International Journal of Food Science and Nutrition
ISSN: 2455-4898
Impact Factor: RJIF 5.14
www.foodsciencejournal.com
Volume 3; Issue 5; September 2018; Page No. 86-92

Physicochemical, microbial and sensory properties of MOI-MOI as affected by processing method

Agbara Gervase Ikechukwu[1], Haruna Blessing[2], Chibuzo Elizabeth Chinyere[3], Agbara Helen Ngozi[4]
[1-3] Department of Food Science and Technology, University of Maiduguri, Nigeria
[2] Department of Home Economics, Kashim Ibrahim College of Education, Maiduguri, Nigeria

Abstract
Cowpea seeds were differently processed into flours by sprouting, steeping, supplementation with dehulled maize flour (30%), each had dehulled and undehulled counterpart, the controls were untreated cowpea flour making a total of eight samples code-named: DC, UC, SDC, SUC, 16DC, 16UC, 16DC+DM, 16UC+DM; from each moimoi was prepared. Some of the functional and proximate properties of the flours were evaluated, prepared moimoi were subjected to proximate, mineral content and sensory evaluation. The water and oil absorption capacities (WAC & OAC) were low, highest values of WAC (143.57% and 142.98%) were recorded in the sprouted dehulled (SDC) and (16 h steeped dehulled cowpea flour plus maize flour (16DC+DM) respectively. OAC (126.45% & 126.24%) followed the same trend, the control had the least WAC or OAC (73% and 65%); bulk densities of the sprouted were the least (0.448 & 0.437%). Moisture, fat, protein, ash, crude fiber and carbohydrate contents of the moimoi varied significantly ($p<0.05$), 62.65-71.26%, 3.80-9.30%, 4.72-10.32%, 2.16-3.45%, 2.26-3.65%, and 5.29-19.15% respectively. The control had the highest dietary energy (158.64kcal), significantly different from cowpea-maize moimoi (16DC+DM) which had the least (119.34kcal). The mineral contents (mg/100g) differed significantly ($P<0.05$) and the undehulled control had better mineral profile. The highest Iron content (1.45) was observed in the sprouted (SDC), but the highest level of Calcium (73), Magnesium (2.01), Potassium (98) and Phosphorous (2.98) were located in the control (DC).The control had the best sensory scores and moimoi made from sprouted cowpea flours were least appreciated, however were not disliked. The nutrient profile of the sprouted cowpea flours/moimoi were the best although the organoleptic attributes were unlike the traditionally made moimoi consumed for a long time immemorial.

Keywords: steeping, sprouting, dehulling, cowpea flour, supplementation, moimoi

1. Introduction

Moi-moi is a gel made from dehulled, wet-milled cowpea (*Vigna unguiculata* Walp) paste with added ingredients such as vegetable oil, spices etc. and the subsequently steamed to a soft gel which further solidifies on cooling. Cowpea is the foremost grain legume in Nigeria and other West African countries, consumed in different forms: processed chiefly and eaten as moi-moi, akara, danwake etc. or cooked together with a cereal grain usually rice, or with a root or tuber such as yam, cocoyam, potatoes etc. These cowpea-containing meals are the major source of protein to Nigerians of the low income group [1, 2]. Cowpea centre of domestication is under speculation however Steek and Mehra [3] believed West Africa is the origin of cowpea on the basis of common availability of the progenitors in the wild and a suitable agro-climatic environment for its cultivation. Nigeria and Niger have been the leading producers of cowpea in the world [4]. Demand for cowpea in Nigeria outstripped its production due to rising population and awareness of its nutritive value, therefore Nigeria is also one of the importers of cowpea in the world. Urbanization comes with crave for convenient or instant foods or eat-always. Traditional food preparation is laborious therefore time-conscious city dwellers look with disdain on indigenous food preparation process. Olapade *et al.* [5] and Owuamanam *et al.* [6] stressed the need for the use of cowpea flour for preparation of cowpea based products such as moimoi, akara, in order to avoid such unit operations as soaking, dehulling, wet milling. Pulses are loaded with high quality nutrients enough to promote health and wellness [7, 8]. Cowpea seeds contain 20-25% protein, 1.5-4% crude fiber, 1-2% fat, 3-4% ash and 55-68% carbohydrate in addition to vitamins and beneficial phytochemicals [9, 10]. Processing methods such as dehulling, soaking, cooking, germination, fermentation etc. help reduce or eliminate anti-nutrients which according to Singh [11] and Bressani [12] include protease inhibitors, goitrogenic factors, flatulence factors, hemagglutinins, phytates etc. which individually or collectively reduce protein or carbohydrate digestibility, mineral and vitamin bioavailability [13, 14]. Steeping and germination activates endogenous and exogenous enzymes that modify the seed polymeric units into simpler highly absorbable forms, decrease anti-nutrients, liberate chelated minerals [15, 16]. However, dehulling the cowpea seeds prior to moimoi or akara preparation deprives the consumers the needed dietary fiber that ensures healthy digestive system, reduce the risk of chronic diseases such as diabetes, obesity, cardio-vascular diseases through lowering bad cholesterol and postprandial glucose surge [17, 14]. Cereal grains and legumes mutually complement each other when consumed together in a beneficial ratio (28:72, legume: cereal) therein they provide equal amounts of highly needed quality protein [18, 12].The common traditional practice of consuming cowpea- based products alongside with cereal foods (Ogi, kunu zaki, bread etc.) in Nigeria is long and how it started like many other food habits/practices is uncertain. Supplementation of cowpea with maize will ensure better amino-acid profile; lysine deficient maize protein complements the sulphur amino acids lacking in cowpea thereby enhancing the nutritive value of a meal such as moimoi. Therefore the aim of this study was to produce cowpea flours by different processing methods, thereafter evaluate some of the physicochemical properties, microbial and acceptability of the moimoi/flour.

