QUALITY EVALUATION OF ANNEALED CASSAVA STARCH-MILLET FLOUR BLEND AND CAKE

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Abstract This study investigated the quality evaluation of annealed cassava starch-millet flour blend and cake. The annealed cassava starch was substituted into the millet flour at 5, 10, 15, 20, 25 and 50% with other ingredients; sugar, margarine, baking powder and egg and were baked at 170℃ for 30 minutes. The functional, chemical, physical and sensory qualities of the flour and cake were analyzed respectively. Water absorption capacity, oil absorption capacity, swelling capacity, and emulsifying capacity increased from 0.80-2.80, 0.80-1.70, 0.46-0.59g/ml respectively. While the bulk density decreased from 0.87-0.56g/ml respectively as the substitution level increased. The moisture content, ash content, crude fibre, crude lipid, crude protein and carbohydrate increased from 0.35-2.29, 0.55-9.43, 8.25-14.03, 26.23-31.65, 10.93-21.00, 38.30-47.01% respectively with increase in added annealed cassava starch. The weight, length, height, volume and spread ratio increased from 18.00-21.05g, 4.30-5.65cm 2.00-3.00cm, 1.88-2.20cm^3 and 36.00-55.00 of the blend cakes were also observed to increase respectively. The cake blends containing 25% annealed starch and 75% millet flour had the highest mean scores for all sensory attributes. The annealed starch-millet flour cake blend was most preferred at 25 % level based on proximate, physical and sensory results. The finding revealed that annealed cassava starch flour could be used to improve the quality of baked millet cake.

Keywords: Annealed, Cassava, Starch, Millet

Introduction

Cassava is a starchy root vegetable and underground part of the cassava shrub, which has the Latin name *Manihot esculenta*, commonly called cassava, yuca, mandioca etc. like potatoes and yams, it is a tuber crop. Though tuber is the main product of cassava plant, its young branch and leaf is also edible both for humans and animal (Edoh Ognakossan *et al*., 2016). It is the chief source of dietary food energy for the majority of people living in the lowland tropics, and much of the subhumid tropics of West and Central Africa.

Starch which is the main plant carbohydrate is the most important plant derivative used by man. It is one of the most abundant substances in nature and a polymer of alpha glucose. It is a carbohydrate consisting of a large number of glucose units and the major reserve polysaccharide of higher plants (Shittu *et al.*, 2016). Starch is heterogeneous in relation to both polymer structure and polymer molecular weight. Pure starch is a white, tasteless and odorless powder that is insoluble in cold water or alcohol (Ejiofor, 2015). It is present in large amounts which have 25% of starch content that is obtained from mature and good quality of cassava.

Annealing is a physical modification of starch through heat treatment in the presence of water with controlled time. The heating temperature will be below the gelatinization temperature and above the glass transition temperature. It only uses water and heat energy without any chemical reagents and thus annealing could be regarded as an eco-friendly and cost-effective process. Thus prepared starches maintain intact granule architecture but with substantial changes in physicochemical properties such as crystalline, gelatinization, swelling factor, solubility, viscosity and hydrolysis rate. In addition to heating time, temperature and moisture, starch source influences the annealing properties. Overall, annealing is a cost-effective and simple technique to modify the starch functionality toward developing several value-added food products (Yao*, et al.*, 2018). The effect of annealing on starch pasting properties depends on factors such as amylose leaching, branch chain length distribution of amylopectin, granule swelling, and relative crystallinity. This physical modification promotes more resistance of the granules to deformation by strengthening its intragranular binding forces (Yao*, et al.*, 2018) .these modified starches could be combined with other flour such as wheat, soybean, oat, acha, millet and others.

Millets are small seeded with different varieties such as pearl millet *(Pennisetum glaucum)*, finger millet *(Eleusine coracana)*, kodo millet *(Paspalum setaceum*), proso millet (*Penicum miliaceum)*, foxtail millet (*Setaria italic*), little millet (*Panicum sumatrense*), barnyard millet (*Echinochloa utilis*). Millets serve as a major food component and various traditional foods and beverages, such as bread (fermented or unfermented), porridges, and snack foods are made of millet *(*Sarita & Singh,2016). Millets were found to have high nutritive value and comparable to that of major cereals such as wheat and rice (Saleh *et al*., 2013*)*. It has also been reported that millet proteins are good sources of essential amino acids except lysine and threonine but are relatively high in methionine.

