Physical, Proximate Composition and Sensory Properties of Tigernut-Cowpea Flour Pancakes

Obinna-Echem PC[*], **Wachukwu-Chikaodi HI, China MAH**

Department of Food Science and Technology, Rivers State University, Nkpolu-Orowurokwu, Port Harcourt, Rivers State, Nigeria
*Corresponding author: patience.obinna-echem@ust.edu.ng

Abstract This study evaluated the proximate composition and sensory properties of pancakes produced from tigernut-cowpea flour blends. The samples were coded TCPA, TCPB, TCPC, TCPD, TCPE and TCPF for pancakes produced from 5, 10, 15, 20, 30, 40 and 50% cowpea substitutions respectively. Pancake samples coded WP, TP and CP were also respectively, produced from 100 % of wheat, tigernut and cowpea as controls. Standard methods were used for all used for the analysis. The diameter and thickness of the pancakes varied significantly ($P \leq 0.05$) from 114.45 - 145.05 mm and 2.00 - 3.90 mm respectively. Increase in thickness resulted in decrease in spread ration of the samples which ranged from 37.22 - 66.43 %. The proximate composition of the pancakes varied from 6.74 - 35.23, 4.68 - 10.55, 25.11 - 29.68, 1.08 - 2.05, 1.50 - 7.74 and 25.58 - 53.83 % for moisture, protein, fat, ash, crude fibre and carbohydrate respectively. The protein content increased significantly ($P \leq 0.05$) with increase in cowpea substitution. The energy value ranged from 370.51 - 484.69 Kcal/g, and can meet about 43 - 52 % and 34 - 41 % of the energy requirement of an adult male and female involved in moderate activity. Mean scores of the sensory attributes ranged from 5.35 - 6.30, 4.55 - 7.00, 4.85 - 7.00, 5.50 - 6.10, 5.15 -7.05, 6.00 - 6.55 and 5.60 - 6.55 respectively for aroma, appearance, colour, flavor, crunchiness, sweetness and overall acceptability. The pancakes were rich in nutrients and energy and were acceptable to the assessors regardless of the degree of substitution. Thus, offering a value addition to the less utilized root and legume.

Keywords: *cowpea, tigernut, flour, pancake, proximate composition and sensory properties*

1. Introduction

Tiger nut (*Cyperus esculentus*) is a weed plant (yellow nut sedge) of tropical and Mediterranean regions [1]. It is a tuber crop that belongs to the family *Cyperaceae* and produces sweet almond-like tubers. The tuber is consumed widely in Nigeria and other parts of west Africa, East Africa, parts of Europe particularly Spain as well as in the Arabian Peninsula [2]. In Nigeria, tigernut is known as *Aya* in the North, *Ofio* in the West and *Akiausa* in East and South-East. Three varieties (Black, brown and yellow) are cultivated in the country. The yellow and brown varieties are readily available either in fresh, semi-dried or dried forms in the market and are mostly consumed uncooked [3]. The yellow variety is of a fleshier body, bigger size and attractive colour hence it is preferred to other varieties [4]. Tiger nut is highly appreciated for its nutritive and health benefits. It has been reported to aid in reducing the risk of cardiovascular diseases, colon cancer, thrombosis and activates blood circulation [1], [5,6] Tiger nut is rich in protein of high biological value, high in its content of fiber, and sugars and also a good source of minerals and vitamins [1], [7,8]. Tigernut flour has a sweet taste and researches are on its use as composite flour in bakery products. Though the awareness of the importance of tigernut is very low, its potential for designing functional food products, application in pharmaceutical formulations, agricultural production and biofuel was reported by Adenowo and Kazeem [9].

Cowpea (Vigna unguiculata) is a dicotyledonous plant belonging to the family *Fabaceae* and sub-family, *Fabiodeae*. It is an indigenous edible leguminous crop to Africa and is widely distributed in regions of tropical and temperate climates [10]. Cowpea is a popular grain legume often called beans in Nigeria and other West African countries. It is nutritious and provides protein, vitamins, and minerals. It's protein content, makes it extremely valuable where many people can't afford proteins from animal sources such as meat and fish [11]. In Nigeria, cowpea is the important indigenous legume largely grown in most northern areas of River Niger and Benue [12]. Its flour is a useful ingredient in the making of beans cake (*akara*) and beans pudding (*moimoi*) [13]. The flour is predominantly composed of starch (35.0-52.0%) which has unique properties (i.e. low gelatinization temperature, freeze thaw stability) and serves as an important energy source for human nutrition [14,15]. Cowpea is also rich in protein and contains micro

-nutrients such as minerals: iron and zinc which are necessary for health living [16] and vitamins: thamin, riboflavin, niacin in comparable amounts with meat and fish [17]. Legume flours has been used by several authors as ingredients in various food products such as breads, biscuits, pasta, tortillas, *akara*, *moimoi* and doughnuts [11].

