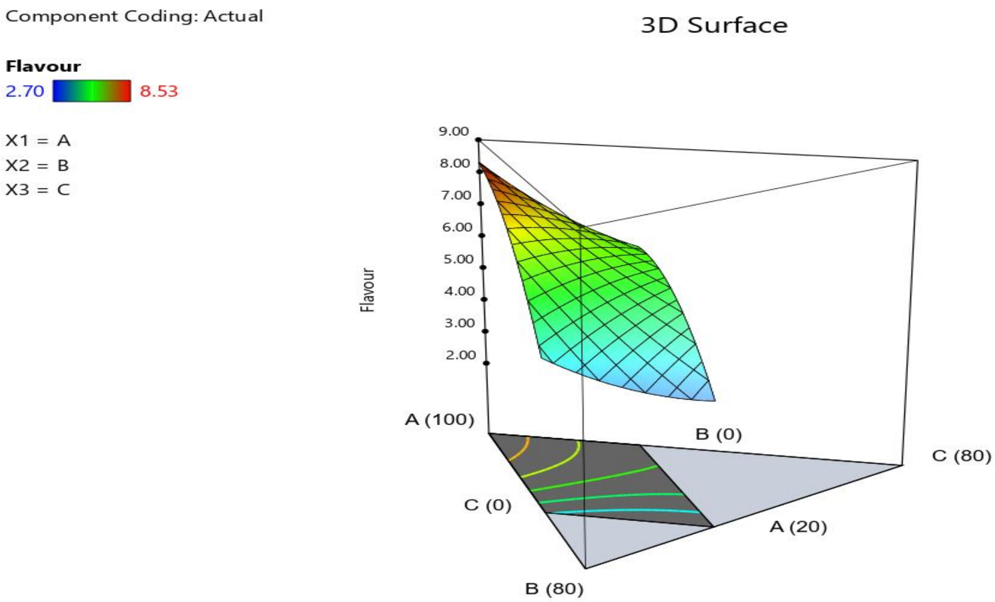


**Figure 6: Effects of mixture components on the flavour of instant noodles**

### 3.2.3 Mouthfeel

The mouthfeel or sensory texture of cooked noodles is a parameter of great importance. It is generally accepted as the main criterion for assessing overall quality of cooked noodles. The scores for mouthfeel ranged from 3.30 to 8.23 (Table 4). The difference in sensory data for mouthfeel of the noodle samples produced from 100% wheat flour and that made from wheat-rice flours in the ratio of 75:25 rice were not statistically significant (p>.05). Likewise, noodles made from wheat-rice flours in the ratio of 75:25 were not significantly (p>.05) different from the noodle samples made from wheat-rice-water yam flours in the ratios of 60:25:15, 70:30:0, and 85:0:15.

The mixture response surface in Figure 7 showed an initial insignificant decrease (p>.05) in the scores for texture/mouthfeel as the components of rice and water yam replaced the component of wheat. However, the decrease became significant (p<.05) as the component of rice exceeded 25%. Hardness of rice flour gel is a dominant factor in rice noodle quality [12], coupled with absence of semolina gluten network which is the main structure-forming protein, and its absence results in technological and quality problems [20]. Also, the low amylose content and relative high breakdown viscosity of the local rice flour caused low firmness and low cooking tolerance of the instant noodle samples as the rice component of the composite flours exceeds 25%. In other to increase rice utilization in noodles production, the selection of local rice with higher amylose content and lower breakdown viscosity is advised.

