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Effect of Supplementing Cassava with Okara on Biscuit Quality

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Abstract

Okara is a nutritious by-product of soy milk industry; however it is discarded as industrial waste because it is perishable and other uses for it have not been fully identified. The feasibility of utilization of okara in food formulations was investigated. Five blends of composite flour were prepared by combining cassava flour with 10% to 50% of okara flour, respectively. The 100% cassava flour served as control. The functional and pasting properties of the flour blends as well as the chemical and sensory properties of biscuit samples were determined. Statistically significant ($p \leq 0.05$) difference in functional properties was observed between cassava flour supplemented with different levels of okara. The pasting properties showed that peak and final viscosities decreased with increase in level of okara flour in the blend. The biscuit samples had protein (4.7-11.9%), ash (1.63-2.17%), crude fibre (17.13-20.38%), fat (17.9- 23.4%), carbohydrate (34.9-53.0%) and energy (349.8-363.5 Kcal/g). Anti-nutritional components (oxalate, phytate and tannin) were significantly affected by inclusion of okara in the formulation. The sensorial characteristics of biscuits prepared from cassava and okara showed significant difference ($p \leq 0.05$) compared to the control. Cassava flour could be supplemented with okara flour up to 20% level in the production of biscuits with improved nutritional quality without affecting sensorial acceptability. The results from this study could be adopted by indigenous food industries that want to take the functional and nutritional advantage of okara flour to supplement starchy food ingredients.

Keywords: Cassava; Okara; Biscuit; Nutrient; Sensorial properties.

1. Introduction

Composite flour is a mixture of different flours from cereal, legume or root crops that is created to satisfy specific functional characteristics and nutrient composition [1]. Although such flours do not contain functional protein as in the case of wheat flour for bread/biscuit making, research has shown that baked products from the composite flours had desirable baking properties. Moreso, the increasing number of applications of composite flours in numerous bakery and pastry products has shown that such flours had improved nutritional, physicochemical and functional properties.

Cassava (*Manihot esculenta* Crantz) is a long tuberous root crop that belongs to the family of *Euphorbiaceae*. Sub-Saharan Africa is the most important cassava production region in the world and Nigeria the world's leading producer as indicated by Food and Agriculture Organisation Corporate Statistical Database FAOSTAT [2]. Cassava flour is made from cassava roots which are rich in carbohydrate, fibre, calories. It is mild and neutral in flavour unlike other gluten-free flours.

Soybean belongs to the family *Leguminosae a*nd sub-family *Papilionaceae*. It is a leguminous vegetable of the pea family that grows in the tropical, subtropical, and temperate climates. Nigeria is the largest producer of soybean in sub-Saharan Africa followed by South Africa as reported by International Institute of Tropical Agriculture IITA IITA [3]. Soybean seeds contain appreciable quantity of protein (about 40%) and approximately 20% fat. Soybean also provide adequate amount of carbohydrate, digestible fibres, minerals, vitamins etc [4]. In addition to its high food value, soybean is one of the least expensive sources of protein when compared to eggs, milk, beef and cowpea and ranks the highest among leguminous crops in terms of protein utilization and efficient ratio compared with other plant sources. For instance, soybean has a higher total digestible nutrient percentage of 91.99% compared to cowpea with 79.52% [4]. Seeds of soybeans have been used in Asia and other parts of the world for many centuries to prepare nutritious food products such as tofu, soy milk, soy sauce, miso, okara etc. Okara is a by-product from soy milk production; it is solid non-soluble fraction obtained from hydrothermal treatment of the crushed soybeans. Most of the by-product, however, is discarded as industrial waste because it is perishable and other uses for it have not been identified as reported by Ohno and Shoda [5].

It is imperative to note that besides the identified problems with okara, studies have shown that it is a nutrient-rich product containing about 25% protein, 20% fat and 33% dietary fibre on a dry basis [6]. Other components which are also present in okara include isoflavones, lignans, phytosterols, coumestans, saponins and phytates [7].

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Similarly, scientific evidence had indicated its potential for preventing diabetes [8] and [9]. Therefore, it could be useful as a functional ingredient with health-promoting attributes.