Pancakes are among the popularly consumed bakery products all over the world. They are starch-based products prepared by pouring batter onto a hot solid surface and cooking until solid [18]. Conventionally, the batter is a blend from wheat flour and other basic ingredients such as sugar, salt, baking powder, water, egg and milk etc. [19]. Pancake is mostly flat, thin and round in shape though the shape and structure may vary worldwide. Consumer awareness and demand for gluten-free, nutritive and functional products has led to the use of composite flour in the preparation of various food products. The replacement of wheat flour with tiger nut and cowpea flour will not only improve on the improve the nutritive value and functionality of pancake but will aid in overcoming the problems of high cost of wheat flour importation as well as value addition to these lesser utilized tuber and legume. Hence this study was aimed at determination of the physico-chemical properties of tiger nut-cowpea flour blends, proximate composition and sensory properties of the tiger nut-cowpea pancakes.

2. Materials and Methods

2.1. Tigernut and Cowpea Samples

The cowpea and yellow variety of fresh tigernut used in this study were purchased from Mile III market in Port Harcourt Rivers State, Nigeria.

2.2. Preparation of Tigernut Flour

According to the method by Adejuyitan, [8], the fresh tigernuts were sorted to remove organic matters and damaged tubers, washed in water and oven dried at 60°C for 24 h in an air oven (Gallenkamp, UK). The dried tubers were milled with an attrition mill and sieved through a net with mesh size of 75 µm to obtain a fine flour. The flour was packaged in low density polyethylene bags, sealed and store in refrigerators till required for analysis.

2.3. Preparation of Cowpea Flour

Cowpea flour was prepared according to the method of Madode *et al.,* [20]. Briefly, the cowpea seeds were sorted and cleaned to remove extraneous matter (stones, chaff, broken seeds and insect), soaked in water and dehulled. The dehulled beans were oven dried at 60°C for 24 h in an air oven (Gallenkamp, UK) and then milled with an attrition mill. The milled samples were sieved through a net with mesh size of 75 µm to obtain a fine flour that were packaged in low density polyethylene bags, sealed and stored in refrigerators till required for analysis.

2.4. Pancake Preparation

The flour blends used in the production of the tigernut - cowpea pancakes are shown in Table 1. The pancake formula was adopted from the recipe of shih *et al.,* [21] with some modification. The slurry was made the flour blends as shown in Table 1 and a mixture of ingredients: sugar (19 g), salt (2 g), baking powder (4 g), instant milk powder (10 g) egg beaters (39 g) and water (110 g). The dry ingredients where thoroughly mixed before the addition of the liquid ingredients. About 25 ml of the slurry was fried at a time in a preheated frying pan sprayed with vegetable oil. The first side was cooked for about 3 min until it turned brown with bubbles on the top and then the second side cooked until it turned brown.

2.5. Determination of the Physical Properties of Tigernut-cowpea Flour Pancakes

The method described by Giami and Barber, [22] was used in the determination of the spread ration of pancakes produced from tigernut-cowpea flour blends. The diameter and thickness of the tigernut-cowpea pancakes were measured and the Spread Ratio calculated by dividing the diameter of the pancakes by the thickness.

2.6. Proximate Analysis of Tigernut-Cowpea Flour Pancakes

The proximate analysis was carried out using standard analytical methods AOAC, [23]. Moisture was determined gravimetrically after drying to a constant weight in an air oven for moisture. Determination of protein was by Kjeldahl method. After distillation and titration, the nitrogen was corrected using a factor of 5.7. Fat was determined by soxhlet extraction method with ethyl ether. Ash was determined gravimetrically after incarnation a murffle furnace (Sanyo Gallenkamp, Weiss Technik, West Midlands, UK) at 500°C for 24 h. Chemical solubilization and gravimetric method was used to determine the crude fibre content. Carbohydrate was obtained by difference {100 - (Crude protein + crude fibre + ash + fat)} and Energy values were calculated using Atwater factor of 4 Kcal/g for protein and carbohydrate and 9 Kcal/g for fat.