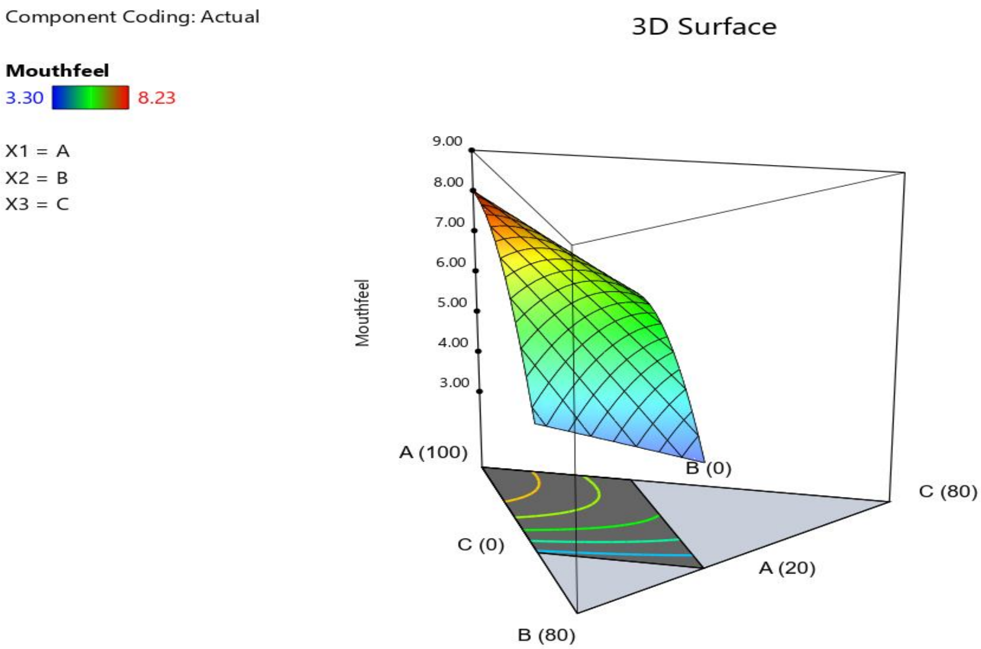


**Figure 7: Effects of Mixture components on the mouthfeel of instant noodles**

### 3.2.4 Taste

The sensory score for taste ranged from 3.10 to 8.67 as shown in Table 4. Noodle samples produced from 100% wheat flour had the highest score (8.67) which was significantly ($p<.05$) different from the second best score (7.40) obtained from sample made from wheat-rice flours in the ratio of 75:25. This difference in taste might be due to the bland taste of rice. However, the taste of cooked noodles can easily be improved upon adjusting the quantity of the ingredients used in cooking the noodles.

The response surface curve (Figure 8) depicts a quadratic decrease in the preference for taste of the instant noodle samples as the components of both rice and water yam flours increased in the mixture. This implies that there was initial gradual decrease and more decrease in taste as the component of wheat is further substituted with rice and water yam flours.

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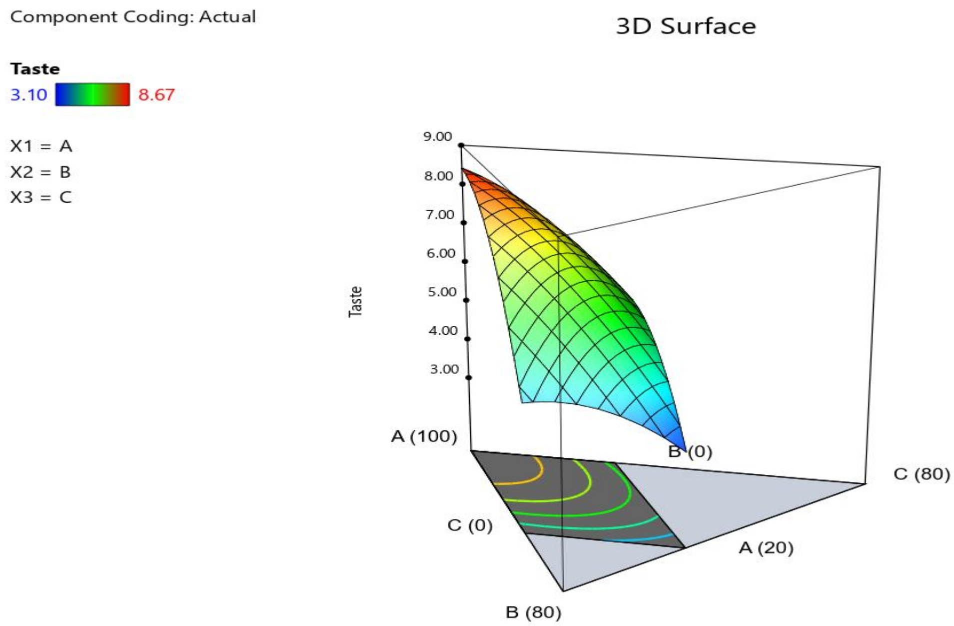


**Figure 8: Effects of mixture components on the taste of instant noodles**

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### 3.2.5 Overall acceptability