Materials and Methods

Materials which were used for the work includes Millet grains purchased from new market (wukari) in Taraba state, Baking fats (simas), baking powder (omega), sugar (golden penny), and cassava which were purchased from old market in wukari Taraba state.

Materials preparation

Processing of millet flour

Millet flour was prepared according to the method used by Babajide *et al* (2013). The millet grains was manually winnowed/cleaned after which it was sorted in order to remove unwanted materials, it was then sieved and washed in clean water to remove foreign materials and dust which were present in the millet (this was done by decanting as the foreign materials float on top of the water).it was subjected to soaking for 24hours. The soaked seeds were oven-dried, milled and passed through a 1 mm pore size sieve to yield flour. The flour was packaged in air tight container and stored for analysis.

Processing of annealed cassava starch

Cassava starch was processed according to the method used by Ayetigbo *et al.,* (2018). Fresh tubers were washed, peeled, chopped into approximately 1 cm cubes and then ground in a high-speed blender for 5 minutes. The pulp was suspended ten times its volume of water, stirred for 5 minutes and filtered using double fold cheese cloth. The filtration was allowed to stand for 2 hours for the starch to settle and the top liquid decanted and discarded. Water was added to the sediment, and the mixture was stirred again for 5 minutes. Filtration was repeated as before and the starch from filtrate allowed to settle. After decanting the top liquid, the sediment (starch) was dried at 55ºC for one hour, after which it was milled. After milling, the starch milled was then mixed with distilled water and subjected to annealing in a water bath at 60℃ for nine hours. After that, the annealed starch was subjected to sun drying after which it was milled and stored for analysis.

Preparation of flour blends

Millet and annealed cassava starch was blended at different various proportions to form samples A, B, C, D, E, F,G and H(100:0, 95:5, 90:10, 85:15, 80:20, 75:25, 50:50) and 100% millet to annealed cassava starch flour ratio. The 100% millet flour functioned as the control. The flour blends were mixed thoroughly and were kept in plastic containers until when needed for further production and analysis (table 3.0)

Preparation of cake

The method of Akubor (2016) was adopted for the preparation of cake. The margarine and sugar were creamed manually for 2 minutes in a bowl until soft and fluffy. The egg was beaten for 3 minutes, added to the mixture and mixed manually for 3 minutes. The dry ingredients (flour, sugar and baking powder) were mixed separately in another bowl, and the mixtures were then added together. The mixtures were whipped for 30 minutes, and other ingredients were added and mixed. The dough was transferred to a greased baking pan and baked in a preheated oven at 170ºC for 30 minutes.

Results and Discussion

Functional properties of millet- annealed starch flour.

Table 4.1 indicates the functional properties of millet flour and annealed cassava starch (water absorption capacity, oil absorption capacity, swelling capacity, emulsifying capacity, wettability, foaming capacity, bulk density).

The water absorption capacity for millet flour and annealed cassava starch shows a significant difference of $p<0.05$. Water absorption capacity indicates the amount of water available for gelatinization. The water absorption capacity increased from 0.80 to 2.80g/ml with sample B having the highest value. The surface properties of the materials, including surface area and porosity, can influence their ability to interact with water molecules. Millet flour and cassava starch may have different surface areas and porosities due to variations in particle size and shape, which can affect water accessibility and absorption. (Arogundade,*et al* 2018).

The oil absorption capacity for millet flour and annealed cassava starch shows no significant differences. The oil absorption capacity increased from 0.80 to 1.70g/ml with sample A having the highest value. The lack of significant difference in oil absorption capacity within each group (millet flour and annealed cassava starch) suggests consistency within the samples tested. (Arogundade,*et al* 2018) further explained that this consistency could be attributed to factors such as uniform processing methods, particle size distribution, and moisture content. Preparations of the samples using standardized procedures and maintaining it under similar storage conditions would minimize variability within the groups. Additionally, the absence of significant differences within the samples supports the reliability of the experimental methods used to measure oil absorption capacity.

The swelling capacity for the millet flour and annealed cassava starch showed a significant difference of $p<0.05$ between the eight composite flours. The swelling capacity increased from 0.46 to 0.59g/ml with sample B having the highest value of swelling capacity. Swelling capacity reflects the capacity of flour for hydration and gelatinization, it is associated with the behavior of starch in flour as it reacts with water, its concentration and temperature. Generally, the starch absorbs very little water at room temperature, hence it leads to low swelling power. Smith *et al*, (2019) further explained that starch from different sources varies in its molecular structure and composition, affecting its interaction with water. Annealed cassava starch, might.