Table 1. Flour blends used in the production of tiger nut - cowpea pancakes

Flour	Blend codes									
	WF*	TF	CF	TCFA	TCFB	TCFC	TCFD	TCFE	TCFF	TCFG
Tigernut	0	100	0	95	90	85	80	70	50	60
Cowpea	0	0	100	5	10	15	20	30	50	40

* Sample WF is 100% wheat flour.

2.7. Sensory Analysis of Tigernut-cowpea Flour Pancakes

The method by Iwe [24] was adopted in the evaluation of the sensory properties of the pancakes. A panel of 20 panelists consisting of staff and students chosen from the university community were used for evaluation of the sensory attributes of the tigernut-cowpea pancakes. The pancake samples were assessed based on the following attributes: aroma, appearance, colour, flavor, texture, sweetness and overall acceptability. Assessors rating were based on a 9-point hedonic scale with the degree of likeness express as: 1 - dislike extremely, 2 - dislike very much, 3 - dislike moderately, 4 - dislike slightly, 5 - neither like nor dislike, 6 - like slightly, 7 - like moderately, 8 - like very much and 9 - like extremely.

2.8. Statistical Analysis

Minitab (Release 18.0) Statistical Software (Minitab Ltd., Coventry, UK) was used for the analysis of the data obtained. Statistical differences were obtained using analysis of variance (ANOVA) under the general linear model and Fisher pairwise comparison at 95% confidence level. Statistical differences among the sensory attributes was established using the non-parametric Friedman test.

3. Results and Discussion

3.1. Physical Properties of Tigernut-cowpea Flour Pancakes

The diameter, thickness and spread ratio of the pancakes produced from different blends of tigernut and cowpea flour are shown in Table 2.

Table 2. Physical properties of tigernut-cowpea flour pancakes

Sample	Diameter	Thickness	Spread ratio
WP	124.30 ± 0.10^e	2.10 ± 0.00^b	59.19 ± 0.47^{cd}
TP	145.05 ± 0.08^a	3.90 ± 0.01^a	37.22 ± 1.55^e
CP	135.60 ± 0.08^{bc}	2.25 ± 0.02^b	60.55 ± 6.09^{bcd}
TCPA	130.00 ± 0.00^{cde}	2.15 ± 0.01^b	60.50 ± 1.99^{bcd}
TCPB	139.50 ± 0.07^{ab}	2.10 ± 0.00^b	66.43 ± 0.34^a
TCPC	129.90 ± 0.01^{cde}	2.00 ± 0.00^b	64.95 ± 0.07^{ab}
TCPD	132.90 ± 0.18^{bcd}	2.05 ± 0.01^b	64.85 ± 1.34^{ab}
TCPE	126.45 ± 0.79^{de}	2.05 ± 0.02^b	61.82 ± 2.57^{abc}
TCPF	114.45 ± 0.63^f	2.05 ± 0.01^b	55.81 ± 1.15^d
TCPG	137.65 ± 0.30^{ab}	2.15 ± 0.01^b	64.04 ± 0.69^{abc}

Means with the same superscript along the same column are not significantly ($P\geq0.05$) different. N = 2 ± SD.
Key: WP = 100% Wheat flour pancake;
TP = 100% Tigernut flour pancake
CP = 100 % Cowpea flour pancake;
TCPA = 95 % Tigernut: 5 % Cowpea flour pancake
TCPB = 90 % Tigernut: 10 % Cowpea flour pancake
TCPC = 85 % Tigernut: 15 % Cowpea flour pancake
TCPD = 80 % Tigernut: 20 % Cowpea flour pancake
TCPE = 70 % Tiger nut: 30 % Cowpea flour pancake
TCPF = 60 % Tigernut: 40 % Cowpea flour pancake
TCPG =5 0 % Tigernut: 50 % Cowpea flour pancake

