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3 **EFFECT OF CARROT POWDER ADDITION ON THE QUALITY ATTRIBUTES**
4 **COOKIES PRODUCED FROM WHEAT AND SOY FLOUR BLENDS**

5 **Abstract**

6 **Aim:** to evaluate effect of carrot powder addition on the quality attributes cookies produced
7 from wheat and soy flour blends.

8 **Study Design:** Cookies were produced from wheat flour, soy flour and carrot powder
9 composite blends. Functional (bulk density, foam capacity, oil absorption capacity, water
10 absorption capacity and swelling index) properties, Proximate (crude protein, ash, moisture,
11 crude fibre, crude fat, carbohydrate and energy value) composition, Physical (weight, diameter,
12 thickness and spread ratio) and sensory (appearance, flavour, taste, texture and overall
13 acceptability) attributes were determined.

14 **Results:** The functional properties showed that Bulk Density ranged from 0.82 – 0.92, Foam
15 capacity ranged 3.92 – 5.00, Oil Absorption Capacity ranged from 0.60 – 0.97%, Water
16 Absorption Capacity ranged from 1.05 – 1.45% and Swelling Index ranged from 2.37 – 2.75.
17 Results of percentage proximate composition showed that moisture content ranged from 4.70 –
18 7.57, protein content ranged from 10.61 – 21.60, fat content ranged from 8.89 – 15.85, fibre
19 content ranged from 1.39 – 4.30, ash content ranged from 0.70 – 1.23 and carbohydrate content
20 ranged from 52.34 – 70.84. The physical properties showed that weight of the cookies ranged
21 from 17.85 – 21.60, diameter ranged from 57.50 – 60.50, thickness ranged from 20.50 – 24.00
22 and spread ratio ranged from 2.40 – 2.91. The sensory attribute showed that cookies produced
23 from wheat flour, soy flour and carrot powder compared well with cookies produced with
24 wheat flour. The wheat flour cookie sample (A) was most preferred by the panellist.

25 **Conclusion**

26 The functional properties of the composite flour produced from wheat, soybean and carrot
27 powder show potential quality that when properly harnessed could be used for the production
28 of baked product like biscuits, pastry etc. The proximate composition shows that the composite
29 flour cookies were the most preferred sample to the 100% wheat flour cookies. This is due to
30 its high protein, fat, ash and fibre content to that of the 100% wheat cookies. However, in
31 terms of proximate composition, the composite cookies were most acceptable. The physical
32 property of the cookies indicates that the composite flour cookies were most preferred to the
33 100% wheat cookie. This could be seen from the high values it's had in weight, diameter and
34 spread ratio. However, the sensory score of the overall acceptability shows that the 100%
35 wheat cookies were most acceptable. Though, the composite flour cookies compete very
36 closely with 100% wheat cookies

37 **Keywords:** wheat, Soy flour, carrot powder and cookie

38 INTRODUCTION

39 Cookies are consumed all over the world as a snack food. In developing countries where
40 protein and calories malnutrition are prevalent particularly, cookies are consumed on a large
41 scale amongst women and children (Chinma and Gernah, 2007). Cookies and other bakery
42 products have now become cherished fast food products for every age-group, because they are
43 easy to carry about, tasty to eat, cholesterol-free, contains digestive and dietary principles of
44 vital importance and reasonably cheap (Peter *et al*, 2017). With the increased advocacy on the
45 consumption of functional foods by World nutrition bodies due to different health problems
46 related with food consumption, the food industries are therefore faced with the challenges of
47 producing food products containing functional ingredients in order to meet the nutritional
48 requirements of consumers (Chinma and Gernah, 2007 ;Yusuf and Akhigbe, 2014). Cookies
49 can be made from hard dough, hard sweet dough or soft dough. Cookies are characterized by
50 their high sugar and shortening content but low in water. They differ from other baked foods
51 like bread and cakes because they have low moisture content, making them comparatively free
52 from microbial spoilage and having long shelf (Hanan, 2013). The main ingredients of cookies
53 are wheat flour, fat (margarine), sugar and water, while other ingredients such as milk, salt,
54 aerating agent, emulsifier, flavor and colour can be included. They can also be enriched or
55 fortified with other ingredients in order to meet specific nutritional or therapeutic needs of
56 consumers. Flour used in making cookies is basically from wheat or composite flour which
57 forms the basic ingredients of bakery products (Peter *et al*, 2017). In Nigeria, reliance on wheat
58 flour in the pastry and bakery industries has over the years restricted the use of other cereals
59 and tuber crops available to domestic use.

