



# **Effect of Gum Arabic Incorporation on the Proximate Composition and Sensory Properties of Biscuits Produced from Flour Blends of Wheat and Water Yam**

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## **ABSTRACT**

The aim of this study was to evaluate the influence gum Arabic incorporation on the proximate composition and sensory properties of biscuits produced from flour blends of wheat and water yam. Water yam was processed into flour and used in composite with wheat flour for biscuit production. Two formulations A and B were produced from the mixture of wheat and water yam flour in the ratios of 50:50 and 30:70, respectively. The two formulations each were used to produce biscuits with different concentrations of gum Arabic (0%, 0.3% and 0.5%) and 100% wheat flour as control. Biscuit samples were subjected to proximate and sensory analysis using standard methods. Increase in the concentration of gum Arabic resulted to an increase in the moisture content (5.63-6.41% and 5.31-6.01%), crude fibre (1.13-1.95% and 2.22-3.40%) and carbohydrate contents (76.96-78.99% and 73.73-77.75%) for formulations A and B, respectively. A

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decrease in the ash content (3.11-2.85% and 4.60-2.78%), fat (5.35-2.56% and 5.62-2.51%) and protein content (7.82-7.24% and 8.52-8.05%) was also observed as the concentration of gum Arabic increased for formulations A and B, respectively. Result of the sensory analysis revealed that the control biscuit sample was more preferable for colour, taste, flavor, softness and general acceptability while biscuit samples containing 0.5% gum Arabic was more preferred for crispiness and hardness. The result also showed that the incorporation of gum Arabic led to increased sensorial attributes of wheat/water yam composite biscuits. The control sample and biscuit sample containing 30% water yam flour, 70% wheat flour and 0.5% gum Arabic were significantly similar for crispiness, hardness, softness and overall acceptability suggesting that gum Arabic can be incorporated at 0.5% into wheat and water yam composite flour at 70% and 30%, respectively for the production of acceptable and quality biscuits.

**Keywords:** Biscuits; wheat; water yam; gum Arabic; proximate; sensory.

## 1. INTRODUCTION

Biscuits are ready-to-eat snacks produced from unpalatable dough transformed into appetizing product through the application of heat [1]. They are cheap and convenient baked product which is consumed among all age groups in many countries [2]. They are produced from a mixture of flour and water, but may contain fat, sugar and other ingredients mixed together to form a dough which is rested for a period of time and then passed between rollers to make a sheet [3]. The nutritional content of biscuits depends on the type of flour used during production. For biscuits making, the most suitable is the soft wheat flour [4]. This is chosen due to its ability to form a visco-elastic matrix (gluten), which is responsible for the rising nature of dough as well as its gas retention ability [5].

The consumption of ready-to-eat baked products in Nigeria is continually increasing which has also resulted to increase in demand for wheat flour by households and food industries for biscuit production [6]. Despite this, wheat flour is insufficient in the country and in other regions of the world resulting in importation of the flour by regions with limit supplies [7]. This also has led to high cost of production of baked products such as biscuits [1]. However, other crops grown other than wheat such as tubers (yam, cassava, and sweet potato), cereals (maize), legumes and nuts can be used to partially substitute wheat flour for the production of baked products [8,9,10,11,12]. There is therefore, a compelling need to develop composite flour from locally available food materials which would serve as an adequate substitute for wheat flour. This substitute should be readily available, cheap and capable of replacing wheat in functionality [13].

Water yam (*Dioscorea alata*) is a monocotyledonous plant belonging to the family

*Dioscorea* spp. *Dioscorea alata* is one of the six yam species of economic importance [14]. It is an underutilized crop in Nigeria due to traditional bias and poor recognition of the unique quality characteristics of this specie. It is a seasonal and perishable crop which can be converted to flour to enhance its shelf life [15]. *Dioscorea alata* has been reported to contain 2.93% ash, 1.15% lipids, 6.79% moisture, 2.31% fibre and 76.57% carbohydrate [16]. They are also known to contain bioactive compounds such as dioscorin, diosgenin and water soluble polysaccharides which play an important role in the management of hypertension an control of cholesterol metabolism [17,18]. They can be eaten boiled, mashed, fried, or mixed with pal oil or groundnut oil and steamed [19]. It can also be made to a stiff porridge and eaten with soups. Snacks such as queen cakes, biscuits and pastries have also been reported from water yam flour [7,20,14].