The diameter of the pancakes varied from 114.45 - 145.05 mm for sample TCPF (40 % cowpea substitution) and sample TP (100 % tigernut flour pancake) respectively. The thickness of the pancakes ranged from 2.00 - 3.90 mm for sample TCPD (20 % cowpea substitution) and sample TP (100 % tigernut flour pancake) respectively. The spread ratio varied significantly ($P\leq0.05$) from 37.22 - 66.43 %. Pancakes from 100 % tigernut flour (TP) had significantly ($P\leq0.05$) the least spread ratio while sample TCPB (pancake from 10 % cowpea substitution) had the highest. The spread ratio is a function of the diameter and the thickness, hence pancake from 100 % tigernut with significantly ($P\leq0.05$) the highest diameter and thickness had the highest spread ratio. The diameter and thickness of the tigernut-cowpea pancakes were lower than the report by Messaoudi and Fahloul [18] for pancake supplemented with freeze dried date pomace powder, while the spread ratio of the tigernut-cowpea pancakes were higher. The report by Ola *et al.,* [25] for wheat and germinated tigernut flour pancakes was similar to diameter and thickness of the tigernut-cowpea pancakes while the spread ratios of the tigernut-cowpea pancakes was lower.

3.2. Proximate Composition of Tiger Nut-cowpea Flour Pancakes

Table 3 showed the proximate composition of pancakes produced from tigernut-cowpea flour blends. Moisture content of the pancakes varied significantly ($P\leq0.05$) from 6.74 - 35.23 % for sample WP (100% wheat flour pancake) and sample CP (100% cowpea flour pancake). Moisture content of the tigernut-cowpea pancakes were comparable with the report by Ola *et al*., [25] for wheat and germinated tigernut flour pancakes, but higher than the report by Messaoudi and Fahloul [18] for pancake supplemented with freeze dried date pomace powder and lower when compared with the report by Shih *et al*. [21] for rice-sweet potato flour pancake. The difference could be attributed to the quantity of water used in batter preparation and the characteristics of the different flour. Though high moisture content is associated with short shelf life of food products as they encourage microbial growth, the pancakes however, were not for storage.

There was significant ($P\leq0.05$) difference in the protein content of the tiger nut-cowpea pancakes. The values ranged from 4.68 - 10.55 %. Sample CP (100% Cowpea flour pancake) had significantly ($P\leq0.05$) the highest protein content while sample TP (100% tiger nut pancake) had the least. There was significant ($P\leq0.05$) increase in the protein content of the tigernut-cowpea pancakes with increase in cowpea substitution. For a carbohydrate based tuber as tigernut, supplementation with cowpea can be considered appropriate as increase in protein content was observed. The values for the tigernut-cowpea pancakes are lower than the report by Ola *et al*., [25] for wheat and germinated tigernut flour pancakes. The difference may be attributed to the effect of germination of the tigernut. The recommended dietary reference intake (DRI) of protein for an adult (19-30 years) with body weight of 60 kg is 0.66 g/Kg/d [26]. The consumption of 100 g of this tigernut-cowpea pancakes will protein will meet about 11.81 - 26.64 % of the RDI.

Table 3. Proximate composition (%) and energy (Kcal/g) value of tigernut-cowpea flour pancakes

Sample	Moisture	Protein	Fat	Ash	Crude fibre	Carbohydrate	Energy
WP	6.74±0.30[g]	9.63±0.06[c]	25.65±0.19[d]	1.32±0.16[cd]	2.84±0.77[de]	53.83±0.67[a]	484.69±3.72[a]
TP	26.32±1.57[cd]	4.68±0.31[h]	27.21±0.28[c]	1.19±0.34[d]	7.74±0.79[a]	32.86±1.30[cd]	395.05±7.56[e]
CP	35.23±0.36[a]	10.55±0.00[a]	25.11±0.14[d]	2.05±0.09[a]	1.50±0.42[e]	25.58±1.01[e]	370.51±1.52[f]
TCPA	24.59±1.03[e]	6.18±0.00[g]	29.40±0.00[ab]	1.08±0.13[d]	5.71±0.74[b]	33.05±0.16[cd]	421.52±0.64[c]
TCPB	26.70±0.00[cd]	6.20±0.00[g]	28.91±0.85[ab]	1.85±0.00[a]	4.63±0.34[bc]	31.71±1.19[d]	411.83±8.16[cd]
TCPC	27.82±0.17[c]	6.53±0.00[f]	28.50±0.40[b]	1.79±0.20[ab]	4.08±0.71[cd]	31.28±1.47[d]	407.74±7.86[d]
TCPD	32.85±0.49[b]	7.50±0.00[e]	28.90±0.00[ab]	1.17±0.20[b]	2.85±0.77[de]	26.75±1.05[e]	397.10±4.20[e]
TCPE	25.43±0.47[de]	7.56±0.00[e]	25.30±0.00[d]	1.65±0.00[b]	2.89±0.70[de]	37.07±0.24[b]	406.22±0.48[d]
TCPF	21.05±0.00[f]	8.88±0.06[d]	29.68±0.74[a]	1.45±0.00[bc]	3.59±0.55[c]	35.35±1.22[bc]	444.04±8.08[b]
TCPG	27.66±0.34[c]	10.11±0.00[b]	25.30±0.13[d]	1.15±0.15[d]	3.97±0.88[cd]	31.82±0.94[d]	395.42±4.28[e]

