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DEVELOPMENT OF *AKARA* STRIPS THROUGH SUBSTITUTION OF COWPEA WITH CASSAVA FLOUR: EFFECTS ON PRODUCT QUALITY AND CONSUMER ACCEPTANCE

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ABSTRACT

Akara snack (fried cowpea paste) is an oil-dense fried product, and fried snacks have associated fat-related ailments due to higher amount of oil uptake. The need for designing healthy foods with minute oil content. The study evaluated substituting cowpea flour with high-quality cassava flour (HQCF) with the aim of improving the quality of *akara* into strips, and enhancing consumer acceptance. Strips were made by formulating cowpea and HQCF composite blends into different ratios: 70:30, 60:40, 50:50, and 40:60, with 100:0 as the control. Flour blends and other ingredients were mixed to form batters, and extruded manually and fried. Flour blends analysed (bulk density, water/oil absorption capacity, dispersibility, and pasting properties) while *akara* strips were evaluated for quality (texture, colour and sensory properties). The results showed significant differences in all the parameters evaluated for both flour blends and snacks. Colour analysis indicated the values of lightness, redness, yellowness and colour intensity differed significantly among samples. The snacks showed decrease in lightness and yellowness, while brownness and colour intensity increase with increasing HQCF addition. Composited snacks were rated higher than the control in terms of crispiness, aroma, flavour and consumer acceptance. Sample 60:40 had the highest preference score (4.4) on a-5-point scale. Hence, by substituting cowpea with HQCF added value to *akara* and enhancing consumers' acceptance. This novel idea could promote UN-SDGs on zero hunger, good health and wellbeing, industrial innovation, responsible consumption and production.

Keywords: Composite Flour, Crispiness, High Quality Cassava Flour, Snack, UN-SDGS

INTRODUCTION

Akara or *koose* (deep-fried cowpea snack) is a staple legume food product that is commonly consumed by the large population of the people residing in both rural and urban segments in West African regions such as Nigeria, Togo, Ghana and the Republic of Benin. The product is consumed with the cereal-based breakfast meals, notably are the fermented soft (*Ogi*) and hard (*agidi* or *eko*) porridges, and bread or as snacks with different beverages. The product has been ordained by traditionalists since time immemorial. Celebration of *Egungun* festivals in the south-west Nigeria remains incomplete without the frying and consumption of *akara*. Dehulled cowpea paste after whipping (with pepper, salt, onion, etc.) is gently portioned into hot oil and deep-fried. Deep-frying involves transfer of mass and heat process simultaneously such that oil is absorbed and moisture is evaporated from the food materials (Lui-ping *et al*., 2005). The traditional frying method poses health hazards to consumers of the product due to the poor cooking practices such as extremely high frying temperatures and repeated use of the frying oil. Continuous use of this oil causes lipids deterioration and formation of acrylamide and trans-fatty (Olusola & Ajibade, 2022). These compounds are harmful to human health arising from prolonged consumption of *akara*, and have been linked to weight gain, obesity and high cholesterol levels in human body systems. The incorporation of locally available food materials for new food product development can enhance its quality, and over-reliance on imported wheat thereby strengthen food and nutritional security (Adeosun, Adetula, & Uchechukwu, 2026). Could substituting cowpea flour with high quality cassava flour reduce oil uptake in *akara* if shaped to strips and, could possibly enhance the product quality and promote further consumer patronage and acceptability?

