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Physical, proximate and sensory properties of pancakes from cocoyam *(Xanthosoma sagittifolium)* and soybean (*Glycine max* L*)* flour blends

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Abstract

Physical, proximate and sensory properties of pancake made from blends of cocoyam-soybean flour was evaluated. Analysed using standard analytical methods was pancakes from six blends of cocoyam and soybean flour in the ratio of 95:5, 90:10, 85:15, 80:20, 75:25 and 70:30 and controls from 100% cocoyam and 100% wheat flour. The samples were coded CSP1, CSP2, CSP3, CSP4 CSP5 and CSP6 respectively, while the control were coded CFP and WFP. Pancake diameter, thickness and spread ratio ranged from 206.97-283.21 mm, 2.35 - 4.67 mm and 49.99 - 91.37 respectively. Moisture, protein fat, ash, crude fibre and carbohydrate content of the pancakes varied from 46.18 - 59.12, 3.46 - 6.32, 5.60 - 10.17, 0.75 - 1.98, 1.18 - 1.98 and 26.10 - 39.13% respectively. Energy value ranged from 188.96 – 245.00 Kcal/100g. Assessors' degree of likeness of the pancakes' sensory attributes: aroma, appearance, taste, mouth-feel, texture and overall acceptability were in the range of 5.50 – 6.60, 5.70 - 6.60, 5.40 - 6.85, 5.60 - 6.50, 5.30- 6.70 and 5.55 - 6.63 respectively. Addition of soybean to cocoyam flour lead to significant ($P<0.05$) increase in proximate composition of the pancakes. Sensory attributes of the pancakes were liked by the assessors with varying degrees of likeness from neither like nor dislike to like slightly while 75% of the degree of likeness was that of like moderately to like very much. Sample CPS3 (with 15% soybean flour) had the highest degree of likeness for all attributes except for texture. A blend ratio of 85% cocoyam and 15% soybean flour is recommended for the production of nutrient packed pancakes with high degree of likeness by the consumers as a means of value addition to the lesser utilized cocoyam tubers.

Keywords: *Cocoyam flour, soybean flour, pancakes, proximate composition, sensory properties*

Introduction

Pancake is a flat, thin and round starch-based cake. It is prepared by pouring a fluid batter containing eggs, milk, baking powder, and other ingredients onto a hot surface and cooked until it bubbles and begin to puff, thereafter the other side is flipped and cooked until golden brown. (Ahmed, 2023) [2]. Pancakes are ready to eat convenient and inexpensive food product that is a widely consumed by all ages. The principal ingredients used in pancake preparation are flour, water, sugar, baking powder, eggs while other ingredients are milk, salt, pepper, onions, nutmeg, vanilla flaour and vegetable oil. The flour is mostly from wheat either the hard or soft wheat. Soft wheat contains low protein content and gluten strength and gives a good pancake unlike the hard wheat flour with high protein content that produces smaller and thicker pancakes due to decreased viscosity (Eunjin *et al*., 2019) [6]. This implies that flour for pancakes may not require higher protein content. This necessitate the research on other sources of flour for use in pancake production and as means of value addition to some lesser unutilized flour sources like cocoyam.

Cocoyam *(Xanthosoma sagittifolium)* is one of the root crop that provides edible starchy storage corms or cormels. It is highly digestible and is used in foods for the invalid and in baby foods (Sanful and Darko 2010) [15]. Though it is not as important as other root crops such as yam, cocoyam and sweet potatoes, it has been reported to be more nutritious, in terms of protein content. It is also known for its significant carbohydrate content, good source of some vitamins and minerals and soluble dietary fibre (Ojinnaka and Nnorm, 2015) [12]. This useful tuber is highly perishable and the processing into flour for utilization in various food preparations is a remedy.

Therefore, the consideration of use of the flour in pancake production. The protein content of cocoyam tubers has been reported to vary from 1.5 – 10% (Ndabikunze et al., 2011; Olayiwola et al., 2013; Wada *et al*., 2019) [8, 14, 17]. Like other root crops cocoyam protein is limiting in sulfur-containing amino acids of which blending with legumes would be a good complement. Legumes such as cowpea and soybean would complement that of cocoyam.