2. Materials and Methods

2.1 Collection and preparation of raw materials

Cowpea seeds (var., black-eyed white), maize(white flint), red oil, powered red pepper, bullion cubes, onions etc. were purchased at Maiduguri Monday market, northeastern Nigeria, the materials were taken to Food Processing Lab., Department of Food Science & Technology, University of Maiduguri.

1. The cowpeas and maize seeds were sorted, and winnowed to remove extraneous materials. 2kg of the cleaned cowpea 20 minutes to soften the seed coat, they were divided into two portions. One portion was manually dehulled, oven dried (70°C, 10h) milled sieved (0.4mm screen) and packaged in a low density polythene and stored. The other portion was not dehulled but was oven dried, milled, sieved, packaged and stored.
2. Another 4kg of cleaned cowpea seeds were steeped (1:4 w/v) for (16h). One portion was dehulled, oven-dried, milled and sieved (0.44mm mesh screen) and bagged, the other was not dehulled rather oven-dried, milled, sieved and bagged.
3. The method of Obioza *et al.* [19] was used to sprout the cowpea seeds. A 2kg of cleaned cowpea seeds were steeped 16 h, and then spread on hot water-washed jute bags to sprout partially for 36 minutes. This was accompanied by six hourly water sprays on the seeds. The partially sprouted seeds were washed, portioned into four. One portion was dehulled manually, oven-dried, milled, sieved and bagged; another portion was not dehulled but oven-dried, milled, sieved and bagged.
4. 2kg of maize seeds were sorted, winnowed to remove impurities. The cleaned maize seeds were moistened with water and taken to a local mill for dehulling. The dehulled maize seeds were sun dried, milled, sieved, (0.40mm mesh screen) and bagged.16h steeped dehulled cowpea flour was mixed with dehulled maize flour in the ratio of 70:30 respectively; and the 16h steeped, un-dehulled cowpea flour was mixed with dehulled maize flour in the ratio of 70:30 respectively. The two blends were mixed in a Master Chef blender (HBC-180 Crown star, China). A total of eight (8) cowpea flour/ blends were produced for moi-moi production which were code-named as follows:
   i) DC= Dehulled cowpea flour after 20 minutes soaking.
   ii) UC= Un-dehulled cowpea flour after 20 minutes soaking.
   iii) SDC= Dehulled partially sprouted cowpea flour (36 h germination).
   iv) SUC= Un-dehulled partially sprouted cowpea flour steeping, (36h germination).
   v) 16DC= Dehulled cowpea flour (16 h steeping).
   vi) 16UC= Un-dehulled cowpea flour (16 h steeping).
   vii) 16DC+DM= Dehulled cowpea flour (16 h steeping) blended with dehulled maize flour (70:30).
   viii) 16UC+DM= Un-dehulled cowpea flour (16 h steeping) mixed with dehulled maize flour (70:30).