The use of composite flour from cassava and okara is expected to enhance the utilization of local crops as raw materials and improve the nutritive quality of food products. Most importantly, complete or partial substitution of wheat flour with flours from tropical crops such as cassava and underutilized soybean by-product in biscuit production could tremendously reduce importation of wheat flour. This study was carried out to determine the functional and pasting properties of the cassava/okara composite flours and their effects on biscuit quality.

2. Materials and Methods

2.1. Materials

Soybean variety (TGx 1835-10e) developed by International Institute of Tropical Agriculture (IITA) in collaboration with National Cereal Research Institute (NCRI) was used in the study. Other raw materials such as cassava tubers, Simans cooking margarine, food grade salt, Dangote granulated sugar, Fosters food flavouring and eggs were obtained from local market in Iwo, Osun state, Nigeria. The chemicals used for analysis were of analytical grade.

2.2. Preparation of Cassava Flour

Fresh cassava roots were washed to remove sand and other impurities. The washed cassava roots were then peeled, washed and grated. The resulting mash was dewatered using muslin cloth. The dewatered cake was then dried in hot air oven at 60^{o}C for 24 hr and ground into flour using attrition mill, passed through 0.5 mm sieve. The flour was filled into zip lock bags prior to analysis.

2.3. Preparation of Okara Flour

The okara flour was prepared by reported method of Qstermann-Porcel, *et al.* [10]. The soybean seeds were soaked in water for 8 hr at ambient temperature. The soaked seeds were ground in a blender with addition of water to enhance the grinding. The ground paste was then thermally treated at 90˚C for 20 min. The soybean slurry is separated from the ground paste using muslin cloth and the residue constitutes the wet okara. The wet okara is then dried in hot air oven at 60^{o}C for 24 hr and ground into flour using attrition mill, passed through 0.5 mm sieve and the flour was filled into zip lock bags prior to analysis.

2.4. Experimental Plan

Cassava flour was supplemented with okara flour at 0, 10, 20, 30, 40 and 50%. Table 1 shows the various ingredients in the preparation of biscuit samples.

2.5. Production of Biscuit

Biscuits were produced from the blends using reported method by Onabanjo, *et al.* [11]. Cassava flour was substituted with okara flour at 0% (T-0), 10% (T-1), 20% (T-2), 30% (T-3), 40% (T-4) and 50% (T-5). After baking the biscuits were allowed to cool to ambient temperature and packed in airtight glass containers for subsequent laboratory analyses. The biscuit samples prepared with 100% cassava flour served as control.

Table-1. Laboratory formulations of raw materials used in the preparation of biscuits (g)

Sample	Cassava flour	Okara flour	Margarine	Sugar	Baking Powder	Egg	Salt
T-0	300	0	50	30	0.05	90	0.5
T-1	270	30	50	30	0.05	90	0.5
T-2	240	60	50	30	0.05	90	0.5
T-3	210	90	50	30	0.05	90	0.5
T-4	180	120	50	30	0.05	90	0.5
T-5	150	150	50	30	0.05	90	0.5

2.6. Analyses

2.6.1. Determination of Functional Properties of Flour Blends

The bulk density of flour samples was determined by the gravimetric method reported by Appiah, *et al.* [12]. Water and oil absorption capacities were determined using the reported procedures of Sofi, *et al.* [13]. Additionally, the swelling power and starch solubility of the flour samples was determined using the method reported by Wani, *et al.* [14].

2.6.2. Determination of Pasting Properties of Flour Blends

The pasting behaviour of the flour samples was measured using Rapid Visco Analyzer (Model: RVA-4, Newport Scientific Pty. Ltd., Sydney, Australia, 1995) and Thermocline for Windows software was used to evaluate the pasting properties.

2.6.3. Determination of Proximate Composition of Biscuit Samples

Proximate composition of biscuit samples was determined using the standard methods of the Association of Official Analytical Chemists AOAC [15]. The caloric value was estimated (kCal/g) by multiplying the percentage crude protein, crude lipid and carbohydrate by the recommended factors of 2.44, 8.37 and 3.57 respectively and then taking the sum as reported by Ekanayake, *et al.* [16].

2.6.4. Determination of Anti Nutrient Composition of Biscuit Samples

The titration method was used to determine the oxalate and phytate contents of biscuit samples [17] Tannin content was determined using reported method of Mugaboa, *et al.* [18].