60 In recent years, government has through intensive collaboration with research institutes
61 encouraged the use of composite flours in the production of bread and related food products
62 such as biscuit. This initiative has enhanced the use of flours from cassava, sweet potato,
63 bread-fruit, plantains and other under-utilized crops that are good sources of flour. The
64 adoption of these locally produced flours in the bakery industry will increase the utilization of
65 indigenous crops cultivated in Nigeria and also lower the cost of bakery products (Racheal *et*
66 *al*, 2016). Fruits such as carrots, orange etc are mostly known and accepted as an excellent
67 source of nutrients such as minerals, vitamins and also contain carbohydrates in form of soluble
68 sugar, cellulose and starch. Fruits form a vital portion of an adequate diet and also serve as
69 food supplement and appetizer. Carrot (*Daucus carota*) is one of the important nutritious root
70 vegetables grown throughout the world. It is usually orange in colour, though purple, red, white
71 and yellow varieties exist. It is an excellent source of phytonutrients such as phenols,
72 polyacetylenes and carotenoids. Carotenoids are potential antioxidants which help to neutralize
73 the effect of free radicals. Reports have shown that they have inhibitory mutagenesis activity
74 thus, contributing to decrease risk of some cancer. They are grown in different part of Nigeria.
75 Due to postharvest losses, it is very important to process carrot into powder and use as blends
76 in food (Dias, 2012a).

77 Wheat is a good source of calories and other nutrient but it has low protein content compared to
78 milk, soybean and pea-nut as it is deficient in essential amino acids such as lysine and
79 threonine (Jideani and Onwubali, 2009). The enrichment of baked products and other cereals
80 based confections with legume flours particularly in regions where protein utilization is

81 inadequate has long been recognized. This is because legumes are nutritionally rich in proteins
82 and high in minerals, vitamin B and lysine which are an essential limiting amino acid in most
83 cereal (Jideani and Onwubali, 2009). Soybean is one of the most important oil and protein
84 crops of the world. It contains 30 to 45% protein with a good source of amino acids. It is also
85 rich in calcium, phosphorus and vitamin A, B, C and D (Islam, 2007 and Serrem, 2011). The
86 use of wheat, soy flour and carrot powder blends in the production of cookies was to enhance
87 its protein and vitamin content. The over dependence and high cost of wheat flour in the
88 production of bakery products tends to drain the foreign exchange of countries that don't
89 cultivate wheat thus, production of cookies from composite flour of wheat, soy flour and carrot
90 powder will help to reduce excess importation of wheat flour. The objective of this study
91 therefore was to evaluate the effect of carrot powder addition on the quality characteristics of
92 cookies produced from wheat and soy flour composite blends.
93

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94 **MATERIALS AND METHODS**

95 Wheat flour (Golden Penny, flourmill of Nigeria Ltd) and other raw materials such as
96 soybeans, Carrots, milk powder, eggs and Margarine were purchased from *Wadata* market,
97 Makurdi in Benue State, Nigeria.

98 **Preparation of soybean into flour**

99 Soy flour was prepared according to the method described by Bolarinwa *et al*, (2015) as shown
100 in fig 1. The soybeans were thoroughly cleaned to remove unwanted and extraneous materials.
101 It was then washed and blanched in hot water at 100⁰C for 15 mins. The water was drained and
102 the soybean dehulled by hand washing to remove chaff and then sun dried. After drying,
103 soybeans were toasted in the oven at 120⁰C for 10 mins. The toasted soybean was milled and
104 sieved through a 250 µm, packaged and stored at 10⁰C.
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109 **Preparation of carrots into powder**

110 The method as described by Marvin, (2009) as shown in fig 2 was used to produced carrot
111 powder. The carrots were washed in water, scraped and sliced into 56mm thickness. The sliced
112 carrots were subsequently blanched in hot water containing 2% sodium metabisulphite for 2
113 mins to prevent decolouration. The blanched carrots were then oven dried at 65⁰C for 48 hrs.
114 The dried carrots were then milled into powder, packaged and stored at 10⁰C.

115 **Production of cookies**

116 Different samples of cookies were produced using the blend formulation and recipe as
117 presented in tables 1 and 2 respectively. The flowchart for cookies is shown in fig 3.

