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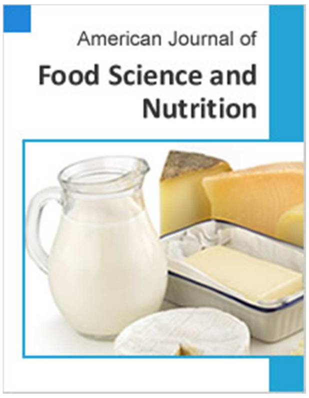

Chemical Composition and Functional Properties of Complementary Diet Developed from Millet *(Pennisetum americanum)* and Cowpea *(Vigna unguiculata)*

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Abstract
The objective of this work was to evaluate the chemical composition and functional properties of complementary diets developed from a blend of malted, unexploited cereal: millet and cowpea for infants. Complementary diet was developed from various blends of malted and unmalted millet mixed with precooked cowpea. This was evaluated for its proximate composition, functional properties and nutritional quality as well as its sensory properties. The result of the chemical composition showed that protein content was between 13.02% -14.98% in all the samples, however protein content of the malted millet-cowpea samples were higher than the unmalted millet-cowpea samples. Supplemented millet-cowpea samples had higher protein contents than the unsupplemented samples (100% malted and 100% unmalted millet). Fibre and carbohydrate contents of the malted samples were generally lower than unmalted samples. Mineral analysis showed that calcium content was between 601mg/100g – 724mg/100g, potassium content between 820mg/100g – 1274mg/100g, magnesium content between 1824mg/100g – 3114mg/100g in all the samples. Pasting characteristics showed that malted samples had lower viscosity, shorter cooking time and low retrogradation tendencies compared to the unmalted millet –cowpea samples. The overall quality of the malted formulated diets were more accepted than the unmalted samples in terms of colour, taste, texture, appearance and flavor. Millet-cowpea 70:30 diet was more accepted by the panelist. This research work revealed that an acceptable nutritious complementary diet can be produced from millet, an unexploited cereal, by malting and enriching it with cowpea flour. This will improve the nutritional value of the diet at a presumable cheaper cost.

1. Introduction

Complementary diet is usually given to infants between the ages of 6 months to 2 years while breastfeeding continues till 2nd – 3rd year. Brown *et al.* [1] described complementary diet as foods that are readily consumed and digested by infants and provide additional nutrition to meet all the growing child's needs. To meet the nutrient need of the child [2] [3], adequate complementary foods added to breastfeeding at about six month of life is very essential for adequate nutrient intake, growth, increasing activity and other necessary body functions needed for development. Insufficient access to affordable, nutritious food and support for mothers on appropriate child feeding practices amongst others are part of the underlying causes of malnutrition. Protein energy malnutrition affects productivity and contributes to high morbidity and mortality in children due to poor complementary feeding.

Traditionally, the diets of most human societies consist of starchy plant staples, such as cereals and root and tuber crops combined with vegetables and fruits. Traditional complementary foods from plant staples often fail to meet the nutritional needs of the infants, due to stiff consistency and high volume, offering a low-cost filling meal lacking adequate nutrients thus leading to poor growth and development [4].

Many underutilized crops have high nutritional value and offer untapped potentials that can contribute to fighting malnutrition [5]. These underutilized crops have potential for making complementary foods which can be available, affordable and accessible by the poor when compared to commercial complementary foods. Achidi *et al.* [6] reported that ready-to-eat complementary food products formulated from locally available food commodities (cowpea, rice, soybean, Irish potatoes, carrot, millet) can meet the macro nutritional needs of infants and children. Laminu *et al.* [7] also reported the need to develop weaning food from locally available resources which are economical, easily digestible and acceptable to children by supplementing locally available cereals with legumes. Legumes are good sources of dietary protein which is rich in lysine and tryptophan, and are cheaper than animal protein [8]. Cereals are good sources of protein, but their protein is deficient in lysine and tryptophan however, they are rich in methionine and cysteine, whereas legumes which are also high in protein are rich source of lysine but deficient in sulphur containing amino acids ([9] [10] [11]). It is therefore expected that a complementary diet developed from a combination of cereal and legumes should be a good source of quality protein. Ozumba *et al.* [12] also reported that the utilization of commonly available cheap cereals and legumes to formulate complementary foods can produce diets with low viscosity and high caloric density which are adequate in necessary nutrients. Complementary food can be developed from a combination of millet (*Pennisetum americanum)* an underutilized crop, and cowpea *(Vigna unguiculata),* a legume which is a good source of protein that is rich in sulfur-containing amino acids such as methionine. A blend of these underutilized cereal (millet) and cowpea (legume), which though widely consumed in Nigeria but is not commonly used in formulating complementary diet, can be used to produce a nutritious complementary diet. This diet can be cheap, affordable, available and culturally accepted by the children, their mothers and other care givers. Malting and pre-cooking are part of the processes used to modify the starch structure of complementary diets from starchy staples to reduce their bulk, and viscosity ([13] [14]). Thus, the objective of this study was to develop and evaluate the chemical composition, functional properties and acceptability of complementary diet developed from varying combinations of malted millet-cowpea and unmalted millet-cowpea. The effect of malting on the nutritional value and acceptability of the complementary food was also determined.