2.7. Sensorial Characteristics of Biscuit Samples

Sensory evaluation of biscuit samples from various blends was conducted using untrained 25-member panel. The panellists were asked to evaluate each sample based on the following parameters of colour, taste, flavour, texture, crunchiness, sweetness and overall quality using a 5-point Hedonic scale (5- like extremely and 1- dislike extremely).

2.8. Statistical Analysis

Statistical analyses were conducted using Statistical Package for the Social Sciences version 17.0software (SPSS Inc., Chicago, IL, USA). The results obtained from the present study are represented as the mean values of three individual replicates ± the standard deviation. Significant differences between the mean values were determined using Duncan's multiple range tests at a significance level of $p \leq 0.05$.

3. Results and Discussion

3.1. Functional Properties of Flour Blends

The functional properties determine the application and use of food material for various food products. The results of functional properties of cassava and okara flour blends are as presented in Table 2. The bulk density of the flour blends ranged between 0.62 and 0.69g/mL. The bulk density decreased as the level of inclusion of okara in the blend increases. However, the bulk densities of the flour blends were very low and this indicates that the flour samples would be an advantage in preparation of complementary foods.

The water absorption capacities (WAC) ranged between 3.51to 3.94g/mL. Incorporation of okara increased the water absorption capacities of the flours. The observed differences in WAC of the starches might be due to various factors such as particle size, amylose/amylopectin ratio and molecular structure [19]. Water absorption capacity is an important processing parameter which greatly affects the viscosity. Increase in water absorption capacity with increase in the level of okara substitution suggests that the blends could be used in food systems such as baking that require higher volume of water to improve mechanical characteristics of the dough.

Oil absorption capacity of the flour blends ranged between 2.94 to3.09 g/mL with significant difference ($p \leq 0.05$) among the samples. The oil absorption capacity decreased as the level of okara in the blend increases. The decrease indicated the diluting effect of okara on oil absorption capacity of cassava flour. It has been reported that variations in the content of non-polar side chains which might bind the hydrocarbon side chains of oil, explains differences in the oil binding capacity of flours [20].

The swelling capacity for the control was 6.92% which was higher than that of flour samples containing different levels of okara flour. This implies that the 100% cassava flour with the highest swelling power will produce a thick viscous gruel, compared to other flour samples. The same trend was observed for starch solubility and their values were on the decrease as more okara was incorporated into cassava flour. Sample T-0 (100% cassava flour) was more viscous than blends containing different levels of okara flour.

In general, okara had been reported to have significantly higher water absorption and swelling capacity, but lower oil absorption capacity and bulk density as compared to soybean [21] which corroborates with the results observed in this study. In essence, the differences among the flour samples in their swelling and solubility patterns influence the functional properties that in turn determine their suitability in product development.

Table-2. Functional properties of flour blends

Sample	Swelling capacity (%)	Starch solubility (%)	Bulk density(g/mL)	Water absorption capacity (g/mL)	Oil absorption capacity(g/mL)
T-0	$6.92^c \pm 0.04$	$6.38^c \pm 0.50$	$0.69^c \pm 0.02$	$3.51^a \pm 0.07$	$3.09^b \pm 0.05$
T-1	$6.38^c \pm 0.50$	$6.29^c \pm 0.38$	$0.67^b \pm 0.00$	$3.67^b \pm 0.01$	$3.05^b \pm 0.01$
T-2	$5.62^b \pm 0.02$	$5.32^b \pm 0.20$	$0.66^b \pm 0.01$	$3.69^b \pm 0.02$	$3.05^b \pm 0.04$
T-3	$5.38^b \pm 0.01$	$5.38^b \pm 1.00$	$0.63^a \pm 0.01$	$3.54^a \pm 0.01$	$2.94^a \pm 0.02$
T-4	$4.91^a \pm 0.02$	$4.91^a \pm 0.06$	$0.63^a \pm 0.01$	$3.92^c \pm 0.00$	$2.98^a \pm 0.02$
T-5	$4.88^a \pm 0.00$	$4.88^a \pm 0.00$	$0.62^a \pm 0.00$	$3.94^c \pm 0.02$	$2.94^a \pm 0.00$