Cowpea *(Vigna unguiculata),* is a good source of plant proteins for people living in tropics with the grains containing appreciable amounts of fibre, minerals, and essential amino acids such as lysine and tryptophan. Cassava *(Manihot spp)* is a staple root crop for large segment of inhabitants in the sub-Saharan Africa, Asia, and Latin America (Udoro, Anyasi, &, Jideani, 2021). Cassava roots deteriorate rapidly after harvesting caused enzyme linamarase, which breaks down starches into sugars leading to spoilage and development of off-flavour. This deterioration in cassava can be curtailed by processing the roots immediately after harvest, to flour (known as high-quality cassava flour (HQCF)). Nutritionally, HQCF is poor in essential nutrients but it is rich in high-quality starch than fermented cassava flour (Udoro *et al*., 2021). So, by replacing partially cowpea flour with HQCF, products, which could offer balanced nutritional profile that match with contemporary health and wellness benefits cab be developed (Oyeyinka *et al*., 2019). In addition, HQCF can improve the texture, oil intake and binding qualities of the *akara* strips boosting their palatability and shelf life. Nevertheless, the production of *akara* strips using cowpea flour and HQCF could be a strategy to develop improved food products capable of addressing some policies of the United Nations on the Sustainable Development Goals, SDGs set for 2030.

To achieve these SDGs, notably are 2, 3, 9, 12, and 13, respectively for zero hunger, good health and wellbeing, industrial innovation, responsible consumption and production, and climate action; researchers have developed *akara* types, such as *akara Ogbomoso* (Falade, Adedeji, & Akingbala, 2003), fried chips (Olapade & Adegboye, 2018), *akara egbe* (Ajetunmobi-Adeyeye, Olajide, & Alade, 2021), and *akara-iwe* (Okon *et al*., 2022). Falade *et al*. (2003) substituted soybean for cowpea and found an increase in the crunchiness of the product (*akara Ogbomoso*) with increasing amount of soybean into cowpea flours. This enhanced consumer acceptance because the traditional *akara Ogbomoso* is known to be very hard and difficult to chew. The researcher proposed that the snack made with 20% soybean flour is most acceptable as evaluated by the panellists. Olapade and Adegboye (2018) reported on fried chips made from cassava-cowpea flour blends, and found that the resulting snacks are crispy. In addition, substituting cowpea up to 60% into HQCF has greater potentials in the baking and confectionery industry. Ajetunmobi-Adeyeye *et al*. (2021) evaluated effects of processing *akara egbe* from cowpea and Bambara groundnut. The authors found that 20% Bambara groundnut inclusion into cowpea flour and frying the flour paste at 190 °C for 8.5 min had the highest preference and the most acceptable product with higher crispiness score by the panellists.

Our literature search revealed that information is not sufficient on the improvement of *akara* into strips using of cowpea and cassava flour blends. This work investigated the effect of substituting cowpea flour with cassava (HQCF) for the production of *akara* strips, with the aims of improving product quality and promote consumer acceptance.

MATERIALS AND METHODS

Materials

Freshly harvested cassava roots (*oko iyawo* variety) were obtained from a Co-operative farm in Ilaro, Ogun State. Cowpea seed (Ife brown variety), edible salt, powdered onions and pepper were purchased from a retail market in Abeokuta, Ogun State. These food materials were then kept in the fridge (-20 ℃) until needed for processing.

Production of Cowpea Flour and High-Quality Cassava Flour

Cowpea grains were manually separated from foreign materials (stones, chaff, and dusts). Grains were soaked in water at 25±2 ℃ for 10 minutes to soften the seed coats and clean cotyledons. The cotyledons were then dried (60±5 ℃, 24 h), cooled and milled into flour (500-µm particle size) using a laboratory-based disc attrition mill. The flour was packaged in ziplock bags and kept in fridge (-20 ℃) until needed for flour formulation.

Cassava roots were sorted to remove soil and bruised roots, and washed with water, peeled and washed repeatedly with portable water. Peeled roots were grated using a cassava grater to wet mash. The mash was packed into a polyethylene sac and pressed mechanically to remove water in the mash. The wet cake from the press was pulverised, spread in stainless steel trays and, dried (80±5 ℃, 4 h) using a cabinet dryer. The dried material was then milled using a hammer mill to obtained high quality cassava flour that was used for this study, packaged in plastic buckets and refrigerated (-20 ℃) until when needed.