2. Materials and Methods

2.1. Materials

Millet (*Pennisetum americanum)* and cowpea *(Vigna unguiculata)*, were obtained from an open market in Iwo, Osun State, Nigeria. The grains were sorted out to remove dirt, stones and other extraneous materials and stored in clean polyethene bags prior to commencement of the experiment.

2.2. Sample Preparation

2.2.1. Preparation of Malted Millet

The sorted millet grains were washed thoroughly with clean water. Malted millet was prepared by the method of [13]. The grains were soaked in water (1:2 w/v) for 6 hours. After 6 hours, the water was drained and the grains were tied in moist jute bags to germinate. The grains were watered 2 times a day at regular intervals. After germination for 2 days (48 hours), the grains were dried in a cabinet dryer at 60°C for 4 hours. The vegetative parts were removed by rubbing between palms and winnowing. The dried malted grains were milled in a disc attrition mill, sieved to obtain fine flour, packaged in polyethylene bag and then stored at room temperature.

2.2.2. Preparation of Unmalted Millet

The sorted millet grains were washed thoroughly with clean water. It was dried in a cabinet dryer at 60°C for 4 hours, milled, sieved and then packaged in a polyethylene bag.

2.2.3. Preparation of Precooked Cowpea

The sorted cowpea was soaked for 10 minutes after which it was washed thoroughly with clean water to remove the hull. The dehulled cowpea was tied in a muslin cloth and parboiled in pot for 9 minutes, to remove the beany smell to a very low degree and this heat treatment may also remove some anti-nutritional factors present in the beans. The parboiled cowpea was dried in a cabinet dryer at 60°C for 5 hours after which it was dry milled.

2.3. Diet Formulation

The diet mixture was formulated as follows: Sample A - 100% malted millet flour, Sample B - 100% unmalted millet flour, Sample C - malted millet and cowpea flour 80:20, Sample D - malted millet and cowpea flour 70:30, Sample E - unmalted millet and cowpea flour 80:20, and Sample F - unmalted millet and cowpea flour 70:30.

2.4. Proximate Analysis

The proximate composition of the samples; moisture content, crude fat, crude protein, crude fibre and ash, was determined by AOAC [15] method. The total carbohydrate was determined by difference (%Carbohydrate = 100 - %Protein + %fat + %Crude fibre + %ash + % moisture).

2.5. Mineral Analysis

The formulated blends were analyzed for some mineral contents: Iron (Fe), Calcium (Ca), Potassium (K) and Magnesium (Mg). The obtained ash of each sample was digested by adding 5ml of 6M HCl to the ash in the crucible and filtered through a Whatman No. 1 filter paper into a 50ml volumetric flask. The filtrate was made up to mark with distilled water, stoppered and made ready for concentration reading. The Iron content was determined by means of Atomic Absorption Spectrophotometer (AAS) while the Calcium (Ca), Potassium (K) and Magnesium (Mg) were determined with a flame photometer (Jenway Digital Flame Photometer PFP 7 Model). The concentration of each mineral in the sample was calculated using the readings obtained and dilution factor.

2.6. Determination of Functional Properties

The bulk density of the samples was determined according to the method of Okaka *et al.* [16], water absorption capacity was determined by the method of Sosulki [17], and swelling power was determined by the method of Leach *et al.* [18].