Soybean (*Glycine max* L.) is a legume commonly cultivated for its edible seeds. Soybean is a very good source of essential nutrients and an excellent and cheap source of high quality protein (Agengo *et al*., 2018) [1]. Its protein content of about 35 – 45% is with all essential amino acid (Zhao *et al.*, 2014; Ojinnaka and Nnorom, 2015) [19, 8]. This makes it a good complement for starchy tubers limiting in lysine. Addition of soybean flour to cocoyam flour in the production of pancakes may not only increase the nutrient content but can affect the physical and sensory quality of the pancakes. This study was therefore aimed at evaluation of the physical, proximate composition and sensory properties of pancakes made from different blends of cocoyam and soybean flour.

Materials and Methods

Samples and Reagents

Cocoyam *(Xanthosoma sagittifolium)* corms and soybean seed (*Glycine max*) were purchased from Mile 1 market in Port Harcourt Rivers State. Chemicals and reagent (sulfuric acid, hydrochloric acid, iodine reagent etc.) were obtained from the Department of Food Science and Technology, Rivers State University, Port Harcourt, Rivers State, and were of analytical grade.

Production of Cocoyam Flour

Cocoyam flour was prepared according to the method described by Kabuo *et. al.*, (2018) [7]. Fresh corms were washed, peeled, rewashed and shredded into thin slices. The slices were blanched with Sodium metabisulphite for 5 min, dried at 70ºC for 10 h and then milled using a disc attrition mill. The flour was sieved using 0.4 mm sieve, packaged in an airtight container and kept in a cool dry place for further use.

Production of Soybean Flour

Soybean flour was prepared according to the method described by Ndife *et. al.*, (2011) [9]. Soybean seeds were sorted, washed, soaked, dehulled manually, oven-dried at 70ºC for 10 h, milled in a disc attrition mill to obtain the flour. The flour was sieved using a 300 µm aperture sieve and kept in an airtight container for further use.

Formulation of Blends

Six blends designated as CS1, CS2, CS3, CS4, CS5 and CS6 were prepared by mixing cocoyam flour and soybean flour using an electric blender in the percentage of 95:5, 90:10, 85:15, 80:20, 75:25 and 70:30 respectively, while hundred percent (100%) wheat (WF) and hundred percent (100%) cocoyam (CF) flours served as the control.

Pancake Recipe and Preparation

The pancake recipe set used are shown in Table 1. The preparation was as described by Ahmed *et. al.*, (2023) [2] with some modifications. The egg was poured into a wide bowl with the sugar and mixed together using a wooden spatula, after which the minced onions, pepper, salt and milk was added together and mixed thoroughly, gradually the flour was added and mixed thoroughly as well. After which the water was also added when the pancake batter seems too thick, stirring continued until it became smooth. The pan was placed on heat with a little oil on it to grease the whole surface until hot. Using a spoon, the pancake batter was scooped and poured into the hot pan. One side of the pancake batter was fried for 3 min, flipped over to the other side and fried for another 3 min.

Table 1: Recipe used in pancake preparation

Ingredients	Quantity (g)
Flour	25.0
Sugar	5.90
Baking powder	3.00
Egg beaters	9.17
Milk	3.83
Salt	0.3
Nutmeg	0.3
Onions	2.98
Pepper	3.00
water	27.0

Determination of Proximate Composition of Cocoyam-Soybean Pancakes

Standard AOAC (2012) [3] was used in the determination of moisture, protein, fat, ash and crude fibre content of the flours. Briefly, moisture was determined by drying the pancake samples in a hot air oven (DHG 9140A) at 70ºC until a constant weight was obtained. The crude protein content was determined by kjeldahl method and a nitrogen conversion factor of 6.25 was used. Soxhlet extraction method with ethyl ether was used for fat determination. Ash content was determined gravimetrically after the incineration of the samples in a muffle Furnace (Model SXL) at 550ºC for 2 h. Enzymatic gravimetric method was utilized in the determination of crude fibre. Carbohydrate was calculated by difference {100 - (Crude protein + crude fibre + ash + fat)}. Energy values were obtained using Atwater factor of 4 Kcal/g for protein and carbohydrate and 9 Kcal/g for fat.

Sensory Evaluation of Cocoyam-Soybean Pancakes.