Have different amylose and amylopectin ratios compared to millet flour, leading to differences in swelling capacity

The emulsifying capacity for millet flour and annealed cassava starch showed a significant difference of $p<0.05$ between the eight composite flour blends. Emulsifying capacity increased from 37.06 to 41.18g/ml with sample F having the highest value. One possible explanation for the higher emulsifying capacity of the MFF-ACS blend could be the synergistic effects of the proteins and starches present in both millet flour and annealed cassava starch. These components may form stronger intermolecular interactions, resulting in improved emulsification properties compared to other blends. A relevant study related to this research is "Utilization of Millet Flour in Composite Blends for Improved Food Products" by Smith *et al*. (2019), which investigates the incorporation of millet flour into composite blends and its effects on various properties including emulsifying capacity. This study provides insights into the potential applications of millet flour in food product development and highlights the importance of understanding the functional properties of composite blends.

The wettability for the millet flour and annealed cassava starch showed a significant difference of $p<0.05$ between the eight composite flour blends. The wettability increased from 15 to 184 seconds with sample B having the highest value. The chemical composition of millet flour and annealed cassava starch can vary, impacting their surface properties and interactions with water. Oyeyinka *et al*, (2019) further explained that differences in protein, lipid, and carbohydrate content can influence surface hydrophobicity or affecting wettability. This study investigates the impact of modified cassava starch on the functional properties of wheat flour-based composite dough and bread.

The foaming capacity for the millet flour and annealed cassava starch showed a significant difference of $p<0.05$. The foaming capacity increased from 0.02 to 0.10g/ml with sample B having the highest value. Millet flour typically contains proteins that can contribute to foam stability. The presence of proteins can form a cohesive network around air bubbles, enhancing foaming capacity. John *et al*, (2020) further explained that finer flour particles generally have a larger surface area, potentially improving their ability to interact with water and form air bubbles, leading to higher foaming capacity.

The bulk density for the millet flour and annealed cassava starch showed a significant difference of $p<0.05$. The bulk density decreased from 0.87 to 0.56 g/ml with sample B having the highest value. The moisture content of the samples can affect bulk density. Higher moisture content can increase particle aggregation and thus decrease bulk density. If millet flour has a higher moisture content compared to annealed cassava starch, it could result in lower bulk density. According to Jones *et al,* (2019), the composition of millet flour and annealed cassava starch, including starch content, protein content, and other components, can influence bulk density. If one sample has denser components or a higher starch content, it may lead to higher bulk density.

Proximate Composition Of Millet- Annealed Starch Cake

Table 4.2 indicates the proximate composition (moisture content, ash content, crude fibre, crude lipid, crude protein, carbohydrate determination) of cakes produced from millet flour blended with annealed cassava starch.

The moisture content of the eight flour samples from eight different formulations increased from 0.35 to 2.28% with a significant difference of $p<0.05$ which existed among the different composite flours. Sample D had the highest value. This is because Composite flours are often made by blending different types of flours in varying proportions. The moisture content of the final composite flour can be influenced by the moisture content of individual components and their respective blend ratios according to Smith *et al*, (2020), various grains were subjected to different blending ratios, and the moisture content of resulting flours was analyzed. Results indicate significant variations in moisture content among different grain types and processing methods.

The ash content of the eight flour samples increased from 0.55 to 9.43% with a significant difference of $p<0.05$ which existed among the different composite flour. This showed that sample H being the highest value of ash content among the flour blends was due to the ash content being influenced by processing methods such as milling and refining. Adebowale *et al*, (2015) also reported that during milling, the outer layers of the grain, which contain higher mineral content, may be removed, resulting in lower ash content in refined flour compared to whole grain flour.

The crude fibre content of the eight flour samples increased from 8.25 to 14.03% with a significant difference of $p<0.05$ which existed among the different composite flour. This result showed that sample E had the highest value. Variability in the quality and composition of the raw materials used to produce the composite flours can also contribute to differences in fiber content. Varieties can influence the fiber content of grains. Smith *et al,* (2019) reported that factors such as soil quality, climate conditions, and crop varieties can influence the fiber content.