Mean± standard deviation of triplicate determination

Key a-c: Means with the same superscripts within each row are not significantly different ($p \geq 0.05$)

3.2. Pasting Properties of Flour Blends

There were significant ($p \leq 0.05$) differences in the pasting profile of the flour samples (Table 3). The RVA results indicated that the composite blends had distinct pasting properties compared to the control sample. The peak viscosity, which is the ability of starch to swell freely before physical breakdown, ranged from 104.00 and 345.91 RVU. Increase in the level of supplementation of cassava flour with okara flour significantly reduced the peak viscosity. The trough viscosity also decreased with increase in the level of okara in the blends. The value was highest in the control sample (T-1) and lowest in T-5 (50% cassava, 50% okara). Trough is the minimum viscosity value and it measures the ability of the paste to withstand breakdown during cooling.

The break down viscosities of the composite flour ranged from 42.95 RVU in sample (T-5) to 211.26 RVU in sample (T-0). The breakdown viscosity significantly reduced with increase in the level of okara in the blends. It is an indication of breakdown or of the starch gel during cooking. The breakdown is regarded as a measure of paste stability. The higher the breakdown in viscosity, the lower the ability of the samples to withstand heating and shear stress during cooking as reported by Adebowale and Lawal [20]. The final viscosity ranged from 76.28 RVU in sample (T-5) to 185.65 RVU in sample (T-0). The depressive effect of okara flour on the breakdown viscosity of the cassava dough increased with increase in level of supplementation. The setback viscosity was highest in 100% cassava flour but declined as the level of okara increase in the blends. In terms of peak time, 100% cassava flour had the highest value of 4.09 min while sample (T-5) had the least value. The pasting temperature of the flour samples ranged from 74.38-77.12°C. The pasting temperature increased as the level of okara in the blend increased. The pasting temperature is a measure of the minimum temperature required to cook a given food sample. In general, supplementation of cassava flour with okara flour reduced the peak time slightly but severely depressed the peak, trough, breakdown, setback and final viscosities.

Table-3. Pasting properties of flour blends

Sample	Peak viscosity (RVU)	Trough viscosity (RVU)	Break down viscosity (RVU)	Final viscosity (RVU)	Setback viscosity (RVU)	Peak time (min)	Pasting temp.(°C)
T-0	$345.91^{f}\pm0.58$	$134.83^{f}\pm4.62$	$211.26^{e}\pm1.17$	$185.65^{e}\pm7.12$	$50.72^{e}\pm2.51$	$4.09^{d}\pm0.96$	$74.38^{a}\pm0.03$
T-1	$265.20^{e}\pm0.82$	$109.86^{e}\pm0.62$	$158.00^{d}\pm1.15$	$153.22^{d}\pm3.75$	$43.36^{d}\pm4.28$	$4.13^{d}\pm0.89$	$75.32^{b}\pm046$
T-2	$192.33^{d}\pm1.73$	$90.09^{d}\pm2.02$	$102.25^{c}\pm0.98$	$119.81^{c}\pm0.29$	$29.72^{b}\pm1.06$	$4.02^{c}\pm0.76$	$75.50^{b}\pm0.35$
T-3	$184.83^{c}\pm4.19$	$84.92^{c}\pm0.00$	$98.91^{c}\pm0.86$	$107.84^{b}\pm3.32$	$22.42^{b}\pm6.78$	$3.95^{b}\pm1.05$	$76.13^{b}\pm0.49$
T-4	$148.55^{b}\pm0.82$	$74.55^{b}\pm0.05$	$72.95^{b}\pm1.18$	$100.44^{b}\pm1.69$	$23.25^{bc}\pm2.89$	$3.43^{b}\pm1.14$	$76.62^{b}\pm0.90$
T-5	$104.14^{a}\pm0.10$	$61.16^{a}\pm0.08$	$42.95^{a}\pm1.28$	$76.28^{a}\pm0.05$	$15.08^{a}\pm1.01$	$3.86^{a}\pm0.89$	$77.12^{c}\pm0.20$

Mean± standard deviation of triplicate determination

Key a-f: Means with the same superscripts within each row are not significantly different ($p \geq 0.05$)

3.3. Proximate Composition of Biscuit Samples

The result of the proximate analysis of biscuit samples are shown in Table 4. Moisture contents of biscuit samples were within the range of 4.98 to 6.23%. The highest moisture content was determined in the biscuit prepared from 90% cassava and 10% okara; while the lowest moisture content was observed in the biscuit prepared from 50% cassava and 50% okara. The moisture content of biscuits decreased with the increase in okara flours. This is attributed to the fact that soy flour can absorb and holds higher amount of moisture in baking process [22].

