Chemical and sensory Properties of Biscuits produced from wheat, soybean and orange fleshed sweet potato

ABSTRACT

Biscuit was produced from blends of wheat, soybeans and orange flesh sweet potato (OFSP) flour at different ratios: CFA (100:0:0), CFB (90:10:0), CFC (90:0:10), CFD (85:10:5), CFE (80:10:10) and F (70:15:15). Standard methods were used in raw material preparation. The biscuits produced were subjected to physical, proximate, minerals, vitamins and sensory evaluation. The inclusion of soybeans and OFSP flour in the blends increased the weight, diameter and spread ratio of biscuit with value ranged of 7.76 – 10.42 (g), 0.78 – 0.89 (cm), 6.41- 6.6 (cm) and 7.2 – 8.25 for weight, thickness, diameter and spread ratio and respectively. The moisture content, crude protein, crude fat increased with level of soybean and OFSP flour inclusion in the blend. Values ranged from 2.68 - 8.72%, 13.25 - 19.43%, 20.40 - 24.45%, 1.83 - 2.64%, 0.12 - 0.51% and 46.28 - 61.18% for moisture, protein, fat content, ash, fibre and carbohydrate respectively. The inclusion of soybeans and OFSP flour in the blends significantly ($p<0.05$) increased the mineral and vitamin content of flour blends biscuit. The calcium, potassium, sodium, magnesium, iron, zinc and manganese content ranged from 118.22 – 161.75 mg/100 g, 171.09 – 480.32 mg/100 g, 109.02 – 815.72 mg/100 g, 20.12 – 41.03 mg/100 g, 0.55 – 3.58 mg/100 g, 0.30 – 0.52 mg/100 g and 0.55 – 1.13 mg/100 g respectively while the vitamin A, B_1, B_2, B_3 and C ranged from 1.30 – 29.60 (μ/100 g), 0.30 – 0.98 mg/100 g, 0.32 – 0.86 mg/100 g and 0.01 – 0.39 mg/100 g respectively. Sensory attributes on a 9-point hedonic scale was carried out by 30 member panelists on thebiscuit and results indicated that all samples were within acceptable range, however biscuit from 100% wheat and 10% soybeans flour inclusion were most preferred by panelists. The study showed that high-quality biscuit can be produced from blends of wheat, soybeans and OFSP flour blends.

Key words: Sensory Properties of Biscuits,Proximate composition, crude protein, crude fat

INTRODUCTION

Biscuit is a baked or quick-bread food that has a sweet or savory flavor and is usually tiny, round, and flat. They consist of flour, liquid, leavening agent (like baking powder), and fat (like butter or shortening) (such as milk or water). Snack foods such as biscuits and crackers are widely consumed, relatively longer in shelf life, good in eating quality and highly palatable foods that can be modified to suit specific nutritional needs of any target population (Vitali et al., 2009). Recent research suggests that the consumption of snacks foods which includes biscuits, cakes and bread, soft drinks, chips and candies has increased with time as most low- to middle-income countries experience nutrition transition phenomena (Thow and Hawkes, 2009). These snacks foods usually in the forms of convenience baked or fried products are mainly produced from refined wheat flour; they are self-fed and eaten between meals (Hess et al., 2016). However, with the cost of importation of wheat flour and need for nutritional improvement, there has been advocacy and research for the use of composite flour from blends of cereals and legumes like soybeans as well of roots and tubers such as cassava orange flesh sweet potato (OFSP).

Orange-fleshed sweet potato is a potential source of dietary pro-vitamin A as it contains carotenoids. The predominant component of carotenoids is beta-carotene and it possesses the highest vitamin A activity among carotenoids (Khoo et al., 2011). The beta-carotene content of orange-fleshed sweet potato depends highly on the sweet potato varieties and it may reach up to 20,000 µg/100 g wb, which is higher than that of pumpkin and carrot (490 - 1, 500 µg and 7, 975 – 8, 840 µg/100 g, respectively) (Jaswir et al., 2011).

Soybean (*Glycine max*) is an annual leguminous crop and is grown to provide food for humans, feeds for animals and raw materials for industries. It is an excellent source of protein (35-40 %). The soya bean seed is the richest in food value of all plant foods consumed in the world. It is used in the production of bread as composite flour (Ogbemudia *et al.,* 2017). Soy bean is used by leading infant food manufacturers in the country because of its high nutritional value. Soy bean is a widely used, inexpensive and nutritional source of dietary protein. Its protein content (40 %) is higher and more economical than that of beef (19 %), chicken (20 %), fish (18 %) and groundnut (23 %). It is also rich in minerals and vitamins such as iron, zinc, copper, thiamine, riboflavin, niacin and pantothenic acid, most of these minerals and vitamins are well-known hematinic and are essential in the formation of red blood cells (Eshun, 2012). Soy bean is of particular interest as a vegetable protein source because of its cholesterol lowering abilities in patients with type II hyper lipo-proteinemia.

This study was therefore aimed at evaluating the physicochemical and sensory properties of biscuits produced from wheat, soybean and orange fleshed sweet potato.