Means with the same superscript along the same column are not significantly ($P \geq 0.05$) different. N = 2 ± SD.
Key: The same as in Table 2.

The pancakes had a fat content that varied from 25.11 - 29.68 %. Sample CP (100% cowpea flour pancake) had significantly ($P \leq 0.05$) the least fat content while sample TCPF (40% cowpea: 60% tiger nut flour pancake) had the highest. These values were lower than the report by Ola *et al*., [25]. The fat content may be a function of the vegetable oil used in the frying of the pancakes. Fat aids absorption of fat-soluble vitamins, provides essential fatty acids and important volatile compounds for flavor and sensory qualities [27].

There was significant ($P \leq 0.05$) variation in the ash content of the cowpea-tiger pancakes. The values ranged from 1.08 - 2.05 %. These values are similar to the ash content of wheat-tigernut pancakes reported by Ola *et al*., [25] but lower than those of cowpea-sweet potato *akara* reported by Moutaleb et al., [10]. Sample CP (100% cowpea flour pancake) had significantly ($P \leq 0.05$) the highest as content and sample TCPA (5% cowpea: 95% tiger nut flour pancake) the least. The high as content of the cowpea pancake confirms the report by Olapade and Aworh [28] that cowpea seeds are relatively high in ash. Ash is the inorganic residue after the incineration of organic matter and an indication of mineral content of the samples.

Crude fibre content varied significantly ($P \leq 0.05$) from 1.50 - 7.74 %. Sample CP (100% cowpea flour pancake) and TP (100% tiger nut flour pancake) had significantly ($P \leq 0.05$) the least and highest crude fibre content. The crude fibre content of the tigernut-cowpea pancakes decreased with increase in cowpea substitution. Crude fibre is a non-carbohydrate residue after extraction by dilute acid and alkali composed mainly cellulose, hemicellulose pectin, lignin and other components that are indigestible in the upper portion of the intestine [26]. It has little food value, but plays important role in nitrogen utilization and absorption of some other micronutrients and provides bulk necessary for peristaltic action in the intestinal tract [29].

Carbohydrate and energy content of the pancakes ranged from 25.58 - 53.83 % and 370.51 - 484.69 Kcal/g respectively. CP (100% cowpea flour pancake) had significantly ($P \leq 0.05$) the least while Sample WP (100% wheat flour pancake) had the highest carbohydrate and energy content. The carbohydrate result for the tigernut-cowpea pancakes was comparable with those of wheat-germinated tigernut pancakes [25] but lower than those of cowpea-sweet potatoes pancakes [10]. The energy requirement for an adult male and female between 30 - 59 years of age that are involved in moderate activities is 172 and 212 KJ/kg body weight respectively [30]. The energy values of the tigernut-cowpea pancakes will meet about 43-52 % and 34 - 41 % of the energy requirement of the adult male and female involved in moderate activity and of 50 kg body weight, this implies that the consumption of more than 100 g of the tigernut-cowpea pancakes as breakfast meal can meet the energy need for the moderate morning activities.