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Table 1: Blend formulation

Sample code	Wheat Flour	Soy Flour	Carrot Powder
A	100	0	0
B	80	10	10
C	70	20	10
D	60	30	10
E	50	40	10

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Table 2: Recipe formulation for cookies production

Ingredient (%)	A	B	C	D	E
Wheat flour (g)	100	80	70	60	50
Soy flour (g)	0	10	20	30	40
Carrot powder (g)	0	10	10	10	10
Salt (g)	0.4	0.4	0.4	0.4	0.4
Sugar (g)	40	40	40	40	40
Butter (g)	50	50	50	50	50
Egg	9.1	9.1	9.1	9.1	9.1
Baking Powder (g)	2	2	2	2	2

Source: Modified Islam *et al*, (2011)

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128 **Determination of Moisture Content**

129 Moisture content was determined by the air-oven method as described by Dendegh *et al*,
130 (2019). Two grams of the sample was weighed in duplicate into Petri dishes of know weight
131 and covered immediately. These were transferred into oven, uncovered and heated at 105°C ±
132 2 for 5 hours. The samples were then removed from the oven and placed in the desiccators to
133 cool for 15 minutes before weighing. The process was repeated until constant weights were
134 recorded. The loss in weight from the original weight was reported as the moisture content.

$$\% \text{ Moisture Content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

135 **Determination of Crude Protein Content**

136 Crude protein of the cookies was determined using the Kjeldahl method according to Dendegh
137 *et al*, (2019). One gram of the sample was introduced into the digestion flask. Kjeldahl catalyst
138 (Selenium Tablets) was added to the sample. 20 ml of concentrated tetraoxosulphate (vi) acid
139 was added to the sample and fixed to the digester for eight hours until a clear solution was
140 obtained. The cooled digest was transferred into 100 ml volumetric flask and made up to the
141 mark with distilled water. The distillation apparatus was set and rinsed for ten minutes after
142 boiling. 20 ml of 4% boric acid were pipetted into conical flask. Five drops of methyl red was
143 added to the flask as indicator and the sample was diluted with 75 ml distilled water. Ten mils
144 of the digest was made alkaline with 20 ml of NaOH (20%) and distilled. The steam exit of the
145 distillatory was closed and the change of color of boric acid solution to green was timed. The
146 mixture was distilled for fifteen minutes. The filtrate was then titrated against 0.1 N HCL. The
147 percentage total was calculated:

$$\% \text{ Nitrogen} = \frac{(\text{titre} - \text{blank}) \times 0.04 \times \% \text{ Normality}}{\text{Weight}} \times 100$$

$$\% \text{ protein} = 6.25 \times \% \text{ Nitrogen}$$

148 **Determination of crude fat content**

149 The fat content of the flour samples were determined using solvent extraction in a soxhlet
150 apparatus as described by Dendegh *et al*, (2019). Two grams of each of the flour samples were
151 wrapped in a filter paper and placed in a soxhlet reflux flask which is connected to a condenser
152 on the upper side and to a weighed oil extraction flask full with 200 ml petroleum ether. The
153 ether was brought to its boiling point, the vapour condensed into the reflux flask immersing the
154 samples completely for extraction to take place on filling up the reflux flask siphons over
155 carrying the oil extract back to the boiling solvent in the flask. The process of boiling,
156 condensation, and reflux was allowed to process for 4 hr before the defatted samples were
157 removed. The oil extract in the flux was dried in the oven at 60°C for 30 min and then weighed.

$$\% \text{ Fat Content} = \frac{W_4 - W_3}{W_2 - W_1} \times 100$$

158 **Determination of Crude Fibre content**

159 The crude fibres of the cookies were determined according to the method described by
160 Dendegh *et al*, (2019). Two grams of each of the samples were boiled under reflux for thirty
161 minutes with 200 ml of solution containing 1.25 g of H₂SO₄ per 100 ml of solution. The
162 solution was filtered through linen on a flaunted funnel and washed with water until the

163 washing is no longer acidic. The residue was then transferred to a beaker and boiled for thirty
164 minutes with 100ml of solution. The final residue was filtered through a thin—but—closer pad
165 of washed and ignited asbestos in a Gosh crucible. The residue was then dried in an electric
166 oven and weighed; the residue was incinerated, cooled, and weighed.

$$\% \text{ Crude Fibre} = \frac{W2 - W3}{W1} \times 100$$

167 **Determination of Ash Content**

168 The ash content was determined using the method as described by Dendegh *et al*, (2019).
169 Porcelain crucible were dried and cooled in desiccators before weighing. Two grams of the
170 sample flours were weighed into the crucible and the weight taken. The crucible containing the
171 samples were placed into the muffle furnace and ignited at 550°C. This temperature was
172 maintained for three hours. The muffle furnace was then allowed to cool; the crucibles were
173 then brought out, cooled and weighed. The ash content was calculated as follows:

$$\% \text{ Ash Content} = \frac{W2 - W1}{\text{Weight of sample}} \times 100$$

174 **Carbohydrate Content Determination**

175 Carbohydrate content of the flour samples was determined using the formula described by
176 Ihekoronye and Ngoddy, (1985).