The scores for the general acceptability were statistically different (p<.05), and ranged from 3.08 to 8.51 (Table 4). The instant noodles made from 100 % wheat had the highest score of 8.51 while that made from 20 % wheat, 50 % rice, and 30 % water yam composite flour had the least score of 3.08. The second best instant noodle samples made from 75 % wheat and 25 % rice composite flour scored 7.60. The scores from the overall acceptability was influenced by the fact that panelists were used to consuming commercially manufactured noodles made from 100 % wheat flour. However, the second best instant noodles that have their wheat substituted with 25% rice flour were also scored 'very good' (approx. 8) on the average.

The 3d graph (Figure 9) indicates a rapid decrease in overall acceptability of the instant noodle samples as the wheat flour being substituted exceeded 25% of rice flour.

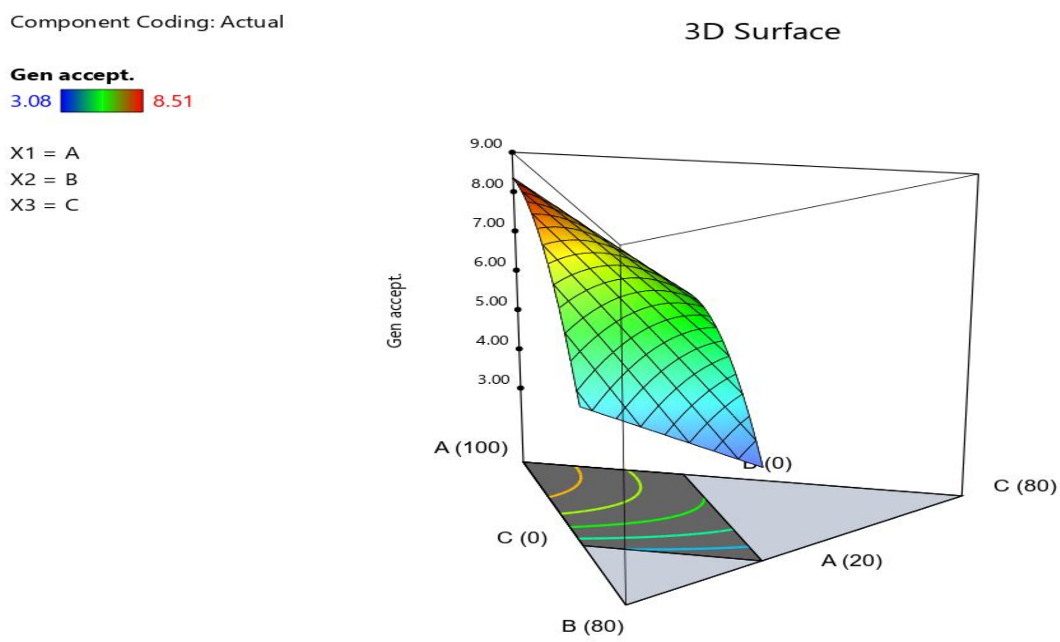


**Figure 9: Effects of mixture components on the overall acceptability of instant noodles**

## 4. CONCLUSION

The cooking time, cooked weight, and cooking loss of the instant noodle samples increased with increase in the rice flour component and decreased with increase in the wheat component of the blends. In other words, instant noodles made from 100 % wheat had the least cooking time, cooking weight, and cooking loss. The rice flour was found to be a better substitute for wheat than water yam flour in the instant noodles production. Noodle samples made from 100 % wheat flour scored the highest/optimum in terms of appearance, flavour, mouthfeel, taste, and general acceptability, but was not significantly (p>0.05) different with the second best noodle samples made from 75 % wheat and 25 % rice flour in all the sensory quality except in taste preference. This difference in the taste preference is not a problem as the taste of noodles could be improved by adjusting the quantity of the ingredients. This implies that instant noodles made from 75 % wheat and 25 local rice composite flours could compete favourably in terms of quality with noodles in the market made from 100 % wheat flour. And the substitution of wheat flour with less or up to 25% Nigerian local rice will to a certain degree increase industrial utilization of local rice, reduce the nation's dependency on wheat in noodles production, and increase noodles variety.

**Disclaimer (Artificial intelligence)**
Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.
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Details of the AI usage are given below:
1.
2.
3.

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