Akara Strips Preparation

Flour samples (500 g) was poured in water and mixed to form semi-thick slurry. Salt, onion, powdered pepper and ginger were added to the slurry and mixed for 3 minutes for uniformity. This slurry mix was then scooped and fed into a manual extruder fixed with star-shaped die was used to disperse and fried in hot oil (170±5 ℃, 5-6 minutes). Strips were turned frequently until golden brown colour is obtained. Strips were drained, cooled and packaged for the different analyses and sensory evaluation.

Analysis

Functional Properties

Functional properties in terms of bulk density (Adebowale & Ajibode, 2022), water/oil absorption capacity (Falade & Okafor, 2015), swelling power and dispersibility (Adebowale & Ajibode, 2022) were determined using the procedures accordingly.

Pasting Properties Determination

The pasting properties of samples were determined using the procedures describe by Adeyanju *et al*. (2024). Three grams of the sample was poured into a canister of a rapid visco-analyser (RVA) apparatus, and distilled water (25 ml) was added. The canister enclosing the sample and the paddle was inserted into the apparatus, initiating the measurement for nearly 14 minutes profile. Condition of measurement used were: an initial resting phase (50 ℃, 1 minute), a temperature increase (50-91 ℃, 4 minutes), holding period (91 ℃, 3 minute), a cooling phrase (50 ℃ within 4 minutes), and a final temperature maintained (50 ℃, 2 minutes).

Instrumental Colour Measurement

Colour values of samples were measured using a tristimulus colorimeter that was calibrated with a white reference plate supplied by the manufacture. Values were recorded in the CIE *Lab* colour space as L^* (lightness), a^* (redness), b^* (yellowness), and ΔE^* (colour intensity) representing the surface colour of samples (Adebowale, Taylor, & de Kock, 2020).

Colour intensity was calculated using equation: $\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$

Sensory Evaluation of Snacks

Sensory evaluation of snack samples that were prepared from cowpea flour and HQCF blends was conducted by 25 trained panellists (13 females, 12 males; aged 17–35 years) with no allergies to the ingredients used in the study, and no sensory acuity disorders. After a 3-day training exercise (2 h/day) to acquit the panellists with the sensory attributes (appearance, colour, taste, aroma, and crispness). The actual evaluation of snack samples was performed in individual booths under white fluorescent lighting in the sensory evaluation room (25±2 ℃, RH 60±5%). Each sample (10 g) was coded with a random 3-digit number and presented in a randomized pattern to panellists. Filtered water and plain crackers were used as palate cleansers in between the test. Panellists evaluated the samples to indicate the degree of difference from the control (akara strips made with 100% cowpea flour paste) on a 5-point scale (from maximum of 5 = no difference to minimum of 1 = extremely different).

Statistical Analysis

Shapiro-Wilk tests were used to assess normality and homogeneity of variance. Results were expressed as mean ± standard deviation (n = 3). A two-way ANOVA model was used to determine the effects of substituting cowpea with HQCF (0, 30, 40, 50, and 40), and their interaction on the functional, pasting, colour, and sensory evaluation). Tukey's HSD Test ($p<0.05$) was performed to separate the means. SPSS (version 23.0, IBM Corp., Armonk, NY, USA) was used for data analysis.

RESULTS AND DISCUSSION

Functional Properties

Table 1 shows the effect of substituting cowpea flour with high-quality cassava flour (HQCF) on the functional properties (measured in terms of bulk density-BD, water absorption capacity-WAC, oil absorption capacity-OAC, swelling power-SP, and dispersibility-DB) of flour blends, which differed significantly ($p<0.05$). There was general reduction in all these parameters with increasing substitution of cowpea with HQCF. The BD ranged from 0.62 g/ml to 0.70 g/m such that $100_{CP}:0_{HF}$ and $50_{CP}:50_{HF}$ respectively displayed highest and least values. The BD is an important parameter considered for packaging, transportation and food storage. BD is reportedly affected by the size of particles and food density (Ogundipe *et al*., 2026). In other words, BD connotes the ability of food materials in relation to support the structure, aids movement of water, and aeration of food materials (Alabi, Adejuyitan & Oyedele, 2026). Low BD recorded in this study suggests that flours have the potential in food formulation and applications without fear or concern for retrogradation tendency. Results of BD in this study agrees with the reports by Ogundipe *et al*. (2026) on maize-tiger nut flour blends for *kokoro* snack production. Contrarily, BD obtained from this study are lower than that reported by Olapade and Adegboye (2018) for the blends of HQCF and cowpea flour.