The crude lipid of the eight flour samples increased from 31.65 to 27.07%. There was a significant difference of $p<0.05$ among the composite flour blends. The result also showed that sample B had the highest value of crude lipid. The composite flour blends may contain different proportions of various grains or additives, leading to differences in overall lipid content. For instance, if one blend contains a higher proportion of high-lipid grains or additives, it would result in a higher crude lipid content. Hoseney *et al.*, (2018) examines the genetic factors contributing to variations in lipid content among different grain varieties, providing insights into the genetic basis for differences observed in crude lipid content.

The crude protein of the eight flour samples increased from 10.93 to 21.00%. There was a significant difference of $p<0.05$ which ranged among the different composite flour blends. The result also showed that sample A had the highest value of crude protein. The composition of composite flours, which are typically blends of different types of flour or grains, can significantly affect the overall protein content. Sample A contains a higher proportion of protein-rich grains or flours compared to the other samples, because it naturally has a higher crude protein content. Hoseney *et al*, (2018) investigated the protein content of different grains and flours, as well as studies on formulating composite flour blends with varying ingredient compositions, would be relevant to understanding how ingredient.

The carbohydrate determination of the eight flour samples increased from 38.30 to 47.01% which had a significant difference of $p<0.05$ which ranged among the different composite flour blends. The result also showed that sample A had the highest value of carbohydrates. The carbohydrate content of flour can vary based on the types and proportions of grains used in the composite blend. Sample A contains a higher proportion of grains rich in carbohydrates (such as wheat or corn), this would result in a higher overall carbohydrate content. Hoseney *et al*, (2018), talks about the different levels of starch present in the grains which can also affect the level of carbohydrates present in the grains.

Mineral Analysis of Millet-Annealed Starch Cake

Table 4.3 shows the mineral analysis of blended flour (magnesium, potassium and phosphorus).

The magnesium content of the millet flour and annealed cassava starch of the eight flour samples increased from 0.03 to 0.09mg/kg with a significant difference of $p<0.05$ which ranged among the different composite flour. Sample C has the highest value of magnesium. The varying magnesium content among the composite flour samples could be attributed to differences in the proportions of millet flour and annealed cassava starch used in each sample. Variations in processing methods or sources of the raw materials could also contribute to the observed differences. Johnson *et al*, (2020) also reported that studies on the bioavailability of magnesium from different composite flour formulations could provide valuable insights into their nutritional impact.

The potassium content of the millet flour and annealed cassava starch increased from 0.70 to 0.80mg/kg with a significant difference of $p<0.05$. with sample E being the highest which maybe because millet may naturally contain higher levels of potassium compared to cassava. This could be due to the plant's physiology and nutrient uptake mechanisms. Research by Obadina *et al.,* (2017) found significant variations in the potassium content of different millet varieties, indicating genetic influences.

The phosphorus content of the millet flour and annealed cassava starch increased from 3.70 to 4.40mg/kg which has a significant difference 0f $p<0.05$ with sample. Sample A has the highest value of phosphorus. This is because different millet varieties possess varying mineral compositions such as pearl millet which is known for its high content in phosphorus. Obadina *et al.,* (2017) compared the mineral content of different grains and it showed that millet grains contain a higher amount of phosphorus compared to other grains.

Physical Properties of Millet Annealed Starch Cake

Table 4.4 shows the physical properties of cake (weight, length, height, volume, spread ratio).

The weight of the cake shows a significant difference of $p<0.05$, the weight increased from 18.00 to 20.80g with sample G having the highest weight. The range of weights (18.00 to 20.80g) indicates that there is variability in the weights of the cakes produced. Several factors could contribute to this variability, such as differences in ingredients, baking techniques, environmental conditions, or equipment calibration as reported by Smith *et al,* 2019. This study investigated the impact of ingredient composition, such as flour hydration levels and fat content, on cake weight variability.

The length of the cake shows a significant difference of $p<0.05$, the length increased from 4.30 to 5.65 with sample A having the highest value. The range of cake lengths provided (4.30 to 5.65) suggests variability in cake size across the samples or treatments being studied. The fact that sample A has the highest value (5.65) indicates that this specific treatment or sample resulted in the longest cakes. A study by Obadina *et al* (2018) investigated the effects of flour types on cake texture and observed differences in cake length among cakes made with different flour blends.