2.7. Determination of Pasting Properties

The pasting properties of the samples were analyzed using Rapid Visco Analyzer (RVA) Super 4 (Newport Scientific Pty. Ltd., Sydney, Australia) with the aid of thermocline for windows (version 1.1 software, 1996). 3.0g of each of the formulated complementary diet was suspended in 25ml of distilled water respectively in an RVA canister and inserted unto the RVA machine. A 13-minute profile as described by Otegbayo *et al.* [19], was used. The 13-minute profile has the following time-temperature regime: idle temperature 50°C for 1min, heated from 50°C to 95°C in 3min 45s, and then held at 95°C for 2min 30s. The sample was subsequently cooled to 50°C over a 3 min 45s period followed by a period of 2min where the temperature was controlled at 50°C. A pasting profile was generated from the machine onto the computer, parameters extracted from the pasting profile (through the software thermocline for windows) were: peak viscosity, holding strength, breakdown, final viscosity, setback, peak time and pasting temperature.

2.8. Sensory Evaluation

The formulated blends were reconstituted into pastes by weighing 25g of each diet into about 50ml of water and then stirred rigorously to form a smooth slurry. Hot boiling water was added to the slurry and mixed until a consistent paste was formed. About 40 ml of paste from each of the samples were put in coded sensory cups and served at room temperature (25°C) for assessment by panelists consisting of ten mothers selected randomly among the female porters from Bowen University in Osun State, Nigeria. These women (the mothers who were used as assessors/panelists) were selected on the basis that they were nursing mothers with at least a child in the range of 6-24 months old (that is, they have children of complementary feeding age) and also on their willingness and availability to participate in the sensory evaluation. Mothers were used instead of children (target recipients) because of their ability to objectively evaluate the sensory qualities of the formulated blends rather than children who cannot distinguish between the samples. The panelists evaluated the paste for appearance, colour, flavor, taste, texture (mouth feel) and overall acceptability using a 9-point hedonic scale, where 9 indicated 'like extremely' and 1 'dislike extremely'. 1-9 hedonic scale was used to have a wider range of choices for evaluation by the panelists.

2.9. Statistical Analysis

The data obtained were analysed using Analysis of Variance (ANOVA). The statistical differences between mean values were separated with Duncan Multiple Range Test (DMRT) at 5% probability level ($p<0.05$) using SPSS (version 16.0). All the experiments were conducted in triplicate.