The sensory evaluation of the pancake that was determined was as described by Obinna-Echem *et. al*, (2018) [10] modified. Twenty assessors consisting of the students of the Department of Food Science and Technology, Rivers State University, Port Harcourt, who were neither sick nor allergic to the raw materials were used to evaluate taste, appearance, color, mouth-feel and general acceptability of the pancakes. The scores were based on a 9-point hedonic scale with the degree of likeness of the product attribute expressed as: 1- disliked 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. Water was provided for rinsing the mouth between each sample evaluation.

Statistical Analysis

All experiments and analysis were carried out in duplicates and the data obtained were subjected to analysis of variance (ANOVA) using Minitab (Release 18.0) under the general linear model and turkey pairwise comparison at 95% confidence level.

Results and Discussion

Physical Properties of Cocoyam-Soybean Pancakes

Physical properties of the cocoyam-soybean flour pancakes: diameter, thickness and spread ratio are shown in Table 2. Diameter of the pancake samples ranged from 206.97-283.21 mm where sample CSP3 with 15% soybean flour significantly ($P<0.05$) the least and CSP1 with 5 % soybean flour had the highest value. Thickness of the pancakes varied from 2.35 - 4.67 mm, sample CSP6 with 30% soybean flour had significantly ($P<0.05$) the least and sample CSP1 with 5 % soybean flour had the highest value. The thickness of the samples decreased with increase in soybean flour addition. Spread ratio of the pancake samples varied from 49.99 - 91.37 for sample CSP3 and CSP6 respectively. The values reported in this study for the diameter, thickness and spread ratios are higher compared to values of 114.45-139.50 mm, 2.05 – 3.90 mm and 55.81 – 66.43 respectively, reported by Obinna-Echem *et.al.*, (2021)[11] for tigernut-cowpea flour pancake. Spread ratio is a function of the diameter and thickness of the pancake, such that the larger the diameter and the smaller the thickness, the higher the spread ratio. This was expressed in

Figure 1, where the thickness had a strong negative correlation (-0.865; P=0.000) with the spread ratio. This explains why sample CSP6 with the least thickness had significantly (P<0.05) the highest spread ratio. There was also a strong negative correlation between protein and thickness of the samples (-0.631; P=0.009). This implies that the increase in protein content, decreased the thickness of the samples. The diameter and thickness of pancakes is influenced by the viscosity of the batter (Eunjin *et al*., 2019) [6] which in turn can affect spreading during frying. Also high protein content decreases viscosity which reduces the diameter but increases the thickness of pancakes.

Table 2: Physical Properties of Cocoyam-Soybean Pancakes

Samples	Diameter (mm)	Thickness (mm)	Spread Ratio
CF	228.91^{b}±10.99	4.47^{a}±0.09	51.2^{e}±1.41
CSP1	283.21^{a}±5.39	4.68^{a}±0.12	60.5^{c}±0.22
CSP2	224.75^{bc}±1.77	3.55^{cd}±0.01	63.4^{c}±0.62
CSP3	206.97^{c}±1.74	4.14^{b}±0.01	49.9^{e}±0.24
CSP4	212.09^{bc}±1.80	3.75^{c}±0.00	56.5d±0.47
CSP5	224.79^{bc}±1.80	3.64^{c}±0.12	61.8^{c}±1.55
CSP6	214.73^{bc}±1.65	2.35^{e}±0.00	91.3^{a}±0.70
WFP	227.30^{b}±1.84	3.34^{d}±0.01	68.0^{b}±0.26

Values are means ± standard deviation of duplicate samples. Means with the same superscript along the column are not significantly (P>0.05) different.

CFP = Pancake from 100% cocoyam flour
CSP1 = Pancake from 95% cocoyam and 5% soybean flour
CSP2 = Pancake from 90% cocoyam and 10% soybean flour
CSP3 = Pancake from 85% cocoyam and 15% soybean flour
CSP4 = Pancake from 80% cocoyam and 20% soybean flour
CSP5 = Pancake from 75% cocoyam and 25% soybean flour
CSP6 = Pancake from 70% cocoyam and 30% soybean flour
WFP = Pancake from 100% wheat flour