II. MATERIALS AND METHODS

II.1 Sources of raw materials and preparation

All raw materials and ingredients used were gotten from Makurdi in Benue State, Nigeria.

II.1.1 Preparation of soybean flour

The method of Ndife et al. (2011) with slight modification was used in the production of soy flour. The soybean (1 kg) was thoroughly cleaned to remove dirt and other extraneous materials such as stones and sticks. It was then washed and boiled in water at 100 ^{o}C for 60 min. The cooked beans were dehulled and recook for 3hr. This was followed by oven drying at 60 ^{o}C for 12-18 h. The dried beans were allowed to cool then dry-milled and stored in airtight containers for further use.

II.1.2 Preparation of orange flesh sweet potato (OFSP) flour

Orange flesh sweet potato flour (OFSP) was prepared following the description of Singh et al. (2008) with modification. The orange flesh sweet potato tubers were washed, peeled and cut into thin pieces manually. The size reduced potatoes were steam blanched at 100 ^{o}C for five minutes to prevent browning reactions and enhance the colour of the flour. This was followed by oven drying at 55 ^{o}C for 12-24 h. The dried orange-flesh sweet potatoes were milled into flour using the laboratory hammer mill sieved (using the 0.05 mm screen) and stored for further use.

II.1.3 Flour blend formulation

Composite flours were prepared from wheat flour, soybeans flour and orange fleshed sweet potato flour at different levels of substitution as in Table 1.

II.1.4 Production of Biscuit

Biscuit was produced from the five formulations using the method of Oluwamukomi et al. (2011) with modification. The formulated flours (100 g), white sugar (45 g), Margarine (45 g), egg (30 mL) and (2 g) were blended to form a dough. The dough was continuously mixed until a smooth consistency was obtained. The dough was kneaded, rolled out thinly on the cutting board where it was cut out into uniform shapes and sizes using a cutter. The cut dough was placed in a greased baking tray and transferred into the oven. The biscuit was baked at 180 °C for 20 min, cooled and packaged.

Table 1: Formulation of flour blends

Samples	Wheat: Soybean: OSFP flours
CFA	100:0:0
CFB	90:10:0
CFC	90:0:10
CFD	85:10:5
CFE	80:10:10
CFF	70:15:15

II.2 Analytical methods

II.2.1 Determination of physical properties of biscuits from wheat, soybeans and OFSP flour blends

The physical properties of the biscuits produced namely; weight, diameter, spread ratio and thickness was carried out as described byGuyih et al. (2020).

II.2.2 Determination of proximate composition biscuit from wheat, soybean and OFSP flour

The proximate parameters were determined using the standard method of Association Official Analytical Chemists (AOAC, 2012).

II.2.3 Determination of Mineral Content of biscuit samples

The mineral content of the formulated samples was evaluated using the method described by (Bongjo et al., 2023). One gram of dried samples was digested with 2.5mL of 0.03N hydrochloric acid (HCl). The digest was boiled for 5 min, allowed to cool to room temperature and transferred to 50 mL volumetric flask and made up to the mark with diluted water. The resulting digest was filtered with ashless Whatman No. 1 filter paper. Filtrate from each sample was then be analyzed for mineral (calcium, phosphorus, magnesium, Iron, sodium, potassium) contents using an Atomic Absorption Spectrophotometer using standard wavelengths. The real values were extrapolated from the respective standard curves. Values obtained were adjusted for HCl-extractability for the respective ions. All determinations were performed in triplicates.

II.2.4 Determination of vitamin content of biscuit samples

The method of AOAC (2010) using the colorimeter was adopted. Vitamins A, B1, B2, B3 and C were determined

II.2.5 Evaluation of Sensory quality attributes of biscuit samples

A panel of 30 individuals were employed for this study, where a 9-point hedonic scale was used; with 9 representing like extremely and 1 representing dislike extremely.

II.2.6 Statistical Analysis

Results were presented as mean value ± standard deviation and analyzed by analysis of variance (ANOVA) using SPSS software package v21. Significant differences between means were determined by Duncan multiple range test at 95 % confidence limit.

III.3 RESULTS AND DISCUSSION

II.3.1 Physical properties of wheat, soybeans and OFSP flour blends biscuit

The physical properties of the biscuits produced are presented in Table 2. The inclusion of soybeans and OFSP flour in the blends had significant ($p<0.05$) effect on the physical properties of biscuit samples. The weight of biscuit significantly ($p<0.05$) increased with addition of soybeans and OFSP flour in the blends. The weight of the flour blends biscuits was significantly ($p<0.05$) higher than the control (100 % wheat) biscuit samples. Bello et al. 2018 reported that difference in weight of the biscuit sample can be attributed to the water holding capacities of the flours and this could be the reason for the difference in weight between the samples.