Water yam unlike wheat flour does not contain gluten and as such, its use as non-wheat flour in making baked products such as composite biscuits is constrained by a number of challenges. These include low quality problems such as weak binding, stretching, and colour properties [21]. Several studies have reported a decreased quality of biscuits as substitution level with other flours increased [7,20]. This decrease in quality characteristics has been reported to be due to gluten dilution thereby leading to a reduction in flour strength and gas retention [22,23]. This finally leads to decreased sensory attributes for most composite biscuits. In order to provide structural stability and quality of non-wheat composite biscuits, the incorporation of several additives, improvers and dough strengtheners for the production of bakery products from composite flours therefore

becomes necessary [24]. These additives can imitate the viscoelastic properties of gluten [25]. Some food additives such as gums can also be added to non-wheat biscuits to obtain the desired quality [26].

Gum Arabic is a dried gummy exudates obtained from the stems and branches of *Acacia Senegal* trees [13]. It is widely used in the food industries either as an emulsifier, a foaming agent or an encapsulating material [27]. They are also added to food products mainly for their thickening and gelling properties. They are used to improve mouth feel and change the viscosity of solution due to their high polymeric nature and their interactions between polymer chains when they are dispersed [28]. Several studies have been carried out showing the potential use of gums in bakery products such as biscuits, cakes and breads [28,29,30]. Elkhalifa *et al.* [13] studied the use of guar gum and gum Arabic as bread improvers for the production of bakery products from sorghum flour. It was found that the addition of guar gum and gum Arabic in different concentrations improved the functional properties of sorghum flour. The utilization of these gums as bread improvers also promoted the acceptability of baked products made from sorghum flour.

In a similar study, Rodge *et al.* [31] also reported the use of gums in bakery products in order to improve the properties of the final product. Rodge *et al.* [32] also stated that the addition of gums results in dietary fibre increase and decreasing caloric value by diluting the moisture content. Thus, the objective of the present research was to investigate the effect of gum Arabic incorporation on the proximate composition and sensory properties of biscuits produced from flour blends of wheat and water yam.

## 2. MATERIALS AND METHODS

### 2.1 Materials

Water yam (*Dioscorea alata*) tuber and refined wheat flour was purchased from Eke-Awka market in Awka, Anambra State. Other ingredients such as Salt, Sugar, Margarine, Baking powder, Milk, and egg were also brought from the same market. Gum Arabic was purchase from Onitsha main market, Anambra State. All reagents used for all analysis were of analytical grade.

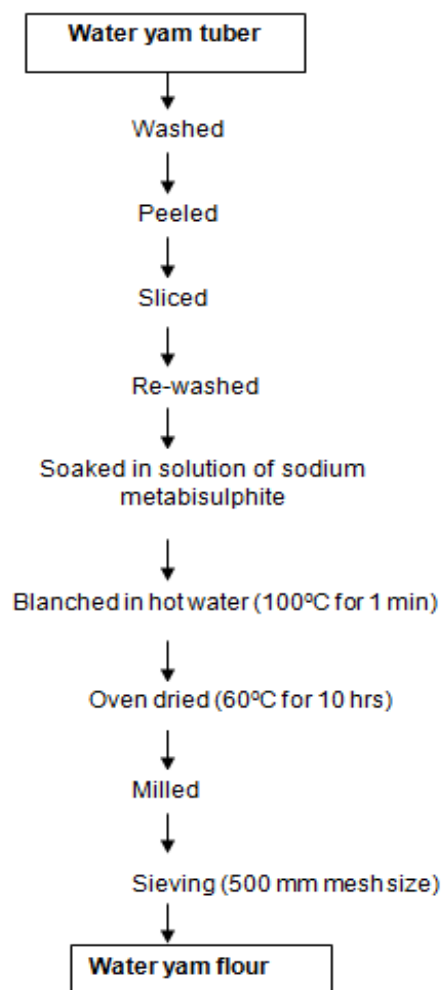


Fig. 1. Flow chart for the processing of water yam flour

### 2.2 Processing of Water Yam Flour

Water yam flour was produced following the method described by China and Ezema [7]. *D. alata* tubers were washed in running tap water and peeled manually using a stainless steel knife. The tubers were then sliced and re-washed. The sliced *D. alata* were soaked in tap water containing sodium meta-bisulphite in order to prevent any browning reaction and were blanched in hot water at temperature of 100°C for a minute. The blanched *D. alata* were oven dried at 60°C for 10 hrs in a hot-air fan oven (model QUB 305010G Gallenkamp UK), milled using a commercial mill and screened through a 500 mm mesh size British standard sieve (model BS 410 Endecott Ltd London, UK) to obtain a