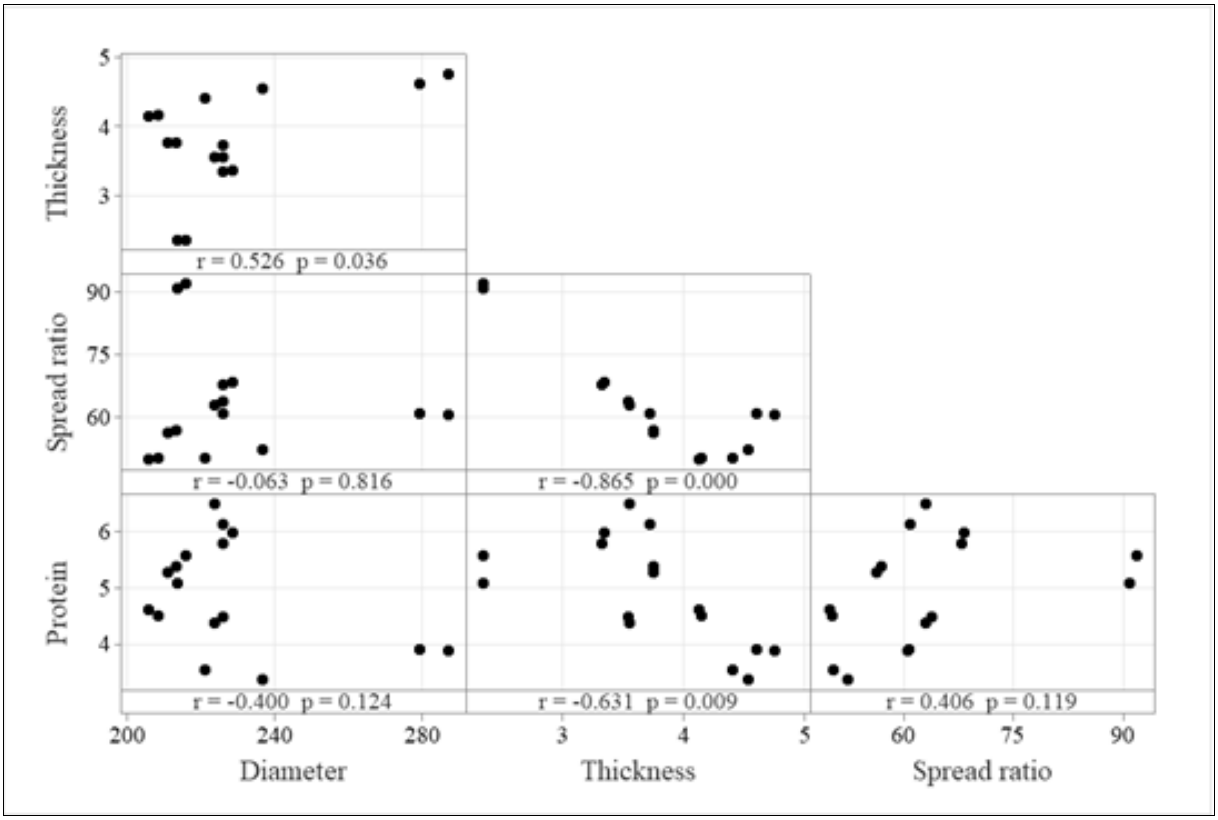

Fig 1: Correlation between Pancake Protein Content, Diameter, Thickness and Spread Ratio. Correlation exist at P<0.05

Proximate Composition and Energy Content of Cocoyam-Soybean Flour Pancakes

Table 3 presents the proximate composition of the cocoyam-soybean flour pancakes. Moisture content ranged from 46.18 - 59.12% for wheat flour pancake (WFP) and sample CSP3 with 85% cocoyam and 15% soybean flour. There was no significant (P<0.05) difference amongst the test samples and the 10% cocoyam flour pancake while the wheat flour pancake had the least moisture content. The moisture content is attributed to the water used during batter preparation and the variations could be due to the ability of the flour blend to absorb water and the amount lost during frying.

Protein content of the pancakes varied significantly (P<0.05) from 3.46 - 6.32%. Sample CSP5 had the highest protein content that didn't vary significantly from WFP, while sample CFP had the least value. Increase in substitution level increased the protein content of the

pancakes. The protein content of this cocoyam-soybean pancakes are lower than the protein content of tigernut-cowpea flour pancakes (Obinna-Echem *et.al*., 2021) [11] and very low compared to wheat-germinated tigernut pancakes reported by Ola *et al*., (2020) [13]. This could be due to the variation in the quantity of egg used in the batter. Higher protein content in pancakes is very important as it will add to the nutrient intake of the consumers.