Table 2: Physical properties of wheat, soybeans and OFSP flour blends biscuit

WF: SF: OFSPF	Weight (g)	Thickness (cm)	Diameter (cm)	Spread Ratio
CFA (100:0:0)	7.76^{e}±0.08	0.89^{a}±0.01	6.41^{d}±0.00	7.20^{f}±0.01
CFB (90:10:0)	9.96^{c}±0.01	0.88^{ab}±0.01	6.41^{d}±0.01	7.31^{e}±0.01
CFC (90:0:10)	10.2^{b}±0.14	0.84^{bc}±0.01	6.81^{a}±0.01	8.19^{c}±0.00
CFD (85:10:5)	9.76^{d}±0.08	0.82^{c}±0.03	6.45^{d}±0.00	7.67^{d}±0.01
CFE (80:10:10)	10.41^{a}±0.01	0.78^{d}±0.01	6.53^{c}±0.04	8.25^{b}±0.01
CFF (70:15:15)	10.17^{b}±0.08	0.81^{cb}±0.01	6.61^{b}±0.01	8.52^{a}±0.01

Values are means ± standard deviations of triplicate determinations. Means in same column with different superscripts are **significantly (p<0.05) different. Key: WF= wheat flour, SF= soybeans flour, OFSPF= orange flesh sweet potato.**

Table 3: Proximate composition (%) of biscuit from wheat, soybeans and OFSP flour blends

WF:SF:OFSPF	Moisture	Crude Protein	Crude Ash	Crude Fat	Crude Fibre	Carbohydrate
CFA (100:0:0)	5.68^{e}±0.03	13.25^{d}±0.01	2.37^{e}±0.01	20.40^{d}±0.06	0.12^{f}±0.01	61.18^{e}±0.20
CFB (90:10:0)	6.00^{c}±0.024	15.43^{c}±0.01	2.42^{d}±0.01	23.77^{b}±0.21	0.27^{e}±0.01	53.21^{c}±0.17
CFC (90:0:10)	6.18^{b}±0.105	13.26^{d}±0.06	2.45^{d}±0.01	22.96^{c}±0.01	0.44^{c}±0.00	55.33^{d}±0.22
CFD (85:10:5)	6.78^{d}±0.20	15.44^{c}±0.01	2.49^{c}±0.01	22.86^{c}±0.00	0.41^{d}±0.01	55.02^{d}±0.18
CFE (80:10:10)	8.70^{a}±0.094	18.84^{b}±0.05	2.52^{b}±0.01	23.40^{b}±0.02	0.53^{a}±0.00	46.28^{a}±0.07
CFF (70:15:15)	8.72^{a}±0.069	19.43^{a}±0.01	2.64^{a}±0.01	24.45^{a}±0.20	0.51^{b}±0.01	47.25^{b}±0.09

Table 4: Mineral content mg/100g of biscuit from wheat, soybeans and OFSP flour blends

WF:SF:OFSPF	Ca	K	Na	Mg	Fe	Zn	Mn
CFA (100:0:0)	55.84^{f}±0.04	171.90^{f}±0.04	109.02^{f}±0.00	20.12±0.01	0.55^{f}±0.00	0.30^{e}±0.00	0.55^{e}±0.00
CFB (90:10:0)	118.22e±0.05	204.06^{e}±0.00	456.42e±0.00	23.78±0.02	0.98^{e}±0.00	0.36^{d}±0.01	0.58^{e}±0.01
CFC (90:0:10)	136.65^{d}±0.01	273.28^{c}±0.01	623.97^{d}±0.00c	27.92±0.01	1.77^{d}±0.01	0.41^{c}±0.00	0.77^{d}±0.01
CFD (85:10:5)	144.08^{c}±0.04	263.87^{d}±0.01	677.15^{c}±0.00d	32.65±0.01	2.86^{c}±0.01	0.44^{c}±0.01	0.97^{c}±0.01
CFE (80:10:10)	149.98^{b}±0.01	321.33^{b}±0.01	815.72^{a}±0.00	39.34±0.02	3.11^{b}±0.00	0.48^{b}±0.01	1.06^{b}±0.01
CFF (70:15:15)	161.75^{a}±0.04	480.32^{a}±0.04	701.04^{b}±0.00	41.03±0.04f	3.58^{a}±0.01	0.52^{a}±0.00	1.13^{a}±0.01

Values are means ± standard deviations of triplicate determinations. Means in same column with different superscripts are significantly ($p<0.05$) different. Key: WF= wheat flour, SF= soybeans flour, OFSPF= orange flesh sweet potato.