uniform fine flour and stored in an airtight plastic container at room temperature (37°C) until used.

### 2.3 Experimental Design

The research design was to test the effect of gum Arabic and composite flours of water yam and wheat on the proximate sensory properties of biscuits. Two formulations A and B were produced from the mixture of wheat and water yam flour in the ratios of 50:50 and 30:70, respectively. The two formulations were used to produce biscuits with different concentrations of gum Arabic each (0%, 0.3% and 0.5%) and 100% wheat flour as control. The different levels of combinations of water yam and wheat flours and gum Arabic are given in Table 1.

### 2.4 Biscuit Formulation

Biscuits were formulated according to the official method AACC 10-53.01 [33] with slight modifications.

### 2.5 Biscuit Production

The short soft dough biscuits were prepared according to the creaming method of

Akubor [34]. The biscuits were produced which contained high levels of fat and low Sugar. During the biscuit making, sugar and fat (margarine) were initially creamed in a Kenwood mixer at medium speed until fluffy. The milk, egg and gum Arabic were added respectively and mixed for 20 mins. The baking powder, salt and the composite flour (wheat and water yam flour) in each case were added into the mixture and mixed thoroughly for 15 mins using hand until homogenous and hard consistent dough was obtained. The dough was rolled on a flat rolling board sprinkled with the same flour to a uniform thickness (2 mm) using a wooding rolling pin. Circular biscuits were cut (using a circular biscuit cutter of diameter 4 cm), placed on a greased baking trays and baked in hot air oven at a temperature 160°C for 15 mins when a very light brown colour was formed biscuit were removed from the oven and allowed to cool at ambient temperature for 20 mins. On cooling, the biscuit were packaged in air tight containers until needed for analysis and sensory evaluation. In addition, the biscuit made with 100% wheat flour were similarly prepared and used as control.

**Table 1. Production of different levels of combinations of wheat flour, water yam flour and Gum Arabic in biscuit baking**

Samples	Codes	%Water yam	%Wheat flour	%Gum Arabic
1	A0%	50	50	0.0
2	A0.3%	50	50	0.3
3	A0.5%	50	50	0.5
4	B0%	30	70	00
5	B0.3%	30	70	0.3
6	B0.5%	30	70	0.5
7	WF0%	0	100	00

Keys: WF: Wheat Flour, WYF: Water yam Flour, GA: Gum Arabic, A0% = 50%WYF: 50%WF: 0%GA, A0.3% = 50%WYF: 50%WF: 0.3%GA, A0.5% = 50%WYF: 50%WF: 0.5%GA, B0% = 30W%YF: 70%WF: 0%GA, B0.3% = 30%WYF: 70%WF: 0.3%GA, B0.5% = 30%WYF: 70%WF: 0.5%GA, WF = 0%WYF: 100%WF: 0%GA

**Table 2. Recipe for biscuit production**

Ingredients	(% flour) short soft dough biscuit
Flour (g)	200.00
Sugar (g)	40.00
Fat (g)	60.00
Baking powder (g)	5.00
Salt (g)	2.00
Milk (powdered) (g)	2.00
Vanilla flavour (g)	2.00
Gum Arabic (%)	(0.0, 0.3, and 0.5 by weight)