The pancakes had fat content in the range of 5.60 - 10.17% respectively, for sample CSP4 least CSP6. There was increase in fat content with increase in soybean flour. The amount of fat though attributable to the oil used in frying of the pancakes, the undefatted soybean flour was also a contributory factor and led to increase with increase in soybean flour addition. High fat content leads to short shelf-life but fat is the most concentrated source of energy and contributes to texture, flavour and aroma of many foods (Drewnowski *et al*., 2010) [5] with the ability to lock up many volatiles responsible for acceptable sensory attributes.

Ash content of the pancakes ranged from 0.75 - 1.98%. The trend was an increase with increase in soybean flour addition. Sample CSP6 with 30% soybean had significantly (P<0.05) the highest ash content and sample WFP had the least value. The values are comparable with the report for tigernut-cowpea pancakes (Obinna-Echem *et al*., 2021) [11] but lower than that of wheat-germinated tiigernut pancakes (Ola *et al*., 2020) [13] Ash is an indication of the mineral content of the pancakes. Minerals have several beneficial effects to the body.

Crude fibre content of the pancakes increased addition of soybean flour. The values ranged from 1.18 - 1.98% for sample WFP and CSP6 respectively. The crude fibre cotent is higher than the report for wheat-germinated tigernut pancakes (Ola *et al*., 2020) [13]. Crude fibre represents variable fraction of dietary fibre and includes mostly the cellulose, noncellulosic polysaccharides, such as hemicelluloses, pectic substances, gum, mucilages and a non-carbohydrate component lignin (Dhingra *et al.*, 2012) [4] and plays significant role in the prevention of several diseases such as; cardiovascular diseases, diverticulosis, constipation, irritable colon, cancer and diabetes (UCSF HEALTH 2023) [16].

The pancakes had carbohydrate content in the range of 26.10 to 39.13%. Sample CSP3 with 15% soybean flour had significantly (P<0.05) the least carbohydrate content while sample WFP had highest value. The reduced carbohydrate content in pancakes with the soybean substituted flour is good for a low calorie diet. The carbohydrate content of the cocoyam-soybean flour pancakes is comparable with that of wheat-germinated tigernut pancakes (Ola et al., 2020) [13].

Energy values for the pancakes are shown in Figure 2. They ranged from 188.96 – 245.00 Kcal/100g for sample CSP1 and CSP3 respectively. The values were lower than the report for tigernut-cowpea pancakes (Obinna-Echem et al., 2021) [11]. This could be due to the higher fat content of the tigernut-cowpea pancakes.

According to WHO (2007) [18], for an adult female and male between 30 - 59 years of age that are weighing 50 kg and involved in moderate activities the energy requirement is 183 and 212 KJ/kg body weight respectively. The energy content of 100 g of the pancakes will be able to meet 9 – 12 and 8 - 10% of the energy requirements respectively, for the female and males. An adult would usually consume more than 100 g of pancakes and with other fluids which may contain energy to make up for the energy requirement.

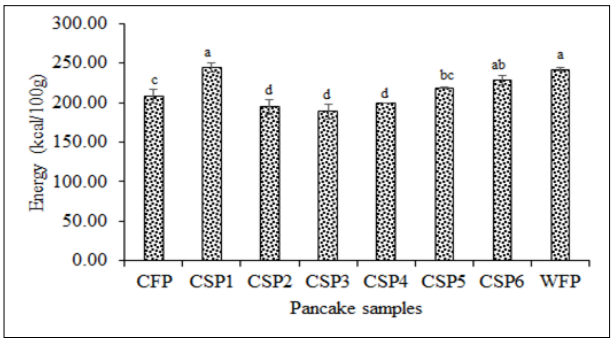

Fig 2: Energy content (kcal/100g) of cocoyam-soybean flour pancakes

Columns and error bars are means ± standard deviation of duplicate samples. Columns with different letters differed significantly (P<0.05).