The ash content of the biscuit samples varied between 1.6 to 2.2%. The highest ash content was observed in cookies made from 50% cassava flour and 50% okara whereas the lowest results were recorded for biscuit prepared from 100% cassava flour. The result of this study indicated that the ash content of the blends was increased steadily with increasing okara flour. This implies that okara flour is a good source of mineral elements.

Protein content of prepared biscuit samples was ranged from 4.7% to 11.9%. The maximum protein content was observed in biscuits prepared from blend containing 50% cassava flour and 50% okara, while lowest protein content was reported in cookies made from 100% cassava flour. Okara is a good source of protein. Moreso, protein found in okara is of extremely high quality and the amino acid profile, determined by the Protein Efficiency Ratio (PER), is slightly superior to that of the soymilk itself, according to reports by Travaglini, *et al.* [23].

The fibre content of cookies samples prepared from composite flours varied between 17.13-20.38%. Biscuits prepared from blends of 50% cassava and 50% okara was showed the highest value. In contrast, biscuit sample prepared from 100% cassava flour had the lowest fibre content. Earlier report had indicated that the total dietary fibre content of okara was more than double the dietary fibre of soybean [21]. The result of the present study was in agreement with Rinaldi, *et al.* [24] who reported that combining wheat flour with okara and soy, respectively improved the dietary fibre contents.

Significant difference ($p \leq 0.05$) was observed in the fat content of the biscuits. The fat content of all biscuit samples varied between 17.9-23.4%. The results indicated significant difference between cassava and okara. The highest value of fat content was determined in biscuits prepared from 50% cassava flour and 50% okara, whereas the lowest value of fat content recorded in biscuits prepared from 100% cassava. This might be because of relatively higher quantity of fat in okara. Okara is a dietary supplement which might prevent diabetes, obesity and hyperlipidemia supported by the fact that the plasma levels of triglycerides as well as total cholesterol in Syrian hamsters were significantly decreased 20% by feeding okara supplemented diets that helped in faecal output [25].

Carbohydrate content of biscuit samples prepared from cassava and okara were highly significant different. Total carbohydrate content of cookies samples ranged from 37.2% to 53.0%. The highest carbohydrate content was observed in cookies sample prepared from 100% cassava flour, whereas the carbohydrate content of biscuit with

50% cassava flour and 50% okara was the lowest. The results of this study showed that okara is not a good source of carbohydrate when compared to cassava.

The gross energy of biscuits samples were varied from 357.46 to 450.37 kCal/100g. The highest gross energy value content was observed in biscuits sample prepared from a formulation of 50% cassava and 50% okara while the lowest gross energy value was observed in biscuits sample prepared from a formulation of 100% cassava flour**.** The high content of carbohydrate in cassava and fat in okara was expected to increase the energy density of the products developed from such food materials. This result was in agreement with the other findings which reported that blending of soy flour in biscuit preparation with wheat showed increment of total energy [26].