Source: AACC 10-53.01 [33] with slight modification

## 2.6 Proximate Analysis of the Biscuits

Proximate analyses of the biscuits were carried out on the samples using standard AOAC, [35] methods. Moisture content was calculated after drying at 105°C to constant weight in an air oven (Thermo Scientific-UT 6200, Germany). Fat content were estimated by exhaustive extraction of known weight of samples with petroleum ether using rapid Soxhlet extraction apparatus (Gerhardt Soxtherm SE-416, Germany). Protein content was carried out using the Kjeldahl method. Ash was determined using the muffle furnace method after incineration the sample in a muffle furnace (Carbolite AAF-11/18, UK) for 24 h at 550°C. Crude fibre was obtained by difference after the incineration of the ash-less filter paper containing the insoluble materials from the hydrolysis and washing of moisture free defatted sample. Carbohydrate content was determined by the difference:

$$\% \text{ Available carbohydrate} = 100 (\% \text{ Moisture} + \% \text{ Ash} + \% \text{ Protein} + \% \text{ Fat} + \% \text{ Crude fibre}).$$

## 2.7 Sensory Evaluation of the Biscuits

Sensory evaluation of the biscuits was done to determine the degree of liking of biscuit. A 20 man trained panelists evaluated the biscuit by affective testing based on a seven point hedonic scale. Panelists consisted of students of Food Science and technology Department, Nnamdi Azikiwe University, Awka, Anambra State. Sensory evaluation was done in the sensory evaluation room of the Food Science and Technology Department. All panelists were familiar with biscuit and have consumed it from

time to time. The 20 panelists evaluated the product at the same time. Biscuit were served on a sauce plate. Panelists were required to taste the product and rinse their mouth with table water which they were provided with. They were provided with a sensory evaluation sheet, and they scored the product based on flavour, taste, colour, hardness, crispness and general Acceptance on a nine-point hedonic scale from 9= like extremely to 1=dislike extremely [36]. The panelists were instructed to rate colour before tasting each product.

## 2.8 Statistical Analysis

Data generated from the analysis was subjected to statistical analysis using Statistical Package for Social Sciences (version 1 7.0) and the means were separated using Duncan's Multiple Range Test (DMRT).

## 3. RESULTS AND DISCUSSION

### 3.1 Effect of Gum Arabic Incorporation on the Proximate Composition of Biscuits Produced from Wheat and Water Yam Flour Blends

Table 3 shows the proximate composition of biscuits produced from wheat and water yam flour blends incorporated with gum Arabic. Moisture content of the biscuits ranged from 5.31-6.70% with sample WF0% (100% wheat flour biscuit) recording the highest and sample B0.5% (30% WYF: 70%WF: 0.5% GA) as lowest. There was a significant ( $p < 0.05$ ) increase in the moisture content of the biscuits as gum Arabic was incorporated. This was also found to

**Table 3. Percentage proximate composition of biscuit baked with wheat flour, water yam flour and Gum Arabic**

S/NO	Moisture	Ash	Fat	Crude Fibre	Protein	Carbohydrate
A0%	5.63±0.30 <sup>d</sup>	3.11±0.25 <sup>b</sup>	5.35±0.25 <sup>a</sup>	1.13±0.10 <sup>c</sup>	7.82±1.07 <sup>cd</sup>	76.96±1.02 <sup>bc</sup>
A0.3%	6.22±0.15 <sup>bc</sup>	2.95±0.20 <sup>b</sup>	5.15±0.13 <sup>ab</sup>	1.40±0.03 <sup>c</sup>	7.61±0.53 <sup>d</sup>	76.67±0.75 <sup>bc</sup>
A0.5%	6.41±0.47 <sup>b</sup>	2.85±0.10 <sup>b</sup>	2.56±0.58 <sup>c</sup>	1.95±0.01 <sup>c</sup>	7.24±0.73 <sup>d</sup>	78.99±1.06 <sup>a</sup>
B0%	5.31±0.12 <sup>d</sup>	4.60±0.28 <sup>a</sup>	5.62±0.28 <sup>a</sup>	2.22±0.86 <sup>b</sup>	8.52±0.70 <sup>b</sup>	73.73±0.76 <sup>d</sup>
B0.3%	5.83±0.75 <sup>cd</sup>	3.02±0.62 <sup>b</sup>	4.71±0.15 <sup>b</sup>	2.65±0.20 <sup>b</sup>	8.35±0.61 <sup>b</sup>	75.44±0.97 <sup>c</sup>
B0.5%	6.01±0.38 <sup>b</sup>	2.28±0.10 <sup>c</sup>	2.51±0.22 <sup>c</sup>	3.40±0.13 <sup>a</sup>	8.05±0.81 <sup>bc</sup>	77.75±0.63 <sup>ab</sup>
WF0%	6.70±0.03 <sup>a</sup>	2.78±0.22 <sup>bc</sup>	2.85±0.10 <sup>c</sup>	3.72±0.19 <sup>a</sup>	9.98±1.07 <sup>a</sup>	73.97±0.17 <sup>d</sup>