The WAC indicates the quantity water imbibe or binds with the flour to achieve the desired consistency for product preparation (Odunlami *et al*., 2023). WAC ranged between 218.2 and 253.5%, with $100_{CP}:0_{HF}$ (control) had the highest value while the lowest was in $40_{CP}:60_{HF}$. The WAC of the flour reduced with the increasing substitution of cowpea flour with HQCF. Milling and heating operations of cowpea and cassava could have damage the fibre chains and hinder the ability of the resulting flours to imbibe (Zhao *et al*., 2017). Particularly, dry milling operation is capable of causing the collapse of the matrix formed to degenerate and prevents water uptake (Gao *et al*., 2020). Reduction in WAC could be of advantage in food preparations by improving flour mixing in water (Alabi *et al*., 2026)., where water uptake does not cause protein dissolution and, thus, increasing both viscosity and thickening. Higher value of WAC indicates that starch polymers are in a free arrangement pattern while lower WAC connotes a more compact molecular arrangement (Gao *et al*., 2020). Ogundipe *et al*. (2026) in their study on maize-tigernut flour blends suggests that lower WAC could mean a good water-binding ability.

The OAC indicates the ability of food material to absorb oil, which may affect the product during processing. The value OAC ranged from 181.7 to 190.8% (Table 1). High values of OAC value recorded in $100_{CP}:0_{HF}$ could be attributed to the lipophilic nature of cowpea proteins, which has a high capacity to retain fat globules (Orisa & Udofia, 2020). The value OAC recorded was higher than that of maize-tigernut flour blends reported by Ogundipe *et al*. (2026). The change in the values of OAC could be attributed the difference in OAC the protein's low hydrophobicity and high lipophilic properties. Higher amount of oil absorption in foods could be responsible for diet-related ailments such as obesity and coronary heart diseases, which are notable problem associated with fried food products (Okon *et al*., 2022). Udoro *et al*. (2021) had reported an inverse relationship between the frying temperature and frying time. Furthermore, the authors proposed that decrease in oil content at higher temperature may be due to the formation of crust on the surface of fried foods. This could imply that the crust acts hindered moisture in the food material from escaping through evaporation and the thus, prevents further oil uptake.

Swelling of aqueous suspension of starch indicates strengths of hydrogen bonding between starch granules. SP, as a function of process conditions, type of materials, and treatment given to a food material is of benefits in the production of bakery products (Alabi *et al*., 2026). The values of SP ranged from 4.82 to 5.81%, such that $40_{CP}:60_{HF}$ had the least (4.82%) while $100_{CP}:0_{HF}$ had the highest (5.81%). A steady reduction in the SP was observed with increasing substitution of cowpea with HQCF (Table 1). Possible reasons for reduction in SP include: changes in starch component and starch modifications due to drying or milling; amylose-lipid complexes formed between starches and available lipids in the presence of adequate moisture at above 80 °C, thus reducing water uptake and swelling power (Ogundele *et al*., 2017); breakdown of fibre matrix and molecular rearrangement within starch granules during milling process (Orisa & Udofia, 2020); and variations in the contents of amylose and other minor components in the flour blends (Oyeyinka *et al*., 2019).