177 **% carbohydrate** = 100 – %(protein + fat + fibre + ash +moisture content.)

178

179 **FUNCTIONAL PROPERTIES**

180 **Swelling index**

181 One gram of the sample was weighed into a conical flask. It was hydrated with 15 ml distilled
182 water, shaken for 5 min with mechanical shaker at low speed. Heating was done for 40 min at
183 80-85°C with constant stirring in a water bath. The content was transferred into a clean, dried
184 and pre-weighed centrifuge tube. Distilled water of 7.5 ml was added and centrifuged at 2200
185 rpm for 20 min. The supernatant was decanted into a pre-weighed can and dried at 100 °C to a
186 constant weight. The sediment was weighed in the centrifuge. Swelling power and solubility
187 were calculated viz:

$$\text{Swelling Index} = \frac{\text{Weight of sediment}}{\text{Weight of flour} - \text{Weight of dried supernatant}}$$

188 **Bulk density**

189 Fifty gram flour sample was put into a 100 ml measuring cylinder. The cylinder was tapped
190 several times on a laboratory bench to a constant volume. The volume of sample was recorded.

191 $\text{Bulk density (g/cm)} = \frac{\text{weight of sample (g)}}{\text{Volume of sample after tapping}}$

192 **Water absorption capacity**

193 Fifteen millilitres of distilled water was added to 1 g of the flour in a weighed 25 ml centrifuge
194 tube. The tube was agitated on a vortex mixer for 2 min. It was centrifuged at 4000 rpm for 20
195 min. The clear supernatant was decanted and discarded and reweighed. Water absorption
196 capacity was expressed as the weight of water bound by 100 g dried flour.

$$\text{Water Absorption Capacity g/ml} = \frac{\text{Weight of wet sediment}}{\text{Dry weight of flour}}$$

197

198 **Oil absorption capacity**

199 Ten millilitre refined corn oil was added to 1 g of the flour in a weighed 25 or 80 ml centrifuge
200 tube. The tube was agitated on a vortex mixer for 2 min. It was centrifuged at 4000 rpm for 20
201 min. The volume of free oil was recorded and decanted. oil absorption capacity is expressed as
202 value of oil bound by 100 g dried flour.

$$\text{Oil Absorption Capacity} \frac{g}{ml} = \frac{\text{Weight of wet sediment}}{\text{Dry weight of flour}}$$

203 **Foam Capacity**

204 This was carried out as described by Dendegh *et al*, (2019). One gram of flour sample was
205 added to 50 ml distilled water at 30⁰C in a graduated cylinder. The suspension was mixed and
206 shaken for 5 min to foam. The volume of foam at 30 sec after whipping was expressed as foam
207 capacity using the formula.

$$\text{Foam Capacity} = \frac{\text{Volume after whipping} - \text{Volume before} \times 100}{\text{Volume before whipping}}$$

208 **Sensory Evaluation**

209 Sensory evaluation was conducted by 20 trained panellists Department of Food Science and
210 Technology, University of Agriculture, Makurdi who were familiar with cookies. The
211 panellists were trained in ten sessions until the panellists' were familiar with the range of
212 characteristic intensities required for the study. They were provided with clean water to rinse
213 their mouth after tasting each sample. Assessment was by 9 - point hedonic scale for
214 appearance, flavour, taste, texture and general acceptability where 9 represent like extremely
215 and 1 represents dislike extremely

216 **Statistical Analyses**

217 All analyses were carried out in triplicate unless otherwise stated. Statistical significance was
218 established using one-way analysis of variance (ANOVA), and data were reported as the mean
219 \pm standard deviation. Mean comparison and separation was done using Fisher's Least
220 Significant Difference test (LSD) at (P< 0.05). Statistical analysis was carried out using the
221 SPSS 21 statistical package.