Table 5: Vitamin content of biscuit from wheat, soybeans and OFSP flour blends

WF:SF:OFSPF	A (µ/100 g)	B_1 (mg/100 g)	B_2 (mg/100 g)	B_3 (mg/100 g)	C (mg/100 g)
CFA (100:0:0)	0.75^{e}±0.03	0.32^{e}±0.03	0.24^{f}±0.01	0.38^{c}±0.00	0.01^{e}±0.02
CFB (90:10:0)	1.30^{e}±0.04	0.30^{e}±0.02	0.41^{d}±0.00	0.63^{b}±0.05	0.02^{e}±0.01
CFC (90:0:10)	16.79^{d}±0.01	0.41^{c}±0.01	0.35^{e}±0.01	0.61^{b}±0.01	0.34^{b}±0.04
CFD (85:10:5)	23.63^{b}±0.04	0.48^{b}±0.01	0.57^{b}±0.00	0.33^{c}±0.01	0.07^{d}±0.01
CFE (80:10:10)	22.19^{c}±0.42	0.98^{a}±0.01	0.86^{a}±0.01	0.86^{a}±0.02	0.15^{c}±0.02
CFF (70:15:15)	29.60^{a}±0.21	0.34^{d}±0.02	0.53^{c}±0.01	0.32^{c}±0.02	0.39^{a}±0.01

Table 6: Sensory quality attributes of biscuit from wheat, soybeans and OFSP flour blends

Sample code	Blend ratio WF:SF:OFSPF	Appearance	Taste	Crispness	Aroma	General acceptability
CFA (100:0:0)	100:0:0	$7.88^{a}\pm0.83$	$7.53^{a}\pm1.14$	$7.65^{a}\pm1.08$	$7.29^{a}\pm1.07$	$7.88^{a}\pm0.96$
CFB (90:10:0)	90:10:0	$7.47^{a}\pm1.04$	$6.82^{ab}\pm0.98$	$7.12^{ab}\pm1.02$	$7.00^{ab}\pm1.03$	$7.23^{ab}\pm0.94$
CFC (90:0:10)	90:0:10	$7.59^{a}\pm1.03$	$7.00^{ab}\pm1.03$	$6.59^{bc}\pm1.09$	$7.00^{ab}\pm1.41$	$6.88^{bc}\pm1.41$
CFD (85:10:5)	85:10:5	$7.18^{a}\pm1.10$	$6.71^{ab}\pm1.36$	$6.65^{bc}\pm1.28$	$6.59^{ab}\pm1.24$	$6.88^{bc}\pm1.18$
CFE (80:10:10)	80:10:10	$7.29^{a}\pm1.07$	$6.71^{ab}\pm1.64$	$6.71^{bc}\pm1.60$	$6.05^{b}\pm1.51$	$6.47^{bc}\pm1.24$
CFF (70:15:15)	70:15:15	$6.18^{b}\pm1.42$a	$6.18^{b}\pm1.58$	$6.06^{c}\pm1.39$	$6.23^{b}\pm1.59$	$6.17^{c}\pm1.79$

Values are means ± standard deviations of triplicate determinations. Means in same column with different superscripts are significantly ($p<0.05$) different. Key: WF= wheat flour, SF= soybeans flour, OFSPF= orange flesh sweet potato, LSD= Least significant degree.

The finding by this study is in agreement with the report of Guyih et al. (2020) whose cookies weight increased (8.20 g to 11.65 g) with inclusion of almond seed and carrot flour in wheat flour blends cookies. Ibrahim and Donaldben (2019) also reported that the weight of biscuit samples increased with inclusion sweet potato and African yam bean flour in wheat flour blends biscuit.

The inclusion of soybeans and OFSP flour in the blend had significant ($p<0.05$) effect on the thickness of the biscuit samples. The thickness of the biscuit samples at 10% soybeans and 0 % OFSP flour inclusion was not significantly ($p>0.05$) different from the control sample (100 % wheat biscuit). However, the weight of biscuit samples decreased with level of soybeans and OFSP flour level of inclusion in the blends. Bello et al. (2018) reported that the hydrophilic nature of substituted flours in wheat flour for biscuit making affects the thickness of biscuit by reducing the spread ratio and this could be the reason for the decrease in thickness of biscuit samples. The finding by this study is in line with the report of Bello et al. (2018) who reported decrease in weight of biscuit samples from 15 % yellow yam and unripe plantain flour inclusion in the blends.

The diameter of the biscuit samples increased with the inclusion of Soybeans and OFSP flour in the blends. The biscuit sample with 15 % soybeans and OFSP flour inclusion had higher diameter than the flour blends biscuit and the control biscuit samples. The low diameter value of biscuits made from 100 % wheat flour may be due to its high gluten content which probably had effect on dough expansion and diameter of biscuit. The finding by this study agrees with the report of Bello et al. (2018) who reported increase in diameter of biscuit at 10 % yellow yam and unripe plantain flour inclusion in wheat flour biscuit. Guyih et al. (2020) reported lower thickness (1.10 – 1.33 cm) than the 6.41- 6.6 (cm) reported by this study. The variation in result could be due to the raw materials used in flour blends formulation.

The spread ratio of the biscuit samples increased with inclusion of soybeans and OFSP flour in the blends. According to Ibrahim and Donaldben, (2019), spread ratio is affected by the viscosity of dough as dough with low viscosity tend to spread faster during baking. The increase in spread ratio with inclusion of soybeans and OFSP flour could be attributed to the visco-elastic properties of dough. The finding by this study is in agreement with the report of Guyih et al. (2020)who reported increased spread ratio (3.31 - 4.43) with inclusion of soybeans and OFSP flour in the blends. Among the flour blends biscuit, the sample with 15 % soybeans and OFSP flour inclusion had higher spread ratio. The lowest spread ration was obtained in sample with 100 % wheat biscuit. The lower the spread ratio the better the crispiness and acceptability of baked products suggesting that biscuit from 100 % wheat flour would be more acceptable by consumers.