3.3. Sensory Attributes of Tigernut-cowpea Flour Pancakes

The aroma, appearance and colour of the pancake samples are shown in Figure 1. The mean score for the aroma of the pancake samples ranged from 5.35 - 6.30 for sample TP (100% tigernut flour pancake) and TCPE (30% cowpea substitution) respectively. The values indicated that the average degree of likeness of the aroma was between neither like nor dislike and like slightly. The mean scores for appearance and colour ranged from 4.55 - 7.00 and 4.85 - 7.00 respectively. Sample TCPB (10% cowpea substitution to tigernut) had significantly ($P \leq 0.05$) the least degree of likeness while Sample WP (100% wheat flour pancake) had the highest degree of likeness for the colour and appearance. The values indicated that the average degree of likeness of the colour and appearance was between dislike slightly and like moderately.

The flavour, Texture (crunchiness) and sweetness of the pancake samples are shown in Figure 2. The mean score for the flavour ranged from 5.50 - 6.10 for sample CP (100% cowpea flour pancake) and sample TCPC (15% cowpea substitution) respectively. The values indicated that the degree of assessor likeness is that of neither like nor dislike to like slightly. The mean score for crunchiness was between 5.15 and 7.05 for sample TP and CP respectively. The values indicated that the degree of likeness was between neither like nor dislike and like moderately. It was not surprised that the crunchiness of the 100% wheat pancake was the most desired by the assessors and that of tigernut the least. The mean score for the sweetness did not vary significantly ($P \leq 0.05$) and the

values ranged from 6.00 - 6.55 for sample TCPA (5% cowpea substitution) and sample TCPF (40% cowpea substitution) respectively indicating that the degree of likeness of the pancakes sweetness was that of like slightly.

In Figure 3, the overall acceptability of the pancakes ranged from 5.60 - 6.55 respectively, for sample TCPD

(20% cowpea substitution) and Sample WP 100% (wheat flour pancake). Sensory evaluation is a subjective test, depending on the assessors' sense of judgment particularly with the untrained assessors. The mean scores for the samples showed various degrees of likeness by the assessors, indicating that the pancakes were acceptable regardless of the degree of substitution.
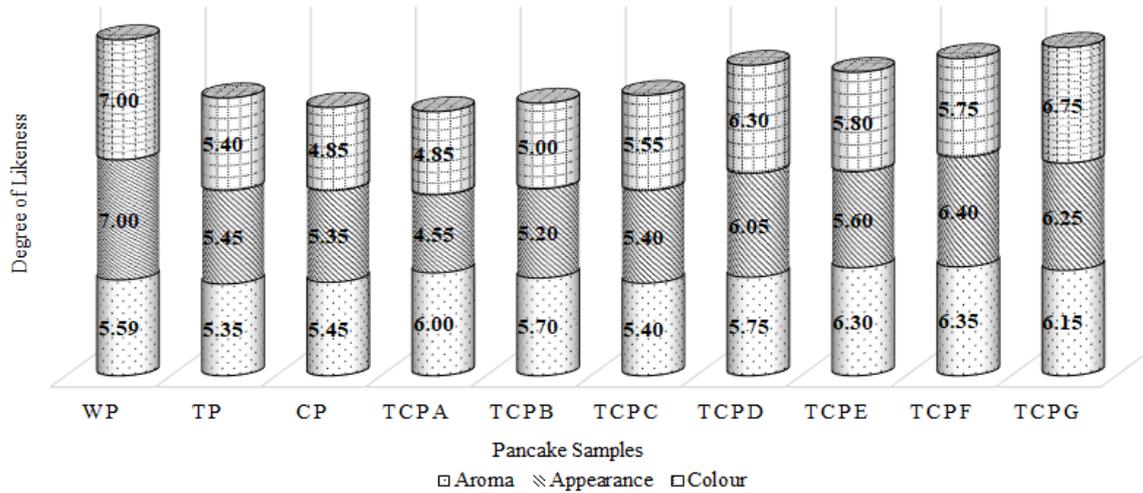