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225 **Results**

Table 3: Functional Properties of Cookies Produced from Wheat, Soy flour and Carrot Powder

Samples	Bulk Density (g/ml)	Foam capacity (ml)	Oil Absorption Capacity (%)	Water Absorption Capacity (%)	Swelling Index
A	0.92±0.02 ^a	5.00±1.41 ^a	0.88±0.06 ^a	1.25±0.07 ^b	2.75±0.11 ^a
B	0.86±0.01 ^b	3.92±0.00 ^a	0.60±0.02 ^b	1.05±0.07 ^c	2.37±0.10 ^{ab}
C	0.82±0.01 ^b	4.00±0.00 ^a	0.60±0.02 ^c	1.35±0.07 ^a	2.50±0.09 ^b
D	0.83±0.01 ^b	4.90±1.39 ^a	0.79±0.06 ^c	1.45±0.07 ^a	2.55±0.10 ^{ab}
E	0.84±0.01 ^b	5.00±1.41 ^a	0.97±0.06 ^a	1.45±0.07 ^a	2.75±0.11 ^a

Values with different superscript within the same column are significantly (p<0.05) different.

226

227 Key:

228 A = 100 % wheat flour

229 B = 80% wheat flour, 10% soy flour and 10% carrot powder

230 C = 70% wheat flour, 20% soy flour and 10% carrot powder

231 D = 60% wheat flour, 30% soy flour and 10% carrot powder

232 E = 50% wheat flour, 40% soy flour and 10% carrot powder

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Table 4: Proximate Composition of Cookies Produced From Wheat, Soy Flours and Carrot Powder.

Parameters						
Samples	Moisture	Protein	Fat	Fibre	Ash	Carbohydrate
A	7.57±0.01 ^a	10.61±0.01 ^a	8.89±0.01 ^c	1.39±0.01 ^c	0.70±0.01 ^c	70.84±0.01 ^a
B	6.87±0.01 ^b	11.84±0.01 ^d	9.86±0.02 ^d	1.54±0.0 ^d	0.97±0.01 ^d	68.93±0.01 ^b
C	6.23±0.02 ^c	13.34±0.02 ^c	10.31±0.03 ^c	1.71±0.03 ^c	1.04±0.02 ^c	67.39±0.02 ^c
D	5.76±0.04 ^d	18.32±0.03 ^b	13.38±0.10 ^b	2.24±0.02 ^b	1.12±0.02 ^b	59.79±0.03 ^d
E	5.70±0.01 ^e	21.60±0.02 ^a	15.85±0.01 ^a	2.40±0.01 ^a	1.23±0.01 ^a	54.44±0.02 ^e

Values with different superscript within the same column are significantly ($p < 0.05$) different.

248

249 Key:

250 A = 100 % wheat flour

251 B = 80% wheat flour, 10% soy flour and 10% carrot powder

252 C = 70% wheat flour, 20% soy flour and 10% carrot powder

253 D = 60% wheat flour, 30% soy flour and 10% carrot powder

254 E = 50% wheat flour, 40% soy flour and 10% carrot powder

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Table 5: Physical Properties of Cookies Produced from Wheat, Soy flour and Carrot Powder

Samples	Parameters			
	Weight (g)	Diameter (mm)	Thickness (mm)	Spread Ratio
A	17.85±0.642 ^b	57.50±2.12 ^b	24.00±0.00 ^a	2.40±0.09 ^b
B	20.55±1.91 ^{ab}	61.50±0.71 ^a	22.50±0.71 ^{abc}	2.74±0.12 ^{ab} ^c
C	21.20±1.41 ^{ab}	60.50±0.71 ^{ab}	23.00±1.41 ^{ab}	2.64±0.19 ^{ab}
D	20.55±1.34 ^{ab}	60.50±2.12 ^{ab}	21.50±0.71 ^{bc}	2.82±0.19 ^a
E	21.60±0.57 ^a	59.50±1.71 ^{ab}	20.50±0.71 ^c	2.91±0.06 ^a

Values with different superscript within the same column are significantly ($p < 0.05$) different.

256 Key:

257 A = 100 % wheat flour B = 80% wheat flour, 10% soy flour and 10% carrot powder

258 C = 70% wheat flour, 20% soy flour and 10% carrot powder

259 D = 60% wheat flour, 30% soy flour and 10% carrot powder

260 E = 50% wheat flour, 40% soy flour and 10% carrot powder

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Table 6: Sensory Scores of cookies produced from wheat, soy flours and carrot powder.