II.3.2 Proximate composition of biscuit from wheat, soybeans and OFSP flour blends

The proximate composition of biscuit from wheat, soybeans and OFSP flour blends (Table 3) showed that the inclusion of soybeans and OFSP flour had significant ($p<0.05$) effect on proximate composition of flour blends biscuit. The moisture content increased with inclusion of soybeans and OFSP flour in the blends. The increase in moisture content could be attributed to inclusion of soybean and OFSP flour in the blends. The finding by this study agrees with the report of Guyih et al. (2020) who reported moisture content ranged of 6.42 – 8.04 % in wheat, almond seed and carrot flour cookies. Ibrahim and Donaldben, (2019) also reported increase in moisture content with inclusion of sweet potato and African yam bean flour in wheat flour for biscuit making. Among the flour blends biscuit samples, the sample with 15% soybeans and OFSP flour had higher (8.72 %) moisture content. Lowest moisture content was reported in 100 % wheat flour biscuit. The moisture content was however below the 10 – 14 % moisture content recommended for microbial safety and storage of baked goods (Atobatele and Afolabi, 2016).

The crude protein content of biscuit samples increased with level of soybeans and OFSP flour inclusion in the blends suggesting that soybeans and OFSP flour had significant ($p<0.05$) on the protein content of biscuit samples. The higher protein content obtained at 15 % level of soybeans flour inclusion in the blends is an indication that soybeans flour inclusion is responsible for increase in protein content of flour blends biscuit samples. The finding by this study agrees with the report of Bello et al. (2018) who reported increase in protein content with inclusion of pumpkin seeds flour in wheat, yellow yam and unripe plantain flour. Guyih at al. (2020) also reported increase in protein content with inclusion of almond seed and carrot flour in wheat, almond seed and carrot flour blends. The finding by this study showed that the inclusion of soybeans and OFSP flour in wheat flour from 10 % and 15 % could meet the 16 % protein requirement for complementary food by the protein advisory group. The result showed that flour blends biscuits could be used to address the protein-energy malnutrition prevalence in most of our communities.

The Ash content of a food product is a non-organic substance containing mineral content of food. Nutritionally, it facilitates the metabolism of other organic substances like fat and carbohydrates (Akoja and Coker, 2018). The ash content also increased significantly ($p<0.05$) with level of soybeans and OFSP flour inclusion in the blends. The increase in ash content could be due inclusion of soybeans and OFSP flour which are probably high in mineral content since ash is an index of mineral constituents of the food (Sanni et al., 2008). The finding by his study agrees with the report of Guyih et al. 2020 who reported increase in ash content of biscuit produced from blends of wheat, almond seed and carrot flour. The finding by this study however disagrees with the report Bello et al. (2018) who reported decrease in ash content of biscuit produced from blends of wheat, yellow yam, unripe plantain and pumpkin flour blends. The raw materials used in flour blends formulation could account for the variation in result.

The fat content of flour blends biscuit samples significantly ($p<0.05$) increases with inclusion of soybeans and OFSP flour in the blends. The sample with 15 % soybeans flour inclusion had higher fat content as compared to the flour blends sample and the control sample (100 % wheat flour biscuit).

There was increase in fat content of flour blends biscuit with inclusion of soybeans and OFSP flour at up to 10 % level. There was no significant ($p>0.05$) in fat content of the control and the biscuit sample with 15 % soybeans and OFSP flour inclusion. Lowest value of fat content was obtained in sample with 100 % wheat flour biscuit. The increasing trend could be attributed to soy flour inclusion in the flour blends as soybeans is reported to be high in fat. Ashaye et al. (2015) reported same trend in fat content for legume-cereal based biscuit. Soybean contains considerable amount of polyunsaturated oil, omega-3 fatty acid and linolenic fatty acids which are good heart health nutrients for infants, children and adults (Ikujenlola and Fashakin 2015). The finding by this study is in agreement with the report of Guyih et al. (2020) who showed increase in fat content in biscuit produced from wheat, almond seed and carrot flour blends.

Fat is a good source of energy, fat soluble vitamins and helps to increase food palatability as it absorbs and retains flavours (Lalude and Fashakin 2006).