Table 3: Proximate Composition (%) of Cocoyam-Soybean Pancakes

Samples	Moisture	Protein	Fat	Ash	Crude fibre	Carbohydrate
CFP	54.20^{ab}±1.37	3.46^{d}±0.13	7.28^{b}±0.36	1.33^{b}±0.07	1.55^{b}±0.02	32.33^{b}±1.44
CSP1	54.86^{ab}±0.76	3.89^{cd}±0.02	6.46^{bc}±0.03	1.72^{b}±0.01	1.49^{bc}±0.02	31.58^{bc}±0.68
CSP2	56.15^{ab}±2.15	4.43^{c}±0.07	6.58^{bc}±0.11	1.77^{a}±`0.03	1.54^{b}±0.00	29.54^{bc}±1.94
CSP3	59.12^{a}±2.40	4.56^{c}±0.09	7.37^{c}±0.14	1.37^{b}±0.03	1.46^{bc}±0.04	26.10^{c}±2.73
CSP4	55.36^{ab}±1.92	5.33^{b}±0.09	5.60^{bc}±0.09	1.23^{b}±0.08	1.94^{a}±0.03	31.94^{b}±0.19
CSP5	53.25^{ab}±0.47	6.32^{a}±0.25	9.23^{a}±0.37	1.97^{a}±0.08	1.50^{bc}±0.19	27.63^{bc}±1.23
CSP6	51.56^{ab}±1.21	5.33^{b}±0.35	10.17^{a}±0.46	1.98^{a}±0.18	1.94^{a}±0.13	29.04^{c}±0.09
WFP	46.18^{c}±0.46	5.89^{ab}±0.12	6.86^{b}±0.07	0.75^{c}±0.03	1.18^{c}±0.03	39.13^{a}±0.23

Values are means ± standard deviation of duplicate samples. Means with the same superscript along the column are not significantly (P>0.05) different.

CFP = Pancake from 100% cocoyam flour
CSP1 = Pancake from 95% cocoyam and 5% soybean flour
CSP2 = Pancake from 90% cocoyam and 10% soybean flour
CSP3 = Pancake from 85% cocoyam and 15% soybean flour
CSP4 = Pancake from 80% cocoyam and 20% soybean flour
CSP5 = Pancake from 75% cocoyam and 25% soybean flour
CSP6 = Pancake from 70% cocoyam and 30% soybean flour
WFP = Pancake from 100% wheat flour

Sensory attributes of cocoyam-soybean flour pancakes

Figure 3 shows the Assessors' degree of likeness of the sensory attributes: aroma, appearance, taste, mouth-feel, texture and overall acceptability of the cocoyam-soybean pancakes. The mean assessor's degree of likeness of aroma of the samples ranged from 5.50 – 6.60, CSP3 (pancake from flour blend with 15% soybean flour) had significantly (P<0.05) the highest degree of likeness which did not differ

from WFP (100% wheat flour pancake) and CSP4 had the least value. Appearance ranged from 5.70 - 6.60 for sample CSP1 (with 5% soybean flour) and CSP3 (with 15% soybean flour) respectively. Taste ranged from 5.40 - 6.85 with CSP6 (pancake from flour blend with 30% soybean flour) had significantly (P<0.05) the least degree of likeness and CSP3 had the highest value. Texture ranged from 5.60 - 6.50 where sample CSP6 was significantly (p <0.05) the least liked and sample CSP2 the most liked. Mouthfeel ranged from 5.30 - 6.70 with CSP3 (pancake from flour blend with 15% soybean flour) had significantly (P<0.05) the highest degree of likeness and CSP6 (with 30% soybean flour) had the least value. Overall acceptability across the samples ranged from 5.55 - 6.63, CSP3 (pancake from flour blend with 15% soybean flour) had significantly (P<0.05) the highest degree of likeness CSP6 had the least value. On the hedonic scale, the values indicated that the assessors' degree of likeness was between neither like nor dislike to like slightly.

Degree of likeness of the sensory attributes decreased with increase in soybean flour. This may be attributed to the beany flavour of the soybean. Though the assessors liked the pancakes with varying degrees of likeness, the third quartile indicating 75% of the assessors' likeness was that of like moderately to liked very much as shown by the upper limit of the interquartile box (Figure 1). Sample CPS3 (pancake from flour blend with 15% soybean flour) amongst the test samples had significantly the highest degree of likeness by the assessors for aroma, appearance, taste, mouthfeel and overall acceptability.