Dispersibility (DB) measures the degree of flour rehydration with water or to reconstitute flour or flour blends in water. (Olorode *et al*., 2022). Table 1 shows that the values of DB ranged from 58.15 to 62.82%., the lowest value was observed in sample 40:60 while the highest was recorded in sample $100_{CP}:0_{HF}$, indicating that values decreased significantly ($p<0.05$) with increasing substitution of cowpea with HQCF. Decrease in DB could be because of variation in the particle size of flours (Okon *et al*., 2022), and increasing addition of HQCF into cowpea flour. However, the values of DB obtained in this study for cowpea-HQCF composite flour are high as 62.0% and 60.2% respectively in $70_{CP}:30_{HF}$ and $60_{CP}:40_{HF.}$ Higher DB value has been reported to better the ability of flour reconstitution in water (Olorode *et al*., 2022). Result from this study is lower than those reported by Olapade and Adegboye (2018) for blends of HQCF and cowpea.

Table 1: Effect of Substituting Cowpea Flour with High-Quality Cassava Flour on the Functional Properties of the Flour Blends

Sample	Functional Properties				
	BD (g/ml)	**WAC (%)**	**OAC (%)**	**SP (%)**	**DB (%)**
$100_{CP}:0_{HF}$	0.70 ± 0.03^{a}	253.5 ± 0.03^{a}	190.8 ± 4.1^{a}	5.81 ± 0.02^{a}	62.8 ± 1.2^{a}
$70_{CP}:30_{HF}$	0.69 ± 0.02^{a}	246.7 ± 0.01^{b}	185.2 ± 3.1^{c}	5.51 ± 0.02^{ab}	62.0 ± 2.2^{b}
$60_{CP}:40_{HF}$	0.68 ± 0.03^{a}	231.6 ± 0.01^{c}	181.7 ± 8.0^{e}	5.38 ± 0.02^{ab}	60.2 ± 1.3^{c}
$50_{CP}:50_{HF}$	0.67 ± 0.02^{a}	226.2 ± 0.03^{d}	182.6 ± 7.2^{d}	5.20 ± 0.00^{bc}	59.7 ± 3.2^{d}
$40_{CP}:60_{HF}$	0.62 ± 0.01^{b}	218.2 ± 0.03^{e}	188.5 ± 5.2^{b}	4.82 ± 0.24^{c}	58.1 ± 3.7^{e}

Values represent means and standard deviations of replicate determinations (n=3). Values with different superscripts on the same column are significantly different at p<0.05 using the Tukey's HSD Test

BD = Bulk Density, WAC = Water Absorption Capacity, OAC = Oil Absorption Capacity, Swelling power = SP, Dispersibility = DB

Pasting Properties

The pasting properties of flour pastes are parameters that can be used to predict their patterns before and after cooking. These properties are known to influence food quality and consumer acceptance. Table 2 indicates that peak, trough, breakdown, final viscosity, setback and pasting temperature of cowpea-HQCF blends differed significantly ($p<0.05$). The parameters increased significantly with increasing levels of substituting cowpea flour with HQCF. The pasting temperature did not follow a regular pattern but ranged from 79.4 ℃ to 84.8 ℃. Peak viscosity indicates the ability of starch in the flour to imbibe water and swell up before breakdown during gelatinisation (Irondi *et al*., 2019; Ogundipe *et al*., 2026). Peak viscosity increased with increasing substitution of cowpea flour with HQCF. It ranged from 1699 to 4386.5 RVU. Sample $100_{CP}:0_{HF}$ had the lowest, and $40_{CP}:60_{HF}$ had the highest peak viscosity. The increase in peak viscosity could be attributed to the increasing amount of HQCF, which has a higher amount of starch compared to cowpea. High peak viscosity could mean that stronger cohesive forces exist within granules than those with lower viscosity and could disintegrate easily. This suggests that stronger cohesive forces exist in the flour blends than the control (100% cowpea).

Trough ranged between 1585 and 2631.5 RVU. The highest was recorded in sample $40_{CP}:60_{HF}$ (2631.5 RVU) and the least $100_{CP}:0_{HF}$ (1585 RVU). Higher value of trough could mean that the paste has the ability to resist breakdown during cooling (Ogundipe *et al*., 2026). Meaning that, a starch with higher trough viscosity has more potential to resist breakdown than the starch with lower trough viscosity. Breakdown viscosity ranged between 114.5 and 1755 RVU among the samples. Highest value was recorded in sample 40:60 while the least value was observed in sample 100:0. Breakdown viscosity (BDV) can be defined simply as a measure of resistance of flour paste to heat and shear forces to attain stability, especially during cooking (Falade & Okafor, 2015). Lower BDV could indicate greater stability tendency because of the tendency of the paste against disintegration during cooking (Ocheme *et al*, 2018). The final viscosity ranged between 2524.5 and 3858.5 RVU and increase generally with higher proportion of HQCF in the blends.