Fibre content consists of hemicelluloses, cellulose and lignin. It contributes to the health of the gastro-intestinal system and metabolic system in man (Atobatele and Afolabi, 2016). The inclusion of soybeans and OFSP flour in wheat flour significantly ($p<0.05$) increased the fibre content of flour blends biscuit samples. The increase in fibre content could be due to the inclusion of soybeans and OFSP flour in the blends. Donaldben et al. (2019) also reported increase in fibre content wit level of OFSP and cashew nut flour inclusion in wheat, OFSP and cashew flour blends cookies. Similar result was reported by Guyih et al. (2020) in wheat, almond seed and carrot flour blends cookies. Fibre residue are good for the body because their presence in food products is essential owing to their ability to facilitate bowel movement (peristalsis), bulk addition to food and prevention of many gastrointestinal diseases in man (Satinder et al., 2011). The high fibre content reported by this study suggests it would be useful in facilitating bowel movement and prevention of gastrointestinal diseases.

The carbohydrate content significantly ($p<0.05$) decreased with inclusion of soybeans and OFSP flour in the blends. The increase in protein and fat content of with addition of soybeans and OFSP flour in the blends could be responsible for the decrease in carbohydrate content of biscuit samples. Guyih et al. (2020) also reported decrease in carbohydrate content with inclusion of almond seed and carrot flour in biscuit made from blends of wheat, almond seed and carrot flour. The carbohydrate content (46.28 - 61.18 %) reported by this study was lower than the 77.11 – 81.18 % reported by Guyih et al. (2020). The raw materials used in flour blends formulation could be responsible for the low carbohydrate content reported by this study.

II.3.3 Mineral content mg/100g of biscuit from wheat, soybeans and OFSP flour blends

The mineral contents of the biscuit samples are presented in Table 4. The inclusion of soybeans and OFSP flour in the blends had significant (p<0.05) effect on the mineral content of flour blends biscuits. All the minerals significantly (p<0.05) increased with the incorporation of soybeans and OFSP flour in the blends. The calcium content of flour blends samples increased with inclusion soybeans and OFSP flour in the blends. The increase in calcium content could be attributed high calcium content in soybeans and OFSP flour. The sample with 15 % soybeans and OFSP flour inclusion had higher calcium content while lowest calcium content was obtained 100 % wheat biscuit sample. Generally, the calcium content of biscuit samples increased with level of OFSP flour inclusion in the blends. The finding by this study agrees with the report of Guyih et al. (2020) who reported increase in calcium content with inclusion of almond seed and carrot flour in flour blends biscuit. Low calcium content (2.12 – 4.45 mg/100) was reported by Adegbanke et al. (2020) in biscuit made from wheat and bambara nut flour. The inclusion of OFSP flour in the blends could be responsible for the variation in result. The calcium content of control and flour blends sample were below the recommended daily allowance (RDA) of 800 mg/day of the US Department of Agriculture (USDA, 2020). However, the samples with OFSP flour inclusion can provide 70-80 % of the RDA of calcium. Calcium is involved in the mechanism of muscle contraction, but also in the transmission of nerve impulses. It plays a role in the cascade of blood clotting and in the metabolism of many hormones. A deficiency of calcium provokes in period of growth, the disease corresponds to rickets and in adults to osteomalacia (Murray et al., 2000). The biscuits produced from the mixture wheat flour-sweet potato-soy would be beneficial for strengthening bones and reducing calcium deficiencies.

The potassium content flour blends biscuit significantly (p<0.05) increased with level of soybeans and OFSP flour inclusion in the blends. The potassium content of the sample with 15 % soybeans and OFSP flour inclusion had higher potassium content while biscuit from 100 % wheat flour was low in potassium content. It was observed that samples with OFSP flour inclusion had higher potassium content. The inclusion of OFSP flour in the formulation is responsible for the increase in potassium content of flour blends biscuit; Badila et al. (2009) reported that sweet potato is rich in potassium with a reported potassium content of 243 mg/100 g. The finding by this study is in agreement with the 184 - 541 mg/100 g reported by Roger et al. (2022) in biscuit made from wheat and sweet potato flour blends. Guyih e al. (2020) also reported increase in potassium content of cookies made from wheat, almond seed and carrot flour blends. The potassium content of control and flour blends biscuit were below the 3500 mg/day RDA for potassium (USDA, 2020).

The sodium content of control and flour blends biscuit differed significantly (p<0.05) among the samples. There was general increase in sodium content with level of soybeans and OFSP flour inclusion in the blends. The sample with 10 % soybeans and 10 % OFSP flour inclusion had high sodium content as compared to the control and other flour blends biscuit. Roger et al. (2022) reported low sodium content (94 - 254 mg/100 g) in biscuit made from wheat and sweet potato flour blends. Guyih et al. (2020) also reported low sodium content (47.03 – 56.12 mg/100 g) in wheat, almond seed and carrot flour blends. The sodium content reported by this study is below the 1000 mg/100 g RDA reported for sodium by United State Department of Agriculture, (2020).

Magnesium is necessary for biochemical reactions in the body, helping to maintain muscle, improving the functioning of the nerve, maintaining the heart rate, and regulating the blood sugar (Saris et al., 2000). The magnesium content of flour blend biscuit significantly ($p<0.05$) increased with level of soybeans and OFSP flour inclusion in the blends. The increase in magnesium content could be due to high magnesium of soybeans and OFSP flour. The finding by this study is in agreement with 32 - 49 mg/100 g reported by Roger et al. (2022) in biscuit made from wheat and sweet potato flour blends. Guyih et al. (2020) also reported increase in magnesium content (58.96 – 56.12 mg/100 g) in biscuit made from wheat, almond seed and carrot flour blends.