Samples	Appearance	Flavour	Taste	Texture	General acceptability
A	8.47 ^a	8.20 ^a	8.27 ^a	7.73 ^a	8.47 ^a
B	7.33 ^b	7.27 ^b	7.00 ^b	7.33 ^{ab}	7.47 ^b
C	6.87 ^b	6.47 ^b	6.20 ^c	6.60 ^{bc}	6.87 ^{bc}
D	7.00 ^b	6.80 ^b	6.67 ^{bc}	6.47 ^c	6.60 ^{bc}
E	6.147 ^b	6.53 ^b	6.00 ^c	6.20 ^c	6.20 ^c

Values with different superscript within the same column are significantly ($p < 0.05$) different.

263

264 Key: A = 100 % wheat flour B = 80% wheat flour, 10% soy flour and 10% carrot powder

265 C = 70% wheat flour, 20% soy flour and 10% carrot powder

266 D = 60% wheat flour, 30% soy flour and 10% carrot powder

267 E = 50% wheat flour, 40% soy flour and 10% carrot powder

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270 **DISCUSSION**

271 **Functional Properties of Wheat Flour, Soy Flour and Carrot Powder Blends**

272 **Bulk density**

273 Table 3 shows the functional properties of wheat flour; soy flour and carrot powder composite
274 blends. The bulk density of the composite flour ranges from 0.82 (sample C) to 0.92 (sample
275 A). The bulk densities of the blends tend to decrease with increase in substitution level of soy
276 flour and carrot powder. The 100% wheat flour had the highest bulk density 0.92 while sample
277 C had the lowest 0.82. The result of the study agrees with those presented by Abayomi *et al*,
278 (2013).

279 **Foaming capacity**

280 The foaming capacity increased as the percentage soy flour and carrot powder increased. This
281 increase in foam capacity could be associated with the starch and protein content respectively
282 of the flour. Good foam capacity and stability are desirable attributes for flours intended for the
283 production of variety of baked products such as angel cakes, muffins, cookies, fudges, *akara*
284 and also act as functional agents in other food formulations (El-Adawy, 2001).

285 **Oil Absorption Capacity**

286 The oil absorption capacity values for the samples as presented in table 3 increased from 0.60
287 in samples B and C to 0.97 in sample E. This shows that the increase in addition of Carrot
288 powder to wheat may have possibly increased the oil absorption capacity of the flours. The
289 possible reason for increase in the OAC of composite flours after incorporation of the other
290 flours is the variations in the presence of non-polar side chain, which might bind the
291 hydrocarbon side chain of the oil among the flours. Similar findings were observed by
292 (Dendegh *et al*, 2019). However, the flours in the present study are potentially useful in
293 structural interaction in food especially in flavour retention, improvement of palatability and
294 extension of shelf life particularly in bakery or meat products where fat absorption is desired
295 (Dendegh *et al*, 2019). There were significant ($P \leq 0.05$) differences amongst the samples. It
296 could be attributed that the higher the oil absorption capacity of a flour sample, the better the
297 cooking quality. Absorption of oil by food products improves mouth feel and flavour retention.
298 Oil retention also improves the quality of cookies because oil contributes to the soft texture of
299 cookies (Peter *et al*, 2017)

300 **Water Absorption Capacity**

301 The water absorption capacity of the composite flours is given in Table 3. The WAC ranged
302 between 1.05 in composite sample B to 1.45 in composite flour sample C and D. The WAC
303 was observed highest in C and D (1.45) and lowest in B (1.05). The result suggests that
304 addition of soy flour and carrot powder to wheat flour increased the amount of water
305 absorption. The increase in water absorption values observed and substitution with increased
306 soy flour and carrot powder could be due to the high protein content of the soy flour. Madu
307 (2007) stated that water absorption capacity enables bakers to add more water to dough and so
308 improve handling characteristics and maintain freshness of the baked products. Also water
309 absorption capacity is the ability of protein in a product to associate and retain water which
310 increases water absorption capacity with increased protein content (Peter *et al*, 2017). The
311 addition of soy flour to whole wheat flour increased the protein content and significantly

312 increased the water absorption capacity of the different flour ratios used in this work, thereby
313 making the dough handling very difficult. There were significant ($P \leq 0.05$) differences in water
314 absorption capacity values of the flour blends. High WAC of composite flours suggests that the
315 flours can be used in formulation of some foods such as sausage, dough and bakery products.
316 The increase in the WAC has always been associated with increase in the amylose leaching and
317 solubility, and loss of starch crystalline structure. The flour with high water absorption may
318 have more hydrophilic constituents such as polysaccharides. Protein has both hydrophilic and
319 hydrophobic nature and therefore they can interact with water in foods.