2.2 Preparation of moi-moi with cowpea flours/ blends

Traditional method of moi-moi preparation as described by Akusu and Kiin-Kabari [20] was adopted for moi-moi preparation with modification. The recipe used presented in Table 1.

Table 1: Recipe for moimoi preparation from the formulations

Formulation	Cowpea flour(g)	Maize flour(g)	Water (ml)	Red oil (ml)	*Spice mix(g)	Bullion cubes(g)
DC	100	-	225	15	7	5
UC	100	-	225	15	7	5
SDC	100	-	225	15	7	5
SUC	100	-	225	15	7	5
16DC	100	-	225	15	7	5
16UC	100	-	225	15	7	5
16DC+MD	70	30	225	15	7	5
16UC+MD	70	30	225	15	7	5

***** Red pepper and Onion powder (1:1)

The cowpea flour blend were separately mixed with the dried ingredients, then red oil was added, the mixing continued in a Kenwood mixer at low speed, then water was added gradually with continuous mixing until watery slurry was formed, which was scooped into transparent light density polythene films and sealed. They were steamed by placing in a pot with small quantity of boiling water, covered and cooked for 45 minutes, steamed gelled paste were removed, cooled and sensory evaluation conducted.

2.3 Sensory evaluation

The cooled moimoi samples were randomly presented to fifteen (15) panelists comprising of part five students of the Department (FST), 9 females and 6 males. The coded samples were presented on disposable plates with disposable spoons. The attributes assessed were appearance, aroma, taste, mouth feel/texture and overall acceptability on a nine-point Hedonic scale where 1 represents dislike extremely and 9 liked extremely, 5 neither liked nor disliked. Table water was provided for mouth gaggling before proceeding to the next sample. The control provides the template or reference point for evaluation of other samples.

3. Physiochemical analysis of the cowpea flours/blends and moimoi

3.1 pH of the flour blends

The pH of 10% suspension of each cowpea flour/blends was obtained using a pH meter. Distilled water was used to standardize the pH meter, the suspension was mixed, allowed to stand for 20 minutes before inserting the pH electrode.

3.2 Water absorption capacity

The oil and water absorption capacities of the differently processed cowpea flours\blends were determined by the method of Beuchat [21] the results expressed in millilitre per gram. Bulk density of flour/blend was determined by the method of Onwuka [22].

3.3 Proximate composition of cowpea flours/blends and moimoi

Moisture, ash, fat, protein (% N × 6.25) and crude fiber contents of the cowpea flours/blends and moi-moi were determined by the approved methods of AOAC [23] approved methods 950.46, 920.153, 991.36, 928.08, and 923.21 respectively. Carbohydrates contents were calculated and obtained by difference. Results expressed as mean of triplicate determination on g/100g (%).

3.4 Mineral contents of the differently processed moimoi samples

Five grams (5g) of each moi-moi samples was dry-ashed at 550°C 6 hours [23]. The ash from each sample, was mixed with 2ml of concentrated Nitric acid (HNO_3) in a 100ml volumetric flask and made up to volume with deionised water. Iron (Fe), Calcium (Ca), Magnesium (Mg), Potassium (K) and Phosphorous (P) concentrations in the digest was determined using atomic absorption spectrometer (Smart Spectro 2000, La Motte, US) according to procedure provided by the equipment manufacturers [24]. 10ml of each digest was scanned black then treated with respective reagents provided, then rescanned, the result was read off the instrument screen in parts per million (ppm) and reconverted to mg/100g

3.5 Microbial status of the moimoi (overnight, 16h)

The microbial status of the moimoi was assessed using the procedures of APHA [25]. Nine milliliters (9ml) of peptone water was dispensed in several mercenary bottles and autoclaved (121°C, 15mm) and cooled. 1g of each differently processed moi-moi samples was infused. Meanwhile Plate count agar (Aerobic mesophilic count) McConkey Agar (Coliform count), Sabouraud Dextrose agar (sda) (Yeast/mould count) and Violet red bile agar (*E. coli* count) were sterilized, cooled and poured separately into labeled duplicate Petri dishes. 1ml of infused moimoi was pour-plated on the listed agar and incubated at 37°C, 48 h except SDA plates that were incubated at room temperature (28±20) for five days. The colonies were counted using a digital colony counter (Gallenkamp, UK) and the mean results expressed in colony forming units per gram of the sample (cfu/g).