Iron plays a role in electron transferring reactions of the mitochondria. It is an important component of hemoglobin which is an oxygen–carrying pigment in the blood (Elinge et al., 2012). The finding by this study showed increase in iron content with level of soybeans and OFSP flour inclusion in the flour blends biscuit. This could be due to the effect of supplementation of wheat flour with soybeans and OFSP flour probably high in micronutrients. The finding by this study agrees with the report of Adegbanke et al. (2020) in biscuit made from wheat and Bambara nut flour whose iron content ranged from 0.97 – 1.21 mg/100 g. The iron content of the control and flour blends biscuit samples were below the RDA of 18 mg/day (USDA, 2018).

Zinc content also increased with the level of soybeans and OFSP flour inclusion in the blends. The sample with 15 % soybeans and OFSP flour inclusion had high zinc content as compared to the control and other flour blends samples. The findings by this study disagrees with the report of Adegbanke et al. (2020) who reported decrease in zinc content with inclusion of Bambara nut protein isolate in wheat-based biscuit. However higher zinc content was reported by Adegbanke et al. (2020). The inclusion of OFSP flour in the blends and the nature could of raw materials used in blends formulation can account for the variation in result. The zinc content of the control and flour blends biscuit samples were below the RDA of 11mg/day (United State Department of Agriculture, 2018).

The manganese content differed significantly ($p<0.05$) among the biscuit samples. The level of soybeans and OFSP flour inclusion in the blends resulted to increase in manganese content. The manganese content of the flour blends biscuit as reported by this study was contrary to the report of Adegbanke et al. (2020) who reported decrease in manganese content with inclusion of Bambara nut protein isolate in wheat. The variation in result could be due to the nature of raw materials used in blend formulation. Manganese plays a role in the formation of hormones including the synthesis of sex hormones and the functioning of the nervous system. The manganese content of the control and flour blends biscuit samples were below the RDA of 2 mg/day (USDA, 2018). The finding by this study showed that the inclusion of soybeans and OFSP flour in wheat flour improved the mineral content of the flour blends biscuit.

II.3.4 Vitamin content of biscuit from wheat, soybeans and OFSP flour blends

The vitamin content of biscuit from wheat, soybeans and OFSP flour blends as presented in Table 5 showed that the inclusion of soybeans and OFSP flour in wheat flour had significant (0.05) effect vitamin content of flour blends biscuit samples. The vitamin content increased with inclusion of soybeans and OFSP flour in the blends. The vitamin A content of the flour increased with proportion of soybeans and OFSP flour inclusion in the blends. The sample with high proportion of soybeans and OFSP flour had high vitamin A content as compared to control sample. Hortz et al. (2012) reported that improved vitamin A content in vitamin A deficiency intervention programmes. The increase in Vitamin A content could be attributed to the inclusion of OFSP in flour blend biscuit. The finding by this study agrees with the report of Makanjuo and Adebowale (2020) who reported increase in Vitamin A content (0.45 – 5.67 mg/100 g) with inclusion of cocoyam flour in wheat-cocoyam flour-based biscuit. Vitamin A is an important vitamin for proper and clear vision. Thus, food with good quantities of vitamin should be consumed to improve the vitamin A content of the body. All the values for vitamin A were below the recommendation of 300 µg/day (IOM 2005).

Thiamine (Vitamin B_1) functions as the coenzyme thiamine pyrophosphate (TPP) in the metabolism of carbohydrates and branched-chain amino acids. The inclusion of soybeans and OFSP flour in the blends resulted to significant ($p<0.05$) increase in thiamine content. The increase in thiamine content could probably be due the inclusion of soybeans and OFSP flour in the blends. The finding by study agrees with the report of Ahure et al. (2020) who reported increase in thiamine content (1.52 – 2.45 mg/100 g) with inclusion almond seed and carrot flour in the blends. The sample with 10 % soybeans and OFSP flour inclusion had high thiamine content as compared to the control and other flour blends biscuit samples. All the values obtained were within the WHO /FAO safe level recommendation of 0.2 - 0.9 mg/day for infants and children.

The vitamin B_2 and B_3 also increased with inclusion of Soybean and OFSP flour in the blends. Vitamin B_2 and B_3 was also high in the sample with the sample with 10 % soybeans and OFSP flour inclusion in the blends. Ahure et al. (2020) also reported similar trend in vitamin B_2 and B_3 with values ranging from 0.65 – 0.92 mg/100 g and 3.12 – 3.52 mg/100 g respectively. The B vitamins are needed for carbohydrate and protein metabolism, and are essential for growth, well structuring and functioning of the cells (Ahure et al., 2020). The nutrient intake requirement for infants and children given by WHO / FAO (2000) recommendation for Riboflavin is 0.3 – 0.9 mg. The result obtained in this study was in line with the above recommendation. The vitamin B_3 content fell short of 2 – 12 mg/day recommendation for infants and children.