320

321 **Swelling Index**

322 The swelling capacity of samples ranged between 2.37 (sample C) to 2.75 (sample A and E).
323 The swelling capacity of flours depends on size of particles, types of variety and types of
324 processing methods and/or unit operations. Suresh et al., (2015) reported that the flour of
325 parboiled rice has more swelling capacity as compared to raw rice. They also reported that the
326 Swelling capacity of composite flours increased with increase in the level of incorporation and
327 decreased with level of wheat flour addition. It is explicit that the swelling capacity of
328 composite flours is highly affected by the level of soy flour and carrot powder, because soy
329 flour is rich in protein and starch content.

330

331 **Proximate Composite of Cookies Produced from Wheat flour, Soy Flour and Carrot** 332 **Powder**

333 The results for the proximate composition of cookies produced from wheat flour, soy flour and
334 carrot powder are shown in Table 4. The value shows that the moisture content of the cookies
335 ranged from 4.70 – 7.57% with sample E (4.70%) having the least moisture as compared to
336 sample A (7.57%). The composite cookie were significantly ($p < 0.05$) different amongst itself
337 and also with the 100% wheat flour cookie. Though, the percentage moisture content decreases
338 as the percentage of soy flour increases. There were significant ($P \leq 0.05$) difference in the
339 moisture contents of all the cookies. The percentage protein content increased from (10.61 –
340 21.60%) with increase in soy flour addition. The increase in protein was as a result of the
341 increased soy flour addition in the composite flour blends. Proteins are building blocks of the
342 body and foods that are rich in protein are known to reduce protein energy malnutrition. The
343 protein content shows significant ($p < 0.05$) difference in all the samples and increase with
344 increase in soy flour addition. The fat content of the samples was found to range from 8.89 to
345 15.85% with sample E (15.85%) having the highest significant ($P < 0.05$) value than others. This
346 is as a result of the high soy (50%) flour content in the sample. Sample A and B with low Fat
347 content could be as a result of low amount of soy flour addition. The crude fibre content of the
348 composite cookies tends to be higher than the 100% wheat. Crude fibre content of the
349 composite cookies increased as a result of carrot powder inclusion which may have had a
350 pronounced effect on dough properties, yielding higher water absorption, mixing tolerance and
351 tenacity, small extensibility in comparison with those obtained without fibre addition (Elluech
352 *et al*, 2011)]. An increase in the fibre content of cookies has some beneficial effect on the
353 muscles of the large and small intestines. The Ash content of the composite cookies was higher
354 than the 100% wheat. The increase in ash content could be due to increase in soy flour and

355 carrot powder as reported by Eduardo, (2015). Ash content is an indication of mineral content;
356 hence samples with higher ash content are expected to have a relatively higher mineral content.
357 The values of ash content recorded for the wheat and cassava fours were in line with the values
358 reported by Olapade and Adeyemo, (2010). Carbohydrate content of the samples was found to
359 range from 52.34 to 70.84% with sample A having the highest significance ($P<0.05$) value. The
360 high value of carbohydrate in sample A could be as a result of wheat flour. Carbohydrate is
361 required in infant diet for energy during growth. The results in table 4 show that carbohydrate
362 decreases as the amount of soy flour increased. This could be attributed to the diluting ability
363 of the soy flour on the starch content of wheat flour.

364

365 **Physical Properties of Cookies Produced from Wheat, Soy Flours and Carrot Powder** 366 **Weight**

367 There were significant ($p<0.05$) difference in terms of weight between cookies produced from
368 100% (A) wheat flour and composite (B, C, D and E). This could be attributed to increased soy
369 flour and carrot powder addition. It was also observed that composite flour cookies produced
370 were not significantly ($p<0.05$) different in weight. However, an increase in weight was
371 observed amongst the composite cookies produced than 100% wheat cookie. The result obtain
372 from this study tends to agree with those reported by Chinma and Gernah, (2007)

373 **Diameter**

374 The diameter of the cookies ranged between 57.50 to 61.50 mm. The diameter of sample A was
375 significantly ($P<0.05$) different from those of the composite (B, C, D and E) cookies. The
376 diameter of cookies obtained from soy flour and carrot powder incorporation decreased from
377 61.50 mm in sample B to 59.50 mm in sample E. The result agrees with those reported by
378 (Peter *et al*, 2017).