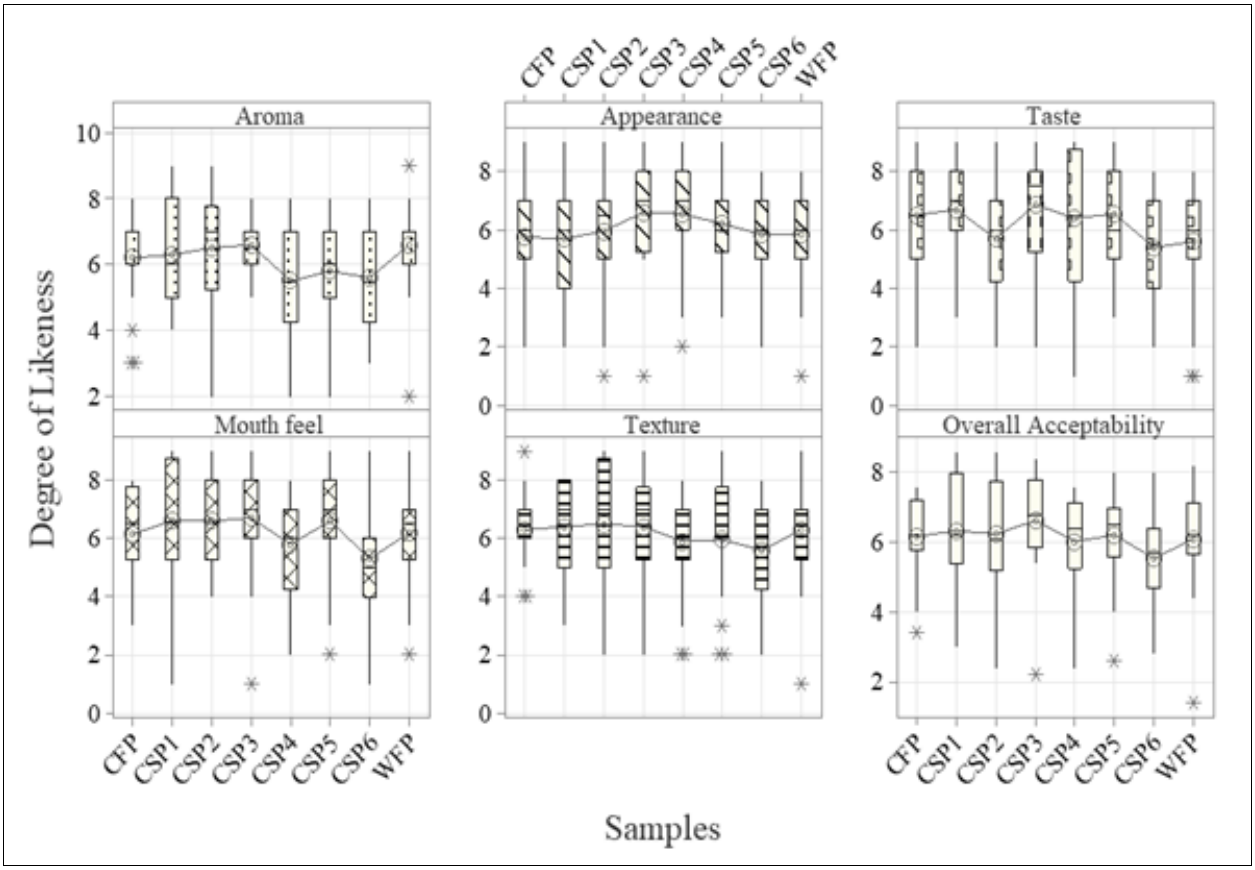

Fig 3: Sensory Attributes of Cocoyam-Soybean Flour Pancakes. Box plot showing the interquartile range, mean, outliers, minimum and maximum scores

CFP = Pancake from 100% cocoyam flour
CSP1 = Pancake from 95% cocoyam and 5% soybean flour
CSP2 = Pancake from 90% cocoyam and 10% soybean flour
CSP3 = Pancake from 85% cocoyam and 15% soybean flour
CSP4 = Pancake from 80% cocoyam and 20% soybean flour
CSP5 = Pancake from 75% cocoyam and 25% soybean flour
CSP6 = Pancake from 70% cocoyam and 30% soybean flour
WFP = Pancake from 100% wheat flour

Conclusion

The addition of soybean to cocoyam flour lead to significant increase in nutrient content of the pancakes and the sensory analysis revealed that the samples were liked by the assessors with varying degrees of likeness. Sample CPS3 (pancake from flour blend with 15% soybean flour) amongst the test samples had the highest degree of likeness by the assessors for all attributes except for texture. A blend ratio of 85% cocoyam and 15% soybean flour would be recommended for the production of nutrient packed pancakes with high degree of likeness by the consumers.

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