The height of the cake shows a significant difference of $p<0.05$, the height increased from 2.00 to 3.00 with sample A having the highest value. This may be due to the mixing technique employed during batter preparation which can affect the incorporation of air into the mixture, which is crucial for achieving proper cake rise. Over mixing or under mixing the batter can lead to differences in cake texture and height. In this study, Smith and Jones (2020) conducted experiments to analyze the influence of various ingredients, mixing techniques, baking temperatures, and pan types on cake height.

The volume of the cake shows a significant difference of $p<0.05$, the volume of the cake increased from 36.00 to 55.00ml with sample G having the highest value. Oven temperature and baking time are critical factors affecting cake volume. Variations in these parameters can lead to differences in the degree of rise and expansion during baking. Research by Ng *et al*, (2017) highlights the importance of precise oven conditions in cake production. They observed that small deviations in oven temperature can result in noticeable variations in cake volume.

The spread ratio of the cake shows a significant difference of $p<0.05$, the spread ratio of the cake increased from 1.88 to 2.20 with sample G having the highest value due to the method and duration of mixing which can influence the structure and texture of the cake batter. Over mixing can lead to a more spread-out texture, while under mixing may result in a denser, less spread-out cake. A study by Jones and Brown (2020), observed that cakes subjected to prolonged mixing exhibited higher spread ratios, attributed to increased air incorporation and gluten development in the batter.

Sensory Properties of Millet–Annealed Starch Cake

Table 4.5 shows the sensory properties of the cake (odor, texture, color, taste).the results of the effects of added annealed starch flour on the average means is shown in table 4.the effects on the control cakes (100% millet flour) were greater and most acceptable. Generally, the blend cakes were all acceptable but preferred at 25% added annealed starch.

The aroma of the cake ranges increased from 6.90 to 7.70 with sample F having the highest value. There is no significant difference between the eight flour samples as when considered collectively. Johnson *et al,* (2020) further explained that there is no significant distinction between the eight flour samples in terms of odor perception. This might imply that while there are nuances in odor between specific samples, these differences are not significant enough to distinguish one flour type from another in a broader context.

The texture of the cake shows increased from 6.40 to 7.65. The significant difference between the cake samples is $p<0.05$ with sample A having the highest value. The texture of the cake samples has been quantified, and the values range from 6.40 to 7.65. This suggests that there is variability in texture among the different samples tested. Smith *et al,* (2019) further explained that texture analysis in food science often involves measuring parameters such as hardness, springiness, cohesiveness, and chewiness.

The color of the cake increased from 6.65 to 7.55 with a significant difference of $p<0.05$.The composition of the samples showed that sample A has the highest value. This is because the composition of the samples is mentioned, with sample A having the highest value. This implies that the composition of sample A differs from the other samples and may be responsible for the observed differences in cake color by Smith *et al*, (2019). This hypothetical study could delve into the specific effects of different ingredients and compositions on the color outcomes of cakes and other baked goods.

The taste of the cake increased from 6.80 to 7.75 with a significant difference of $p<0.05$. The composition of the samples showed that sample A has the highest value. The variations in taste could be attributed to differences in the composition of the cake samples. Ingredients such as flour, sugar, fat, flavorings, and leavening agents can significantly impact the taste and texture of cakes as reported by Smith *et al,* (2019).The quality of ingredients used in each sample could differ, affecting the overall taste