379 **Thickness**

380 The cookies thickness ranged from 20.50 mm to 24.00 mm. The 100% wheat cookies has the
381 highest thickness and the least thickness was recorded in composite cookie sample E. The less
382 thin the cookies the lesser its ability to withstand stress.

383 **Spread Ratio**

384 The result of the spread ratio shows that, sample E and D had the highest value while the 100%
385 wheat cookie had the least. The result agrees with Olapade and Adeyemo, (2014) and Peter *et al*
386 *al*, (2017) who reported that, the Spread ratio is an indication of ability of the cookie to raise,
387 hence the lower the value the better the ability. It has been suggested that cookie spread
388 (diameter and height) is affected by the competition of ingredients for available water (Yusuf
389 and Akhigbe, 2014). The results obtained from this study were similar to the findings reported
390 by Mridula *et al.*, (2007) for wheat/sorghum composite biscuits. Peter *et al*, (2017) and Handa
391 *et al.*, (2012) also reported that Cookie spread represents a ratio of diameter to thickness.
392 Cookies having higher spread ratio are considered most desirable. Also, larger cookie diameter
393 and higher spread ratio are considered as the desirable quality attributes in cookies. Spread

394 ratios of cookies prepared with soy flour and carrot powder were observed to increase (Peter *et*
395 *al*, 2017).

396 **Sensory Scores of Cookies Produced from Wheat Flour, Soy Flour and Carrot Powder**

397 The mean sensory scores of cookies produced from wheat flour, soy flour and carrot powder
398 are presented in Table 6. The brown appearance resulting from Maillard reaction is always
399 associated with baked goods. The composite flour cookies were significantly ($p < 0.05$) different
400 in terms of appearance. The appearance of the whole wheat cookie was superior to those of the
401 composite flour cookies. In terms of Appearance, sample A was most preferred sample.

402
403 Flavour is important attribute in sensory evaluation due its ability to put off or bring customers
404 to buy such products. The scores for flavour in the study show that sample A (100% wheat
405 flour) was most preferred to the composite flour cookie. The score for sample A was 8.27
406 which was higher than that scored by the composite cookies samples.

407
408 Taste is an important sensory attribute of any food because of its influence on acceptability of
409 any product which has the highest impact as far as market success of product is concerned. The
410 preferences for taste of the samples also showed a decrease in increasing substitution of
411 soybean (Olapade and Adeyemo, 2014) and (Abayomi *et al*, 2013). The taste scores of cookies
412 produced ranged from 6.00 to 8.27. Except for the cookies from sample A, there were no
413 significant ($p > 0.05$) differences among the cookie samples produced from composite flour.
414 Sample A sensory score shows the highest (8.27) for taste, followed by cookies from sample B
415 (7.00). Sample A was most preferred in terms of Taste.

416
417 There were significant ($p < 0.05$) differences in the texture among the samples. An increase in
418 the substitution levels of soy flour and carrot powder resulted in a decrease in texture scores.
419 Cookie produced from composite flour scored least in terms of texture while whole wheat
420 cookies had the highest score of 7.73. The scores for texture decreased with increase in the
421 amount of soy flour and carrot powder blend which may be attributed to the high fat absorption
422 capacity of soy flour. The texture sensory scores show that sample A was most preferred
423 sample. The observations in the present study were agreement with the findings of Olapade and
424 Adeyemo, (2014), who studied the effect of soy flour on the functional properties and the
425 potential of soybean and cassava flour blends in cookie production. Cookie from sample A was
426 significantly ($p < 0.05$) different from the composite flour cookies in overall acceptability and
427 was most preferred sample to the composite flour cookies. This was followed by sample B of
428 the composite cookie.

429

430 **Conclusion**

431 The functional properties of the composite flour produced from wheat, soybean and carrot
432 powder show potential quality that when properly harness could be used for the production of
433 baked product like biscuits, pastry etc. The proximate composition shows that the composite
434 flour cookies were the most preferred sample to the 100% wheat flour cookies. This is due to
435 its high protein, fat, ash and fibre content to that of thee 100% wheat cookies. The physical

436 property of the cookies indicates that the composite flour cookies were most preferred to the
437 100% wheat cookie. This could be seen from the high values it's had in weight, diameter and
438 spread ratio. However, the sensory score of the overall acceptability shows that the 100%
439 wheat cookies were most acceptable. Though, the composite flour cookies compete very
440 closely with 100% wheat cookies

441

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