Table-4. Proximate composition of biscuit samples

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	Carbohydrate (%)	Energy (kCal/100g
T-0	$5.63^{f}\pm0.03$	$4.72^{a}\pm0.02$	$17.87^{a}\pm0.11$	$1.63^{a}\pm0.07$	$17.13^{a}\pm0.01$	$53.02^{f}\pm0.20$	$350.37^{a}\pm0.97$
T-1	$6.23^{e}\pm0.03$	$6.55^{b}\pm0.02$	$20.30^{b}\pm0.56$	$1.83^{b}\pm0.01$	$18.02^{b}\pm0.03$	$47.07^{e}\pm0.11$	$353.93^{bc}\pm1.01$
T-2	$5.52^{d}\pm0.02$	$8.22^{c}\pm0.02$	$20.86^{cd}\pm0.12$	$1.81^{b}\pm0.02$	$19.38^{cd}\pm0.07$	$44.32^{d}\pm0.21$	$352.88^{b}\pm0.82$
T-3	$5.42^{cd}\pm0.02$	$9.64^{d}\pm0.03$	$21.92^{d}\pm0.06$	$2.02^{c}\pm0.01$	$19.44^{d}\pm0.03$	$41.56^{c}\pm0.13$	$355.36^{c}\pm1.00$
T-4	$5.02^{b}\pm0.03$	$11.13^{e}\pm0.01$	$22.29^{e}\pm0.08$	$2.08^{c}\pm0.00$	$20.08^{e}\pm0.01$	$39.40^{b}\pm0.14$	$354.39^{c}\pm0.86$
T-5	$4.98^{a}\pm0.03$	$11.89^{f}\pm0.01$	$23.37^{f}\pm0.07$	$2.17^{cd}\pm0.02$	$20.38^{f}\pm0.01$	$37.21^{a}\pm0.13$	$357.46^{cd}\pm1.11$

Mean± standard deviation of triplicate determination
Key a-f: Means with the same superscripts within each row are not significantly different ($p\geq0.05$)

3.4. Anti- Nutritional Composition of Biscuit Samples

From Table 5, significant difference ($p\leq0.05$) exists between all the samples in terms of their anti-nutritional components. Phytate content of the biscuits ranged from 0.27-0.44 mg/100g. The highest concentration of phytate was recorded in the biscuits prepared solely with cassava flour. Phytate content was significantly influenced by the proportion of cassava and okara in the biscuit samples. In present study, phytic aid content decreased by the more supplementation of soy okara. Phytate content had been reported to be high in unfermented cassava flour (129.2-3339.5mg/100g) depending on the variety [27]. Moreso, okara flour contains significantly lower concentration of phytic acid than soybean as reported by Ambawat and Khetarpaul [21]. Results revealed that sample (T-0) had significantly ($p\leq0.05$) lowest mean value for oxalate**.** This might be due to the high concentration of oxalate in okara than cassava flour.

Tannin content of biscuits ranged from 0.36-0.62% and was significantly affected by the level of okara in the biscuit formulation. The highest concentration of tannin was noted in the sample (T-5) containing 50% okara while the lowest value was observed in the control sample. This point to the fact that the concentration of tannin in the biscuit sample increases with the quantity of okara in the formulation. Earlier studies indicated that the tannin content of prepared food is increased by the increasing the level of soy flour [28]. The increase noted in the concentration of tannin in biscuit samples as the level of okara in the formulation increases could have negative effect on nutrients bioavailability and absorption. Hence, tannin is one of the factors to be considered during optimizing the proportion of okara supplemented with other flours in food formulation. Although tannin has detrimental effect, it has several benefits in processed food and human health. The antimicrobial property of tannic acid can be used in food processing to increase the shelf-life of certain foods [29].

However, with regards to these anti nutrients, the cassava- okara products had tolerable concentrations considered safe for maximum nutritional benefit. The result pointed out that the level of oxalate concentration in the products were low as the dietary intake comprises average of 50 mg daily with wide variations depending on the type of food as reported by European Agency for the Evaluation of Medicinal Products [30]. Similarly, the phytate concentrations were below the level acceptable in food which is 5 g/100g [31]. Furthermore, all the biscuit samples had their tannin level lower than the detrimental dose of 0.7–0.9% as reported by Obueh and Kolawole [32]

Table-5. Anti-nutritional composition of biscuit samples

Sample	Phytate (mg/100g)	Oxalate (mg/100g)	Tannin (%)
T-0	$0.44^{bc}\pm0.03$	$35.87^{a}\pm0.75$	$0.36^{a}\pm0.01$
T-1	$0.42^{bc}\pm0.64$	$40.70^{b}\pm3.87$	$0.42^{b}\pm0.00$
T-2	$0.38^{b}\pm0.01$	$44.44^{c}\pm1.66$	$0.47^{b}\pm0.01$
T-3	$0.35^{ab}\pm0.01$	$48.40^{d}\pm1.01$	$0.53^{bc}\pm0.01$
T-4	$0.32^{ab}\pm0.03$	$56.10^{e}\pm0.98$	$0.58^{bc}\pm0.01$
T-5	$0.27^{a}\pm0.02$	$58.89^{ef}\pm0.71$	$0.62^{c}\pm0.01$