3. Results and Discussion

3.1. Proximate Composition

The proximate composition of the diets is shown in Figure 1. The moisture content of the samples ranged between 5.30-8.30%. Sample E, 80:20 unmalted millet- cowpea, had the lowest moisture content while sample A and C, 100% malted millet and 80:20 malted millet- cowpea respectively, had the highest moisture content. The results indicated that the moisture content of these samples met the minimum recommendation by FAO/WHO [20], of less than ten (<10) pattern indicated for processed cereal foods (5% - 10%) recommended by Protein Advisory Group [21]. Sample E, 80:20 unmalted millet – cowpea, had the lowest moisture content which is desirable in complementary foods so as to enhance the stability of quality and extend the shelf life of the diet during storage. In addition, Oduro *et al.* [22] and Morris *et al.* [23] also reported that low moisture content can increase the concentration of the nutrients in foods and make it more available. There was significant increase in the protein content with malting from 12.68% for the unmalted to 14.98% of the malted samples. This is in line with the findings of Gernah *et al.* [24] who stated that increase in protein content of germinated maize could be as a result of mobilization of storage nitrogen to aid germination and the synthesis of enzymatic proteins by germinating seed ([25] [26]). Sample D, (70:30 malted millet – cowpea diet), had the highest protein content (14.98%) among the formulated complementary diet samples. The reason for the high protein content in this diet compared to the other diets may be adduced to its higher cowpea content. This result is in agreement with Almeida-Domiguez [27] who reported that cowpea increased the protein content of millet based complementary food. The nutritional value of millet is greatly enhanced when malted and preferably mixed with legumes because it complements its profile of essential amino acids [28]. The ash content ranged from 1% - 3% among the complementary diet samples. The importance of the ash content is that it indicates the mineral portion of a food. There was no significant difference between the malted samples and unmalted samples in terms of their ash contents. This could be as a result of leaching during soaking, though the ash content of the samples still falls within the recommended value of 5% for complementary food [21]. Crude fibre content ranged between 4.00% - 6.65%. Sample B (100% unmalted millet), had the highest fibre content (6.65%). Malted millet- cowpea blends, C and D (80:20 and 70:30 respectively) had the lowest fibre content, 4.00%. The fibre content of the malted samples was below the 5% range recommended by FAO/WHO [20] while those of unmalted samples were slightly higher than this range. The low fibre content of the malted-cowpea diets in this study could be of nutritional advantage in a complementary formula, because it will improve the quality of the complementary diet. Also, it has been reported that when fibre content of a complementary diet is above 5%, it can reduce the nutrient density of the food by adding bulk, and may cause gastrointestinal irritation as well as reduce the availability of minerals such as calcium, magnesium, iron, zinc and copper ([29] [30]). The result also showed that unsupplemented millet diet (i.e. 100% millet without cowpea) either malted or unmalted have higher fibre content than the recommended amount for complementary feeding. The carbohydrate content of the samples ranged from 53.07% - 55.07%. The carbohydrate content of the malted samples were generally reduced probably as a result of the action of enzymes which was liberated during malting [31]. Low carbohydrate content of the malted samples may be as a result of liquefaction and saccharification action on starch by α and β amylases which converted the starch to sugars during malting. The higher carbohydrate content of sample F may be due to the addition of cowpea (Figure 1), (which indicated that more energy will be derived from its consumption). There was significant decrease at $p<0.05$ in fat content of unmalted samples compared to the malted samples. This could be due to the activities of hydrolytic enzymes which hydrolyzed the fat in the millet during malting. The result of the proximate composition of the malted complementary diet samples were in agreement with Gernah *et al.* [24] who reported a significant reduction ($p<0.05$) in carbohydrate, crude fat and crude fibre content during germination.

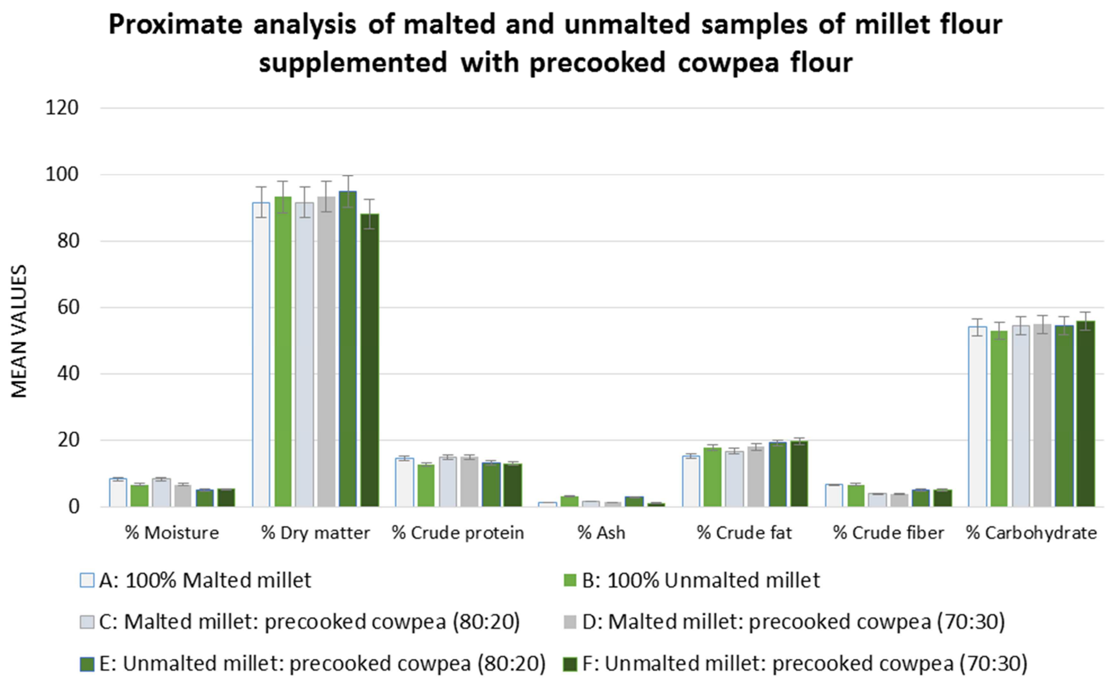

Figure 1. *Proximate analysis of malted and unmalted samples of millet flour supplemented with precooked cowpea flour.*