Figure 1. Assessors' degree of likeness for the aroma, appearance and colour of tigernut-cowpea flour pancakes (Key: The same as in Table 2)
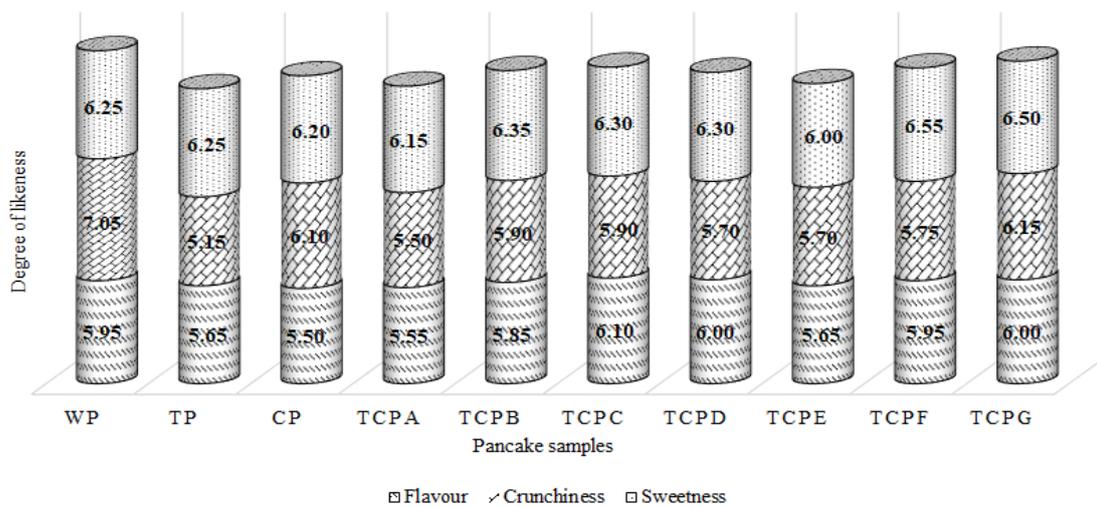

Figure 2. Assessors' degree of likeness for the flavour, crunchiness and sweetness of tigernut-cowpea flour pancakes (Key: The same as in Table 2)
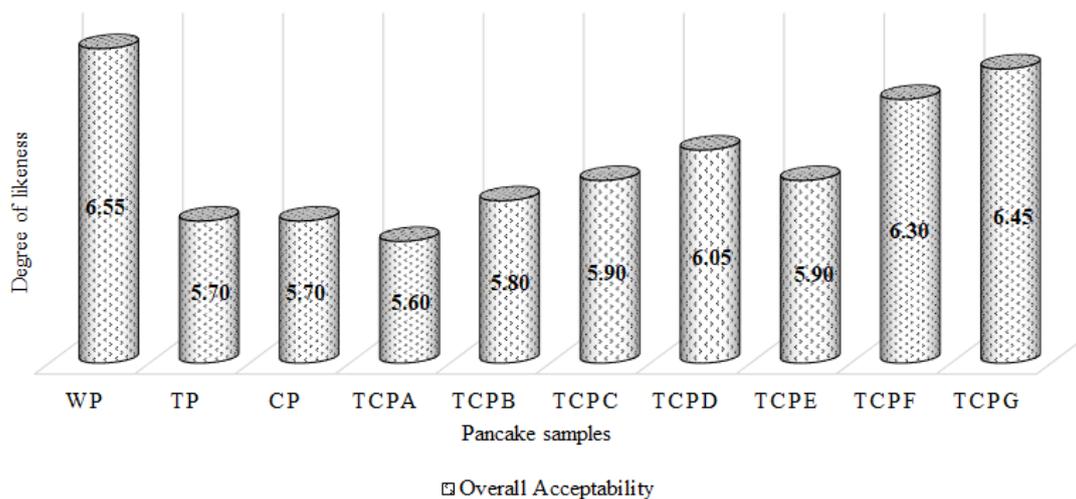

Figure 3. Assessors' overall acceptability of the tigernut-cowpea flour pancakes (Key: The same as in Table 2)

4. Conclusion

The study reveal that for all the cowpea substitution used, the tigernut-cowpea pancakes were rich in nutrients and energy. The protein contents of the tigernut-cowpea pancakes were comparable with that of wheat pancakes and it increased with increase in cowpea substitution. This would be nutritionally advantageous to the developing world where many people can hardly afford animal protein. The mean scores for the sensory attributes of the pancakes showed various degrees of likeness and overall acceptability by the assessors. The production of nutrient rich and acceptable pancakes from tigernut and cowpea flour blends therefore, offers a value addition to the less utilized root and legume.

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