4. Results and Discussion

The moisture, fat, protein, ash, crude fiber and carbohydrate contents varied as follows; 62.65-71.26%, 9.30-3.80%, 4.72-10.32%, 2.16-3.45%, 2.26-3.65%, 5.29-19.15% respectively. Energy values were low (119.34-158.64 kcal), least values were observed in cowpea-maize moimoi due to the least level of fat and protein.

Moisture contents of the moi-moi were high implying low dry matter content and low shelf stability. The controls moimoi(DC and UC) had significant lower moisture contents, the moisture level of the others were not significantly different except the sprouted undehulled(SU) with the highest moisture content (71.26%), no clear cut difference between the moisture content of the dehulled and the undehulled moimoi was observed.

Fat content of the moimoi from dehulled cowpea flours were greater, the sprouted leading with 9.30%, the maize flour supplemented moimoi(16SU+DM) trailing with 4.10%, the 16 h steeped dehulled moimoi (16SD+DM) was also highly significantly different from the control. Highest fat content was recorded for sprouted moi-moi (dehulled) followed by 16 h steeped dehulled moimoi with 7.0% this implies that sprouting or steeping increased the fat, protein, and fiber contents, since cowpea seeds contain 1-2%, fat 3-4% ash, 3.4.5% fiber, and 22-.25% protein [26, 27].

The protein contents of the moi-moi undehulled cowpea flours were significantly higher from then undehulled sprouted having the highest followed by the dehulled sprouted, the maize supplemented moi-moi had the least protein contents, the untreated control moi-moi's protein content were greater than the 16 h steeped moi-moi. Protein contents of the moi-moi made from sprouted cowpea flour were the highest 10.32% for the dehulled and 7.70% for the undehulled. For cowpea-soybean moimoi Ogundele *et al.* [28] reported protein content that ranges from 4.14-11.60%, while Akusu and Kiin-Kabari [20] obtained 15.40-21.59% for cowpea-maize moi-moi. Cowpea like most pulses is noted for high protein content but the product of these legumes will have less protein than the intact seeds due to processing. Devi *et al*. [29] reported 9-12% protein for sprouted cowpea flour and linked the increase to loss of starch. Ahmed *et al.* [14] also observed an increase in protein, fat, and fiber in soaked or germinated guar gum seeds and attributed the increase to enzymatic activities in the sprouted seeds. Dilution of the cowpea flour with starchy dehulled maize flour was responsible for the low values of protein and other nutrients in cowpea-maize moi-moi.

The ash contents of the moi-moi were also greater in the dehulled moi-moi. The highest contents of ash were observed in the maize supplemented moi-moi followed by the sprouted (3.28and 2.70), and then the control (2.96 and 2.73), the 16hr steeped registered the least ash contents (2.61 and 2.16%). The ash contents were greater in the dehulled moimoi, highest levels were obtained in cowpea-maize moimoi 3.45% (dehulled) and 3.75% (undehulled) significantly the same with sprouted moi-moi (3.28% and 2.70%). Least amounts of ash were observed in 16 h steeped moimoi which could be linked to leaching as a result of steeping and rinsing; similar results were reported by Devi *et al*. [29], Owuamanam *et al.*[6]. Dehulling reduced the crude fiber contents of the moi-moi, the reductions were pronounced in 16h steeped cowpea 2.26%

and 2.80% for dehulled and undehuled respectively, the highest crude fiber contents were observed in the cowpea-maize moimoi (3.04% and 3.65%) followed by sprouted cowpea moi-moi (3.53% and 2.39%) not significantly higher than the highest. Ahmed *et al.* [14] similarly reported for soaked dehulled guar gum seeds. Ash and fiber contents of moimoi reported by both Akusu and Kiin-Kabari [20]; Ogundele *et al.* [28] are all less than 2%. Varietal differences and mesh size used in sieving will all bear on ash and fiber contents of foods. Importance of fiber to human nutrition and health has been highlighted by Gibney [30]. Higher dietary fiber diet is beneficial, it reduces the risk of colon cancer and slows down the release of glucose into the blood, decrease reabsorption of bile salts leads to decrease low density lipoprotein cholesterol otherwise called bad cholesterol [30].