Ascorbic acid (vitamin C) is a vitamin found in various foods. It is used in the treatment and prevention of scurvy. It is an essential nutrient involved in the repair of tissue and the enzymatic production of some neurotransmitters. The vitamin C content also increased with addition of soybeans and OFSP flour in the blends. The increase in vitamin C content could be attributed to Soybeans and OFSP flour inclusion in the blends. The finding by this study is in agreement with the report of Ahure et al. (2020) reported increase in Vitamin C content with inclusion of almond seed and carrot flour in the blends. The vitamin C content was however lower than the 2.09 – 3.00 reported by Ahure et al. (2020). The nature of raw materials used in blend formulation can account for the variation in vitamin C content of the biscuit samples. The study showed that the incorporation of soybeans and OFSP flour in biscuit wheat flour improved the vitamin content of the flour blends biscuit.

III.3.5Sensory quality attributes of biscuit from wheat, soybeans and OFSP flour blends

Sensory attributes such as appearance, taste, mouthfeel, aroma and general acceptability are useful in determining the characteristics of food products. The sensory quality attributes as presented in Table 6 showed that the inclusion of soybeans and OFSP flour at 10% levels had no significant ($p>0.05$) effect on the appearance of the samples. However, the inclusion of soybeans and OFSP at 15 % significantly ($p<0.05$) resulted to decrease in appearance of flour biscuit samples. The decrease in appearance could be attributed to the level of inclusion of soybeans and OFSP flour in the blends. Makanjuola and Adebowale (2020) also reported decrease in appearance of biscuit samples with inclusion of water yam flour in the blends. The finding by this study also agrees with the report of Guyih et al. (2020) who reported decrease in appearance rating with inclusion of almond seed and carrot flour in the blends. The appearance rating was within the acceptable limit for all the samples.

The taste rating of the biscuit samples was not significant ($p>0.05$) different at up to 10 % level of soybeans and OFSP inclusion in the blends implying that soybeans and OFSP flour at 10 % level of inclusion did not have effect on the taste of flour blends biscuit. However, at 15 % level of soybeans and OFSP flour inclusion, the taste of the biscuit samples was significantly ($p<0.05$) affected. High level of soybeans and OFSP flour in the blends could have affected the taste of the biscuit sample. The finding agrees with the report of Makanjuola and Adebowale (2020) and Guyih et al. (2020) who reported low acceptability rating in cookies made from composite fours of wheat-water yam and wheat-almond seed supplemented with carrot flour respectively. The high taste rating of samples with high level of wheat could be due to consumer been used to wheat-based bake products.

The control sample was rated high in crispness by consumers. The crispness rating by consumers reduced with level of soybeans and OFSP flour inclusion in the blends. The crispness rating was lowest in the sample with 15 % level of Soybeans and OFSP flour inclusion. The finding by study is in agreement with the report of Amadi et al. (2019) who reported decrease in crispness of biscuit samples with level inclusion okra pod in the blends. The decrease in crispiness with increased substitution levels may be as a result of moisture uptake by soybeans and OFSP flour. It has been reported that moisture uptake leads to loss of crispness of food products (Gernah et al., 2011).

The aroma and general acceptability rating of flour blends biscuit samples also decreased with inclusion of soybeans and OFSP flour in the blends. This could be due to the inclusion of soybeans and OFSP flour inclusion in the blends. The result agrees with the report of Guyih et al. (2020) who reported decrease in aroma and general acceptability rating of the biscuits sample with inclusion of almond seed and carrot flour in the blends. The aroma and general acceptability rating of the control and flour blends samples was however within the acceptable score rating. The study showed that biscuit of acceptable quality can be produced from blends of wheat, soybeans and OFSP flour.

IV. CONCLUSION

The study established that biscuit of acceptable quality was produced from blends of wheat, soybeans and OFSP flour. The weight, diameter and spread ratio of biscuit samples increased while diameter decreased with inclusion of soybeans and OFSP flour in the blends.

The inclusion of soybeans and OFSP flour in the blends had significant effect on proximate composition of biscuit samples. The study showed that the samples with 10 % and 15 % soybeans flour inclusion could meet 90 % of the 16 % protein requirement by the protein advisory group. The crude fat increased while the carbohydrate content increased with level of soybeans and OFSP flour inclusion in the blends.

The result showed that the inclusion of soybeans and OFSP increased the minerals (Ca, Mg, Zn, Fe, Mn, K and Na) and vitamin content (A, B_1, B_2, B_3 and C) of the flour blends biscuit samples. However, the minerals fell short of the RDA/day recommendation by the USDA (2020). The study showed that the control sample (100 % wheat flour biscuit) and 10 % soybeans, 0 % OFSP were highly rated in terms of general acceptability and were the most preferred.

The inclusion of soybeans and OFSP flour in wheat for biscuit making would improve the nutritional profile of wheat biscuit

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