Final viscosity indicates the ability of flour to form a gel after cooking-cooling operations. Our findings agree with the recent findings by Ogundipe *et al*. (2026) in their work on the influence of tigernut sprouting on properties of *kokoro* from maize-tigernut composite flour. The setback value of the blends ranged between 939.5 and 1329.5 RVU such that $70_{CP}:30_{HF}$ had the highest value and $40_{CP}:60_{HF}$ had the least value. There was a gradual decrease in the setback viscosity with increasing amount of HQCF. This decrease could indicate that higher amount of HQCF added resulted in lowering the setback value, therefore retrogradation is highly restricted. Pasting temperatures measure of the lowest temperature that is needed to cook the food due to gelatinisation (Ogundipe *et al*., 2026). The pasting temperatures ranged between 76.7 ℃ and 84.8 ℃.

Table 2: Effect of Substituting Cowpea Flour with High-Quality Cassava Flour on the Pasting Properties of the Flour Blends

Sample	Pasting Properties (RVU)					Pasting temperature(℃)
	Peak	**Trough**	**Breakdown**	**Final Viscosity**	**Setback**	
$100_{CP}:0_{HF}$	1699.0 ± 17.0^{d}	1585.0 ± 12.8^{c}	114.5 ± 14.1^{d}	2524.5 ± 13.2^{c}	939.5 ± 14.5^{c}	79.2 ± 0.7^{e}
$70_{CP}:30_{HF}$	3080.0 ± 11.6^{c}	2262.0 ± 11.3^{b}	818 ± 15.5^{c}	3592.0 ± 65.5^{b}	1329.5 ± 36.6^{a}	80.7 ± 0.0^{b}
$60_{CP}:40_{HF}$	3191.0 ± 14.2^{c}	2295.5 ± 36.6^{b}	895.5 ± 6.3^{c}	3607.5 ± 17.6^{b}	1312.0 ± 53.7^{a}	76.7 ± 0.1^{a}
$50_{CP}:50_{HF}$	3803.0 ± 13.8^{b}	2533.0 ± 14.1^{a}	1269 ± 13.3^{b}	3829.0 ± 16.8^{a}	1295.5 ± 19.1^{ab}	78.3 ± 0.3^{d}
$40_{CP}:60_{HF}$	4386.5 ± 18.1^{a}	2631.5 ± 16.3^{a}	1755 ± 74.5^{a}	3858.5 ± 28.9^{a}	1227.0 ± 22.2^{b}	84.8 ± 0.4^{a}
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Values are means and standard deviations of replicate determinations (n=3). Values with different superscripts on the same column are significantly different at $p<0.05$ using the Tukey's HSD Test

Colour Properties Flour Blends and Snacks

Table 3 presents values of colour properties of cowpea flour-HQCF composite flour and snacks. The colour of flour is a significant attribute to determine a flour and snack quality, and influences consumer's acceptance. The values of L^*, a^*, b^*, and ΔE^* for both the flour blends and snacks are significantly ($p<0.05$) different. For flour blends the values ranged respectively as: 63.40-63.93, 3.69-3.93, 4.99-5.72, and 12.09-12.64 for L^*, a^*, b^*, and ΔE^*, while for snack samples the values of L^*, a^*, b^*, and ΔE^* ranged respectively as: 59.61-61.46, 3.73-3.82, 6.16-6.63 and 18.46-21.31 for L^*, a^*, b^*, and ΔE^*. On the other hand, snack samples recorded a sharp decrease in the values of lightness ranged from 59.61 to 61.46. The increased amount of HQCF added to cowpea flour could have contributed to the increase in L^* value of flour blends. Also, the process of flour production could cause the gradual increase in a^* value due to Mallard browning reaction during the drying of the flour and frying of snack samples (Falade & Amadi, 2015). The colour intensity of the flour blends was significantly greater than that of the control sample, suggesting that that sample could be identified by the human eye.