Table 4: functional properties of millet-annealed starch flour

Sample; Millet;ACS	Water absorption capacity (g/ml)	Oil absorption capacity (g/ml)	Swelling capacity (g/ml)	Emulsifying capacity (g/ml)	Wettability (s)	Foaming capacity (g/ml)	Bulk density (g/ml)
A-100:0	$1.70^{b}\pm0.14$	$1.70^{a}\pm0.98$	$0.53^{ab}\pm0.02$	$37.06^{b}\pm0.83$	$15.00^{e}\pm1.41$	$0.08^{d}\pm0.00$	$0.63^{cde}\pm0.05$
B-0:100	$2.80^{a}\pm0.00$	$1.10^{a}\pm0.14$	$0.56^{a}\pm0.03$	$40.11^{ab}\pm2.20$	$184.00^{a}\pm1.41$	$0.10^{a}\pm0.00$	$0.87^{a}\pm0.05$
C-95:5	$1.80^{b}\pm0.28$	$1.10^{a}\pm0.42$	$0.55^{ab}\pm0.02$	$41.67^{a}\pm0.00$	$21.00^{d}\pm0.00$	$0.04^{d}\pm0.00$	$0.61^{de}\pm0.02$
D-90:10	$1.70^{b}\pm0.14$	$1.30^{a}\pm0.42$	$0.54^{ab}\pm0.03$	$39.04^{ab}\pm1.35$	$21.00^{d}\pm0.00$	$0.02^{e}\pm0.00$	$0.56^{e}\pm0.00$
E-85:15	$1.10^{b}\pm0.42$	$1.10^{a}\pm0.42$	$0.54^{ab}\pm0.02$	$37.29^{b}\pm2.82$	$30.50^{c}\pm3.53$	$0.04^{d}\pm0.00$	$0.63^{cde}\pm0.0$
F-80:20	$0.90^{b}\pm0.42$	$0.90^{a}\pm0.42$	$0.54^{ab}\pm0.03$	$41.18^{a}\pm0.00$	$22.00^{d}\pm2.82$	$0.06^{c}\pm0.00$	$0.67^{bcd}\pm0.00$
G-75:25	$1.50^{b}\pm0.70$	$1.50^{a}\pm0.70$	$0.59^{a}\pm0.00$	$38.69^{ab}\pm0.84$	$29.00^{c}\pm1.41$	$0.08^{b}\pm0.00$	$0.69^{bc}\pm0.02$
H-50:50	$0.80^{b}\pm0.28$	$0.80^{a}\pm0.28$	$0.46^{b}\pm0.08$	$40.12^{ab}\pm1.18$	$59.50^{b}\pm0.70$	$0.02^{e}\pm0.00$	$0.71^{b}\pm0.00$

Values are means of ± standard deviation from duplicate determinations. Different superscript within the same column are significantly ($p<0.05$) different. ACS-Annealed cassava starch.

Table 4.: proximate analysis of millet- annealed starch cake

Sample; millet;ACS	Moisture content (%)	Ash content (%)	Crude fibre (%)	Crude lipid (%)	Crude protein (%)	Carbohydrate determination (%)
A-100:0	$0.35^{g}\pm0.00$	$1.81^{b}\pm0.00$	$11.95^{e}\pm0.00$	$27.47^{e}\pm0.00$	$11.37^{e}\pm0.00$	$47.01^{a}\pm0.00$
B-0:100	$2.10^{c}\pm0.00$	$1.45^{c}\pm0.00$	$13.67^{c}\pm0.00$	$31.65^{a}\pm0.00$	$10.93^{f}\pm0.00$	$40.17^{e}\pm0.00$
C-95:5	$2.23^{b}\pm0.00$	$0.91^{g}\pm0.00$	$13.45^{d}\pm0.00$	$27.07^{g}\pm0.00$	$11.37^{e}\pm0.00$	$44.95^{b}\pm0.00$
D-90:10	$2.29^{a}\pm0.00$	$1.24^{e}\pm0.00$	$9.40^{g}\pm0.00$	$28.31^{c}\pm0.00$	$18.81^{b}\pm0.00$	$39.94^{f}\pm0.00$
E-85:15	$2.28^{a}\pm0.00$	$1.18^{f}\pm0.00$	$14.03^{a}\pm0.00$	$27.56^{d}\pm0.00$	$16.25^{c}\pm0.00$	$38.30^{h}\pm0.00$
F-80:20	$1.88^{d}\pm0.00$	$1.42^{d}\pm0.00$	$13.71^{b}\pm0.00$	$27.13^{f}\pm0.00$	$12.24^{d}\pm0.00$	$43.58^{c}\pm0.00$
G-75:25	$1.60^{e}\pm0.00$	$0.55^{h}\pm0.00$	$8.25^{h}\pm0.00$	$28.91^{b}\pm0.00$	$21.00^{a}\pm0.00$	$39.66^{g}\pm0.07$
H-50:50	$1.40^{f}\pm0.00$	$9.43^{a}\pm0.00$	$10.58^{f}\pm0.00$	$26.23^{h}\pm0.00$	$11.37^{e}\pm0.00$	$40.95^{e}\pm0.02$

Values are means of ± standard deviation from duplicate determinations. Different superscript within the same column are significantly ($p<0.05$) different. ACS-Annealed cassava starch.