3.2. Mineral Composition

Children develop birth defects and inability to learn properly, among other long-term disabilities when minerals are in inadequate supply ([32] [33]). Cereals and legumes are important food sources of Iron, Zinc, and Calcium for young children in rural areas [34]. The process of germination has been reported to increase the level of certain minerals and relief the effect of anti-nutritional factors such as phytic acid in cereals ([8] [35] [36]). The mineral content of the complementary blends were found to be higher in the malted millet-cowpea blends than those in the unmalted millet-cowpea blends. This may be due to the inclusion of cowpea as well as the fact that malting process improves the nutritive value and bio-availability of mineral content in food. Table 1 shows the result of some selected mineral contents of the samples. Calcium which is an essential mineral necessary to build bones and teeth, is higher than the 525mg/day daily intake required in complementary foods for 6-12 months old and the 350mg/day for 12-23 months infant, in the various millet-precooked blends for both malted and unmalted treatment. This indicated that calcium content of the blends will adequately meet the calcium needs from complementary foods [37] for ages 9-11months (based on daily consumption of 250mg/d); and in excess of the required calcium content needed for 11-23months (based on daily consumption of 750mg/d) [38].

Generally, it was observed that the magnesium content of the formulated complementary diets in this study were very high. This however is higher than the values recorded by Ikujenlola and Adurotoye [34], who worked on steamed cowpea and maize. The potassium content of the blends is also higher than 700mg/day [37] recommended intake. However, the iron content of the blends is lower than the 11mg/day recommended nutrient intake.

Table 1. *Mineral content analysis of malted and unmalted millet supplemented with different ratios of precooked cowpea flour.*

	A	B	C	D	E	F
Calcium (mg)	601.0±0.1	652.0±0.0	705.0±0.2	742.0±0.1	611.0±0.1	601.1±0.3
Potassium (mg)	985.0±0.0	1057.0±0.3	1274.0±0.1	1024.1±0.0	1012.3±0.6	820.0±0.3
Magnesium (mg)	1224.0±0.1	2111.0±0.1	2925.0±0.3	2560.2±0.0	3114.2±0.0	2925.1±0.0
Iron (mg)	0.01±0.0	0.02±0.0	0.02±0.0	0.02±0.1	0.02±0.0	0.02±0.0

Sample A –100% Malted millet. Sample B –100%Unmalted millet. Sample C –Malted millet: precooked cowpea (80:20). Sample D – Malted millet: precooked cowpea (70:30). Sample E – Unmalted millet: precooked cowpea (80:20). Sample F – Unmalted millet: precooked cowpea (70:30).

3.3. Functional Properties

The result of the functional properties of the samples are presented in Table 2. The highest water absorption capacity (WAC) was recorded in 80:20unmalted millet - precooked cowpea (sample E). According to Singh [39], WAC is the ability of a product to associate with water under a condition where water is limiting. The significance of water absorption capacity is that such products can be used where lower water absorption capacity is desirable especially in complementary diets which require thinner gruels with high caloric density per unit volume**.** The high water absorption in sample blends having ratio 70:30 (i.e. both malted and unmalted 70:30), D and F, may be attributed to their protein content, as proteins are hydrophyllic in nature and it will make the diet to absorb and bind more water ([40] [41] [42]). All the samples had low bulk density, as all the bulk density values were less than one (< 1), which implies that the gruel or porridge made from this diet will have a lower dietary bulk. This is important in complementary foods because high bulk limits the caloric and nutrient intake per feed per child, and infants are sometimes unable to consume enough to satisfy their energy and nutrient requirements [43]. Apart from the dietary bulk of the gruel made from the diets, the bulk density is also important in the packaging requirement and material handling of complementary diets [44]. Swelling power ranged from 6.13 – 8.20. 100% unmalted millet, (sample B), had the highest swelling power value while the malted millet samples had the lowest values ranging from 6.13 – 6.70. Malting has the potential to modify the starch content of cereal so that they do not thicken and would therefore require no dilution, resulting in nutritionally balanced calorie diets, low dietary bulk and easily digestible food such as complementary food. Reduction in the swelling power of the malted samples may be attributed to reduction in their starch content as a result of dextrinization of the starch by amylases during malting. The implication of this low swelling power to the quality of the complementary diet is that, thinner gruels with low viscosity will be produced while the unmalted samples which had higher swelling power will produce thick viscous gruels which is as a result of their higher carbohydrate content. According to WHO [45], appropriate weaning food is the one which produces a gruel that is neither too thick (when it is too thick, it will be difficult for the infant to ingest and digest because of limited gastric capacity) for the infant to consume. The result of the solubility index ranged from 17.30 to 11.20. Sample A, 100% malted millet, had the highest solubility index value. According to Kinsella [46], solubility is an index of protein functionality such as denaturation and its potential applications. The higher the solubility, the higher the functionalities of the protein in the food.