Mean± standard deviation of triplicate determination
Key a-f: Means with the same superscripts within each row are not significantly different ($p\geq0.05$)

3.5. Sensorial Characteristics of Biscuit Samples

Table 6 shows the mean sensory scores of biscuit samples made from the flour blends of cassava and okara. There were significant differences ($p\leq0.05$) in all the sensory attributes evaluated. The mean scores show that sample (T-5) was rated lowest in terms of colour compared to other biscuit samples. Supplementation of cassava with okara caused a slight colour change in the prepared biscuit samples though not detected up to 40% substitution by the panellists. However, a stronger noticeable effect was observed in samples containing 50% okara flour. Similarly, in terms of taste, sample (T-5) was rated significantly lower followed by sample (T-1) compared to other biscuit samples. For crunchiness, Samples (T-0) and (T-2) were rated significantly ($p\leq0.05$) higher than other samples.

Sweetness of the biscuit samples ranged from 2.28-3.84 with biscuit sample (T-5) having the highest score for sweetness while sample (T-0) had the least. Multiple factors are linked to consumer perceptions of sweetness. Sweetness is mainly due to the sugar content, but it also depends on the fat content and moisture. Reduced sugar was found to have no effect on fat perception, whereas fat increase sometimes provoked increase of sweetness response by the participants in sensorial evaluation [33]. Aroma is another attribute that influences the acceptance of baked products. The aroma of the biscuit samples ranged from 3.00-3.84% with sample (T-2) having the highest value while sample (T-5) had the lowest value. It is imperative to indicate that inclusion of okara into the formulation did not impart noticeable beany flavour to the dough. Moreso, biscuit samples containing okara flour have clean flavour not masked by any trace of beany flavour. Sharma and Chauhan [34], also reported that bakery products supplemented with high protein had no effect on odour and flavour properties. Qualities of the biscuit such as aroma, colour, crunchiness, sweetness and taste influence the overall acceptability. The score ranged from 2.28-3.64 with sample (T-2) rated highest, while sample (T-5) had the lowest value. Thus, the sensory evaluation depicts that highest quantity of flour that can be incorporated to cassava flour to develop acceptable biscuit was 20%. This implies that sample (T-2) was most preferred regarding all the sensory attributes.

Table-6. Sensory characteristics of biscuit samples

Sample	Colour	Taste	Crunchiness	Sweetness	Aroma	Overall acceptability
T-0	4.24^{b}±0.93	3.64^{c}±0.95	3.88^{c}±1.17	2.28^{a}±0.98	3.46^{b}±1.08	3.60^{bc}±0.96
T-1	4.28^{b}±0.84	2.88^{b}±1.24	3.64^{bc}±1.15	2.92^{b}±0.95	3.32^{ab}±1.18	3.28^{bc}±0.89
T-2	4.04^{b}±0.68	3.48^{c}±1.08	3.92^{c}±0.98	2.92^{b}±0.10	3.84^{b}±0.80	3.64^{c}±0.76
T-3	3.68^{b}±1.18	3.04^{c}±0.94	3.64^{bc}±0.86	3.72^{c}±0.84	3.48^{ab}±1.05	3.12^{bc}±1.05
T-4	3.84^{b}±1.03	3.80^{c}±1.15	3.16^{ab}±1.18	3.00^{b}±1.08	3.64^{b}±0.76	3.04^{b}±1.14
T-5	3.28^{a}±1.14	2.26^{a}±0.99	2.12^{a}±1.28	3.84^{c} ±0.94	3.00^{a}±0.96	2.28^{a}±0.89

Mean± standard deviation of triplicate determination
Key a-e: Means with the same superscripts within each row are not significantly different ($p \geq 0.05$).

4. Conclusion

This work showed the peculiar characteristics (functional and pasting) of cassava/ okara composite flour. Flour supplementation of cassava with okara up to levels of 20% produced blends which can be used for biscuit products with improved nutritional and sensorial properties. Overall, the results from this study could be adopted by indigenous food industries that want to take the functional and nutritional advantage of okara flour to supplement starchy food ingredients.

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