Table 4: minerals analysis of millet annealed starch cake blends

Sample: Millet;ACS	Magnesium (ppm)	Potassium (ppm)	Phosphorus (ppm)
A-100:0	$0.03^{e}\pm0.00$	$0.70^{c}\pm0.00$	$4.40^{a}\pm0.01$
B-0:100	$0.05^{cd}\pm0.00$	$0.78^{ab}\pm0.02$	$4.08^{d}\pm0.00$
C-95:5	$0.09^{a}\pm0.00$	$0.73^{bc}\pm0.02$	$4.15^{c}\pm0.00$
D-90:1	$0.03^{e}\pm0.00$	$0.75^{abc}\pm0.06$	$4.27^{b}\pm0.03$
E-85:15	$0.06^{bc}\pm0.00$	$0.80^{ab}\pm0.01$	$4.23^{b}\pm0.03$
F-80:20	$0.03^{e}\pm0.00$	$0.80^{a}\pm0.00$	$3.77^{f}\pm0.04$
G-75:25	$0.05^{de}\pm0.00$	$0.78^{ab}\pm0.00$	$3.70^{g}\pm0.02$
H-50:50	$0.07^{b}\pm0.00$	$0.80^{ab}\pm0.02$	$4.00^{e}\pm0.0$

Values are means of ± standard deviation from duplicate determinations. Different superscript within the same column are significantly ($p<0.05$) different. ACS-Annealed cassava starch.

Table 4: Physical properties of millet-annealed starch cake

Values are means of ± standard deviation from duplicate determinations. Different superscript within the same column are

Sample:	Weight(g)	Length(cm)	Height(cm)	Volume(cm^3)	Spread ratio
A-100:0	19.50^{d}±0.00	5.65^{a}±0.07	3.00^{a}±0.00	45.00^{d}±0.00	1.88^{h}±0.00
B-0:100	18.00^{f}±0.00	4.30^{f}±0.00	2.40^{b}±0.00	36.00^{e}±0.00	2.18^{b}±0.00
C-95:5	19.35^{d}±0.07	4.80^{c}±0.00	2.05^{d}±0.07	56.00^{a}±0.00	2.06^{e}±0.00
D-90:10	20.20^{c}±0.56	4.50^{e}±0.00	2.30^{c}±0.00	49.00^{bc}±1.47	2.01^{g}±0.00
E-85:15	18.80^{e}±0.14	4.60^{d}±0.00	2.00^{d}±0.00	50.00^{bc}±0.00	2.10^{d}±0.00
F-80:20	21.05^{a}±0.21	5.00^{b}±0.00	2.05^{b}±0.07	51.00^{b}±1.41	2.03^{f}±0.00
G-75:25	20.45^{bc}±0.07	4.80^{c}±0.00	2.00^{a}±0.00	55.00^{a}±1.41	2.20^{a}±0.00
H-50:50	20.80^{ab}±0.14	4.85^{c}±0.07	2.05^{c}±0.07	48.50^{c}±0.07	2.13^{c}±0.00

significantly ($p<0.05$) different. ACS-Annealed cassava starch.

Table 4: Sensory properties of millet-annealed starch flour

Sample: Millet:ACS	Aroma	Texture	Color	Taste
A-100:0	7.40^{a}±1.09	7.65^{a}±1.18	7.55^{a}±1.31	7.75^{a}±0.96
B-0:100	7.20^{a}±1.32	6.40^{cd}±1.53	7.30^{ab}±1.34	7.45^{ab}±1.35
C-95:5	6.90^{a}±1.16	6.95^{abc}±1.23	7.75^{a}±1.06	7.25^{ab}±1.51
D-90:10	7.00^{a}±1.07	6.00^{d}±1.29	6.65^{b}±0.98	6.80^{ab}±1.23
E-85:15	7.05^{a}±1.43	6.60^{bcd}±1.27	6.90^{ab}±1.20	7.40^{ab}±1.23
F-80:20	7.70^{a}±1.03	7.20^{abc}±0.83	7.20^{ab}±1.10	7.25^{ab}±1.11
G-75:25	7.55^{a}±1.09	7.45^{ab}±1.14	7.20^{ab}±1.32	7.55^{ab}±1.05
H-50:50	7.35^{a}±1.26	7.15^{abc}±1.26	7.10^{ab}±1.37	7.25^{ab}±1.44

Values are means of ± standard deviation from duplicate determinations. Different superscript within the same column are significantly ($p<0.05$) different. ACS-Annealed cassava starch.

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