Table 3: Effect of Substituting Cowpea Flour with High-Quality Cassava Flour on Colour Properties of Flour Blends and Snacks

Samples	Colour Properties							
	Flour				**Snacks**			
	L^*	a^*	b^*	ΔE^*	L^*	a^*	b^*	ΔE^*
$100_{CP}:0_{HF}$	63.67 ± 0.00^{c}	3.69 ± 0.00^{d}	5.72 ± 0.00^{a}	12.20 ± 0.00^{d}	60.48 ± 0.35^{b}	3.80 ± 0.35^{a}	6.16 ± 0.78^{d}	18.96 ± 0.44^{c}
$70_{CP}:30_{HF}$	63.77 ± 0.06^{b}	3.78 ± 0.02^{c}	5.35 ± 0.00^{b}	12.39 ± 0.06^{c}	60.25 ± 0.05^{c}	3.82 ± 0.05^{a}	6.50 ± 0.23^{c}	21.31 ± 0.26^{a}
$60_{CP}:40_{HF}$	63.83 ± 0.00^{b}	3.92 ± 0.00^{a}	5.17 ± 0.01^{c}	12.49 ± 0.00^{b}	59.94 ± 0.02^{d}	3.76 ± 0.02^{b}	6.58 ± 0.09^{b}	20.74 ± 0.07^{ab}
$50_{CP}:50_{HF}$	63.40 ± 0.00^{d}	3.86 ± 0.00^{b}	5.09 ± 0.00^{d}	12.09 ± 0.01^{e}	59.61 ± 0.11^{e}	3.73 ± 0.11^{c}	6.62 ± 0.29^{a}	20.85 ± 0.23^{ab}
$40_{CP}:60_{HF}$	63.93 ± 0.01^{a}	3.93 ± 0.00^{a}	4.99 ± 0.00^{e}	12.64 ± 0.00^{a}	61.46 ± 0.01^{a}	3.81 ± 0.01^{a}	6.63 ± 0.00^{a}	20.30 ± 0.01^{b}

Values with different superscripts on the same column show that the values are significantly different at $p<0.05$ Tukey's HSD Test

L^* = Lightness

a^* = Redness/Brownness

b^* = Yellowness
ΔE^* = Colour Intensity (Total Colour Change)

Sensory Evaluation of Akara Strips

Figure 1 presents effects of substituting cowpea flour with high quality cassava (HQCF) flour on the sensory attributes (appearance, colour, taste, crunchiness, aroma, and overall acceptability) rating of *akara* strips. *Akara* strips coded as $60_{CP}:40_{HF}$ had the highest significant ($p<0.05$) scores in the sensory attributes (appearance, colour, taste, crispiness, and aroma), and overall consumer acceptance. The appearance of $60_{CP}:40_{HF}$ was rated highest while the least rated was $50_{CP}:50_{HF}$, which is suggesting that panellists showed more preference for $60_{CP}:40_{HF}$. Panellists described the *akara* strips as having a paler, less intense colour than the traditional fresh *akara* made from the 100% cowpea paste, an observation that was confirmed by instrumental colour measurements with increase in b^* value of snacks. This finding agrees with the report of Adeola and Oyeleke (2020), suggesting that appearance significantly influences consumer perception, particularly in snack foods where colour and uniformity play key roles in consumer acceptance. The importance of colour in fried snack products cannot be over-emphasised because, consistency in colour could be linked directly to consumer perception of freshness and quality, and overall acceptance. Sample $60_{CP}:40_{HF}$ had the highest score of taste, suggesting that it was most flavourful among the snack samples. The frying method could be responsible for the unique appearance, taste, aroma, and mouth feel (Okon *et al*., 2022) of the snack. The mouth feel is known to be chewy within and crunchy-like outside, which give a brief satisfaction and acceptance by all classes of consumers (Odunlami *et al*., 2021). Sample $60_{CP}:40_{HF}$ had the highest rating in terms of crispiness among the other samples. The crispiness could be attributed to the reduction in oil up take or content of samples. This finding agrees with the report by Olusola and Ajibade (2022) their study on aroma and its influence on sensory acceptance in fried snacks. The authors stated that the formation of thick crust on strips was caused by HQCF, which retained the moisture and prevent excess oil up take during frying. Sample $60_{CP}:40_{HF}$ has the highest preference with overall acceptability score of 4.4 on a 5.0 hedonic scale (Figure 1). Therefore, cowpea-HQCF blends can be processed into *akara* strips with improvements in the physical and sensory quality, and consumer acceptance.