Table 2. *Functional properties of malted and unmalted samples of millet supplemented with cowpea flour in different ratio.*

	A	B	C	D	E	F
WAC	1.5_{bc}	1.4_{c}	1.7_{bc}	2.2_{a}	1.8_{b}	2.2_{a}
% SI	17.3_{a}	13.0_{ab}	13.7_{ab}	12.8_{ab}	11.8_{b}	11.2_{b}
Swelling power	6.4_{c}	8.3a	6.7_{b}	6.1_{d}	8.2_{a}	8.2_{a}
Bulk Density	0.7_{bc}	0.7_{c}	0.6c	0.8a	0.7_{bc}	0.8_{a}

Values with different subscripts across the same row are significantly different (p≤0.05). Sample A –100% Malted millet. Sample B –100%Unmalted millet. Sample C –Malted millet: precooked cowpea (80:20). Sample D – Malted millet: precooked cowpea (70:30). Sample E – Unmalted millet: precooked cowpea (80:20). Sample F – Unmalted millet: precooked cowpea (70:30). WAC – Water Absorption Capacity. SI –Solubility Index

3.4. Pasting Properties

Pasting quality is the combination of the processes that follows gelatinization from granule rupture to subsequent polymer alignment due to mechanical shear during heating and cooling of starches [47]. It also indicates the viscosity of the complementary diets. Table 3 showed that all the malted formulated complementary diets had very low peak viscosity, holding strength, set back as well as low final viscosity compared to the diets made from all the unmalted millet samples. Peak viscosity indicates the thickness and viscosity of a paste after cooking, while final viscosity represents the viscosity of the cooked paste on cooling, and also point out the retrogradation tendency of the gruel prepared from the diet. The low peak viscosity and low final viscosity of the malted complementary diet samples may be as a result of reduction in the starch content of the diets due to hydrolysis of the starch into simpler units by amylolytic enzymes during malting. This implies that that they will form a low viscous or thin paste on cooking and cooling with low retrogradation tendency. This is in agreement with the report of Ikujenlola [14], Ikujenlola and Fasakin [10] and Desikarchar, [48] on complementary diets developed by malting. The implication of a thick gel to a complementary diet is that it can affect the gastric system of the child since they have limited gastric capacity to metabolize thick or viscous foods [43]. The pasting temperature indicates the gelatinization temperature of the starch, hence its cooking time. From table 3, the pasting temperature of the malted samples were lower than that of the unmalted samples. The implication of this is that the malted complementary diets will have a shorter cooking time (hence reduce energy cost, more economical) compared to those developed from unmalted millet. The pasting temperature of the malted millet-cowpea diets was however higher than that of the malted millet alone. This is probably due to the inclusion of the cowpea (which contain some carbohydrate). The low break down, holding strength and set back viscosities of the malted samples compared to the unmalted samples indicated that the gruel from malted samples will have lower retrogradation tendency and also form cohesive pastes. Kim *et al.* [49] reported that the lower the setback of a paste, the lower its tendency to form a cohesive paste. These pasting characteristics of the cooked gruel thus indicates that complementary diet from the malted-millet-cowpea diets will form a less viscous thin gruel which will not require dilution with a shorter cooking time and lower tendency to retrograde on cooling. It is important for the complementary diet to have low viscous and high caloric density food per unit volume which is needed for the gastric capacity of the children rather than a dietary bulk and thick gel.