Values are means and standard deviation (SD) of three (3) triplicate, Values in same column with the same superscript are not significantly different ( $p < 0.05$ ). Keys: WF: Wheat Flour, WYF: Water yam Flour, GA: Gum Arabic, A0% = 50%WYF: 50%WF: 0%GA, A0.3% = 50%WYF: 50%WF: 0.3%GA, A0.5% = 50%WYF: 50%WF: 0.5%GA, B0% = 30%WYF: 70%WF: 0%GA, B0.3% = 30%WYF: 70%WF: 0.3%GA, B0.5% = 30%WYF: 70%WF: 0.5%GA, WF = 0%WYF: 100%WF: 0%GA

increase as the concentration of gum Arabic increased. The increase in moisture content of the biscuits with increase in gum Arabic concentration is explained by the ability of gums to hydrate at room temperature [37]. Ashwini *et al.* [38] also reported increase in moisture content of eggless cake with gums. Moisture content of the biscuits was lower than 9.34-12.71% and 8.57-11.87% for wheat/sweet potato biscuits and wheat/bambara nut/cowpea flour biscuits, respectively [1,39]. Bakery products with moisture less than 13% are stable from moisture-dependent deterioration [40]. The moisture content of all the biscuits produced was below this specified moisture content making them less liable to microbial attack.

Ash content of the biscuits ranged from 2.28% in sample B0.5% to 4.60% in sample B0%. Ash content was observed to decrease as concentration of gum Arabic increased. This decrease was significant ( $p < 0.05$ ) for 30% water yam flour and 70% wheat flour biscuits incorporated with gum Arabic. Ash content of any food material is an indication of the non-organic compound containing mineral content of food. The biscuits produced without incorporation of gum Arabic had the highest ash content implying that higher mineral content. Ash content of the biscuits from this study is slightly higher than 2.41-2.66% for wheat, sesame and maize composite biscuit [41]. It is also higher than 0.99-1.13% for wheat and African bread fruit biscuits as reported by Agu *et al.* [5].

Fat content of the biscuits decreased significantly ( $p < 0.05$ ) with increase in the concentration of gum Arabic. The values ranged from 2.56% in sample B0.5% (30% water yam: 70% wheat flour: 0.5% gum Arabic) to 5.62% in sample B0% (30% water yam: 70% wheat flour: 0% gum Arabic). The decrease in fat content of wheat/water yam composite biscuits as concentration of gum Arabic increased could be due to the polysaccharide nature of the gum which is characterized by a high proportion of carbohydrates. Similar trend was also observed by Zambrano *et al.* [42] for low fat cakes incorporated with guar and xanthan gums. The decrease in fat content of the biscuits as gum Arabic was incorporated is desirable and suggests that they could be used as weight reducing diets. Buckman *et al.* [43] stated that low fat content in foods reduces the risk of oxidation and rancidity which causes off flavor. This implies that high fat content in baked food products are undesirable as it promotes rancidity

leading to development of unpleasant and odorous compounds. Fat content of the biscuits from this study is higher than that of bambara nut and cowpea flour composites (0.97-1.96%) as reported by Abdulwahab *et al.* [39].

Crude fibre content of the biscuits increased as concentration of gum Arabic increased. These values were observed to range from 1.13% in sample A0% (50% water yam: 50% wheat flour: 0% gum Arabic) to 3.72% in 100% wheat flour biscuits. The incorporation of gum Arabic improved the crude fibre content of the composite flour biscuits with sample B0.5% (30% water yam: 70% wheat flour: 0.5% gum Arabic) having significantly ( $p < 0.05$ ) similar crude fibre content with 100% wheat flour biscuit. This could be due to the composition of gum Arabic as it is composed of polysaccharides. This also supports the statement of Rodge *et al.* [32] that the addition of gums can result in dietary fibre increase. The increase in crude fibre content of the biscuits on incorporation of gum Arabic suggests that they will aid digestion thereby preventing constipation. Recommended dietary fibre for a product to be labeled as a source of fibre is  $> 3\text{g}/100\text{g}$  food [44]. The findings from this study showed that gum Arabic at higher concentrations can be used to increase the crude fibre content of baked products in order for them to be termed as a good source of fibre. Crude fibre content of the biscuits from this study is slightly higher than that of wheat and alfalfa seed flour composite biscuits (0.73-1.62%) as reported by Ullah *et al.* [45]. Eke-Ejiofor *et al.* [46] reported 1.00-2.20% for African breadfruit and sweet potato/wheat biscuit which is close to the values obtained from this study.