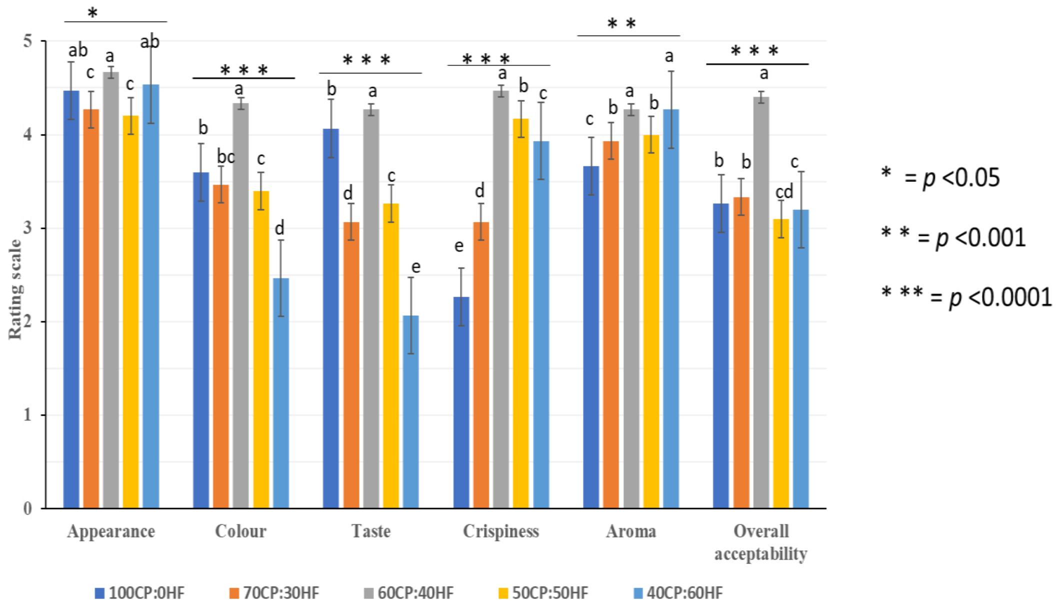

Figure 1: Effect of Substituting Cowpea with High Quality Cassava Flour on the Appearance, Colour, Taste, Crispiness, Aroma, and Overall Acceptability Rating of *akara* Strips. In Each Subgraph, Bars of Different Colour that do not Share the Same Letter Differed Significantly ($p < 0.05$)

CONCLUSION

This study has shown that *akara* strips production using composite flours of cowpea and cassava (HQCF) is possible, with a significant reduction in the oily nature and higher consumer acceptance of the product. Substitution of cowpea with HQCF has a significant effect on the functional and pasting properties of the flour blends. However, 40% of HQCF can be substituted into cowpea flour to produce akara strips without affecting their overall acceptability. Formation of thick crusts on the strips by HQCF and the high-water absorption of HQCF help to retain moisture and prevent oil absorption by products during frying. Snack produced from HQCF and cowpea flour shows improvements in the sensory quality and consumer acceptance. The snack has the potentials to address some food-related UN SDGs policies.

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