Table 3. *Pasting characteristics of the experimental complementary food.*

	Peak visc (cP)	Holding strength (cP)	Breakdown (cP)	Final viscosity (cP)	Set back (cP)	Peak time (mins)	Pasting temperature (°C)
A	43.5_d	22.0_d	21.5_a	96.0_d	26.0_d	3.5_c	53.1
B	227.0_b	218.0_b	9.0_b	748.0_b	526.0_b	5.2_b	97.9_a
C	37.5_d	20.0_d	17.5_{ab}	49.5_d	29.5_d	4.1_{bc}	86.8
D	42.5_d	21.5_d	21.0_a	49.5_d	28.0_d	4.3_{bc}	86.9_a
E	176.0_c	164.0_c	15.0_{ab}	601.0_c	439.5_c	7.0_a	93.7_a
F	248.5_a	228.5_a	20.0_a	851.5_a	623.0_a	37.8_a	93.7_a

Values with different subscripts across the same row are significantly different ($p \leq 0.05$). Sample A –100% Malted millet. Sample B –100%Unmalted millet. Sample C –Malted millet: precooked cowpea (80:20). Sample D – Malted millet: precooked cowpea (70:30). Sample E – Unmalted millet: precooked cowpea (80:20). Sample F – Unmalted millet: precooked cowpea (70:30).

3.5. Sensory Attributes

The result of the sensory evaluation is presented in Table 4. The panelists rated the malted samples better than the unmalted samples in terms of colour, taste, texture (mouth-feel), appearance, flavor and overall acceptability. This may be due to the flavor impacted on the millet during malting. Sample D, 70:30 malted millet- precooked cowpea, was rated the highest in all the sensorial attributes evaluated. Ikujenlola and Adurotoye [34] reported similar result in malted 70:30 maize and steamed cowpea, as well as Oyarekua, [38] in sensorial attributes of fermented 70:30 millet/cowpea *ogi* and Olapade *et al.* [50] recorded similar acceptance in 30% boiled cowpea inclusion in *ogi*. The malted blends were rated creamy brown in colour after cooking which is very desirable in complementary diets.

Table 4. *Organoleptic Evaluation of Experimental Complementary Food by Nigerian Women, Osun State.*

Complementary Food Formulation	Colour	Taste	Texture (mouth-feel)	Appearance	Flavour	Overall acceptability
A	3.8_b	4.1_{bc}	6.1_b	3.9_d	1.8_c	4.0_c
B	3.7_b	3.7_c	5.8_b	3.6_d	2.1_{bc}	4.4_c
C	4.6_b	4.0_{bc}	6.0_b	5.8_b	3.4_b	5.4_b
D	6.1_a	5.4_a	7.5_a	6.8_a	4.8_a	6.7_a
E	4.4_b	5.2_{ab}	5.0_b	5.3_{bc}	3.3_b	4.8_{bc}
F	3.8_b	4.4_{bc}	4.9_b	4.4_d	3.3_b	4.1_c

Values with different subscripts across the same row are significantly different ($p \leq 0.05$). Sample A –100% Malted millet. Sample B –100%Unmalted millet. Sample C –Malted millet: precooked cowpea (80:20). Sample D – Malted millet: precooked cowpea (70:30). Sample E – Unmalted millet: precooked cowpea (80:20). Sample F – Unmalted millet: precooked cowpea (70:30).

4. Conclusion

It can be inferred from this research that malted diets will form a low bulk, low viscous and high caloric density food per unit volume rather than a dietary bulk and thick gel. The use of cowpea is innovative and the blend of these two cheap and culturally acceptable food crops is expected to produce a desirable low cost complementary diet which will help in alleviating malnutrition among children of complementary feeding age. Millet and cowpea are affordable, available, accessible and culturally accepted by both children, their mothers and other care givers hence a complementary diet made from these two acceptable crops will be easy to adopt and adapt by the actual target group that will consume it. Since the blends are acceptable by the mothers (panelists) and mothers influences a child's diet, hence through nutrition education, mothers who are gatekeepers and caregivers of the home will feed their children.

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