Protein content of the biscuits ranged from 7.24% in sample A0.5% to 9.98% in sample WF0% (100% wheat flour biscuit). Increase in concentration of gum Arabic resulted to a decrease in protein content. However, these decreases were not significant ( $p > 0.05$ ). Changes in protein content of the biscuits on incorporation with gum Arabic may be attributed to the ability of polysaccharide to increase water absorption. Similar finding was reported by Murad *et al.* [47] for Krieh cheese incorporated with xanthan gum. Substitution of wheat flour with water yam flour also resulted to a significant ( $p < 0.05$ ) decrease in the protein content of the biscuits. Protein content of 100% wheat flour biscuit was significantly ( $p < 0.05$ ) higher than all other biscuit samples. Since refined wheat flour has a higher protein content than water yam

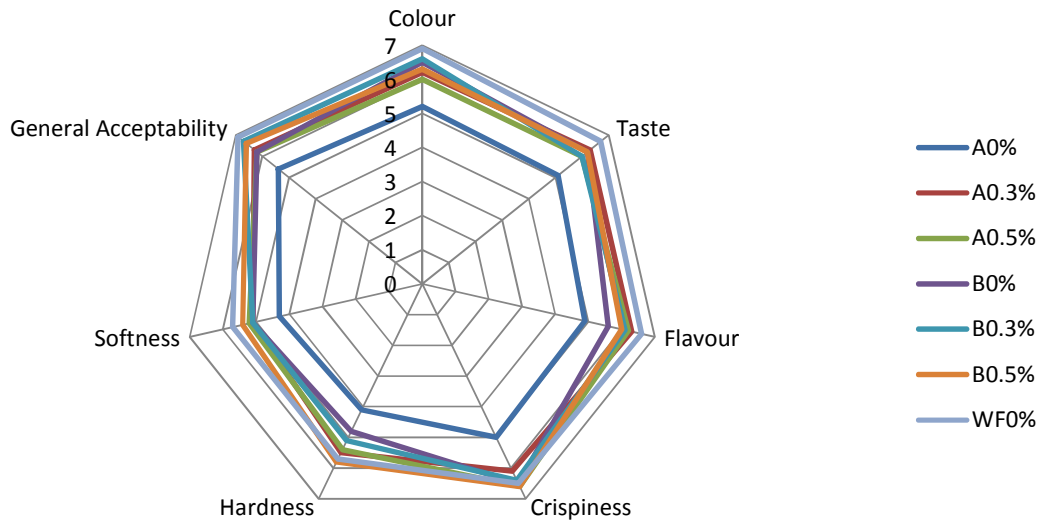
flour, replacement of refined wheat flour with water yam flour resulted in low protein content of the biscuits. Protein content of the biscuits from this study was similar to that of wheat-sweet potato biscuits (4.50-8.92%) as reported by Onabanjo and Ighere [1].

Carbohydrate content of the biscuits ranged from 73.73-78.99%. Biscuit sample containing equal percentage of water yam and wheat flour incorporated with 0.5% gum Arabic (A0.5%) had the highest and sample containing 30% water yam flour, 70% wheat flour without gum Arabic (B0%) was the lowest. Increase in concentration of gum Arabic resulted to a significant ( $p < 0.05$ ) increase in the carbohydrate content of the biscuits. The increase in carbohydrate content of wheat/water yam composite biscuits as concentration of gum Arabic increased may also be due to the polysaccharide nature of the gum which is characterized by a high proportion of carbohydrates. It was also observed that the composite flour biscuits had carbohydrate content significantly ( $p < 0.05$ ) higher than that of 100% wheat flour biscuit (control). This is due to the carbohydrate content of water yam flour (76.57%) as compared with wheat flour (67.43%) as reported by Ezeocha and Ojmelukwe [16] and

Ighere et al. [41] Carbohydrate content of the biscuits from this study is slightly higher than that of wheat and African breadfruit biscuits (56.18-73.21%) as reported by Agu et al. [5].

### 3.2 Effect of Gum Arabic Incorporation on the Sensory Properties of Biscuits Produced from Wheat and Water Yam Flour Blends

Fig. 2 shows the mean sensory scores of biscuits baked with different percentage of wheat/water yam composite flour and gum Arabic. The control biscuit samples was more preferable for colour, taste, flavor, softness and general acceptability while biscuit samples containing 0.5% gum Arabic was more preferred for crispiness and hardness. Colour of control biscuit (WF0%), B0% and B0.3% were significantly ( $p < 0.05$ ) similar. This could be due to higher percentage of wheat flour to water yam flour used in the baking process in the formulation process as the panelists are more familiar with wheat flour biscuits than composite flour biscuits. Similar trend was also observed by China et al. [6] for wheat/cooking banana flour cookies. Taste of the composite biscuits incorporated with gum Arabic was more preferred than biscuits with no gum



**Fig. 2. Mean sensory scores of biscuit baked with different percentage of wheat/water yam composite flour and gum Arabic incorporation**

Keys: WF: Wheat Flour, WYF: Water yam Flour, GA: Gum Arabic, A0% = 50%WYF: 50%WF: 0%GA, A0.3% = 50%WYF: 50%WF: 0.3%GA, A0.5% = 50%WYF: 50%WF: 0.5%GA, B0% = 30W%YF: 70%WF: 0%GA, B0.3% = 30%WYF: 70%WF: 0.3%GA, B0.5% = 30%WYF: 70%WF: 0.5%GA, WF0% = 0%WYF: 100%WF: 0%GA

Arabic incorporation. This same finding was also observed for flavor, crispiness, hardness, softness and general acceptability suggesting that the incorporation of gum Arabic resulted to increased sensorial attributes of wheat/water yam composite biscuits. However, this did not apply to the 100% wheat flour biscuits. Similar findings were also reported by Gul *et al.* [21] who stated that the quality of gluten free cookies produced from corn and rice flours were significantly improved when xathan gum was incorporated. Garcia *et al.* [48] also reported that the addition of *Agave Angustifolia fructans* resulted to increased hardness of cookies. They also reported increasing concentration of the gum with increasing hardness of the cookies produced. Rodge *et al.* [31] also found out that overall acceptability of bread improved linearly with increase in concentration of guar gum. Increase in the hardness of the biscuits from this study can be attributed to the highly branched structure of gum Arabic, along with its ability to interact to form links between other components. The findings of this study supports the statement of Ziobro *et al.* [49] that gums are one of the most commonly used ingredients to improve the texture and appearance of non-wheat flour formulations.

The closest to the control sample was the biscuit sample containing 30% water yam flour, 70% wheat flour and 0.5% gum Arabic. This therefore suggest that gum Arabic can be incorporated at 0.5% into wheat and water yam flour at 70% and 30%, respectively for the production of acceptable biscuits comparable with 100% wheat flour biscuits.

#### 4. CONCLUSION

The result of the current study showed that incorporation of gum Arabic to wheat/water yam flour composite biscuits resulted to increased moisture, crude fibre and carbohydrate contents while a decrease was observed for ash, fat and protein contents. Ash, fat and crude fibre contents of 100% wheat flour biscuit and sample B0.5% (containing 30% water yam flour, 70% wheat flour and 0.5% gum Arabic) were significantly similar. The findings also revealed that the composite biscuits incorporated with gum Arabic were more preferred than those without gum Arabic. Also, sample B0.5% and 100% wheat flour biscuit were significantly similar for crispiness, hardness, softness and overall acceptability. Hence, it was the most preferred composite biscuit by the panelists.

These attributes could be as a result of the sensorial characteristics impacted by gum Arabic incorporation. Gum Arabic should therefore be embraced as a commercial dough strengthener for composite biscuit production from non-wheat flours in order to obtain the desired quality.

#### DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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