The carbohydrate contents of the various moimoi were low, the dehulled control (DC) having the highest of 19.15% not significantly different from 18.46% for cowpea-maize moimoi (dehulled). Undehulled samples had higher carbohydrate contents than the dehulled. The sprouted moi-moi had the least. Owuamanam *et al*. (2011) reported an increase in the protein, ash, and fiber contents of sprouted cowpea but reduction in carbohydrate content. Rahontra *et al*. [31]; Nwosu *et al.* [7]; Devi *et al.* [28] similarly reported increase in nutrient density of sprouted seeds

The energy values were low because of reduced dry matter content, and varied significantly from the highest for the control (158.6 kcal) and decreased in others, the least values were in 16DC+DM, SUC and 16UC+DM moimoi.

Table 2: Proximate composition (%) of moi-moi samples differently processed

Moimoi	Moisture	Fat	Protein	Ash	Crude-fiber	C.hydrate	E(kcal)
DC	62.65	6.20^{e}	6.56^{c}	2.96^{b}	2.48^{d}	19.15^{a}	158.64^{a}
UC	64.28^{b}	5.77^{e}	7.00^{c}	2.73^{bc}	3.11^{b}	17.11^{bc}	148.37^{c}
SDC	67.29	9.30	7.70^{b}	3.28^{a}	2.39^{d}	10.04^{c}	154.66^{b}
SUC	71.26^{a}	6.90	10.32^{a}	2.70^{bc}	2.53^{a}	15.29^{e}	124.54^{d}
16DC	67.13^{b}	7.10^{b}	5.51^{d}	2.61^{d}	2.26^{e}	15.39^{c}	147.50^{c}
16UC	65.71^{b}	6.20^{c}	5.34^{d}	2.16^{e}	2.86^{c}	17.73^{b}	148.08^{c}
16DC+M	68.80^{ab}	4.10^{d}	4.72^{e}	3.45^{a}	3.04^{b}	15.89^{c}	119.34^{e}
16UC+MD	66.44^{b}	3.80^{d}	4.90^{e}	2.75^{bc}	3.65^{a}	18.46^{a}	128.04^{c}

Values are mean of triplicate determinations, Means within the same column with similar superscripts are not significantly different (P<0.05). DC= Dehulled cowpea 20 minutes soaking (control), UC= Undehulled cowpea 20 minutes soaking, SDC= Dehulled partially germinated (36 h) cowpea, SUC= Not dehulled partially germinated (36 h) cowpea, 16DC= Dehulled 16h steeped cowpea, 16UC= Undehulled 16h steeped cowpea, 16DC+MD= Dehulled 16h steep cowpea plus dehulled maize (DM), 16UC+MD= Undehulled 16 hours steep cowpea plus dehulled maize (DM).

Microbial status of the differently processed moimoi 15h later

Aerobic mesophilic bacteria counts varied from 101-303 cfu/g, yeast mould counts 36-298 cfu/g; *E.coli* were detected in four samples about 2 colonies in each, Coliform counts varied from 8-32 cfu/g. The presence of enterobacteriaceae are usually indicators of post processing contamination of heat treated food. Mohammed *et al*. [32] observed that cowpea seeds infested with bruchids produced moimoi with aerobic plate count of 3.6×10^{6} cfu/g while non-infested was 3.2×10^{2} cfu/g. The bacterial and fungal counts as shown in Table 2 are comparable to the findings of Igbadul *et al.* (2013) [33] for bambara groundnut-cassava-soybean steamed paste called akpekpa. *E.coli* counts of less 20 are considered satisfactorily [34]. Although the microbiological load in moi-moi was insignificant however it is an evidence of potential microbial deterioration if not placed in refrigerated storage, moimoi is known to be highly perishable being a good medium for bacterial proliferation.

Table 3: Microbial status (cfu/g) of differently processed moimoi 15h later at room temperature

Moimoi Aerobic	Mesophilic Bacteria	Coliform	Yeast/mould	*E. coli*
DC	208^{c}	32a	298^{a}	ND
UC	204^{d}	28^{b}	266^{b}	2.00^{a}
SDC	254^{b}	25^{b}	203^{cd}	ND
SUC	303	22^{e}	186^{d}	2.00^{a}
16DC	237^{b}	21^{c}	218^{c}	2.33^{a}
16UC	121^{d}	13^{d}	110^{e}	ND
16DC+MD	120^{d}	19^{c}	95^{e}	ND
16UC+MD	101^{f}	8^{e}	36^{f}	ND

Values are mean of triplicate determinations, Means within the same column with similar superscripts are not significantly different (P<0.05). DC= Dehulled cowpea 20 minutes soaking (control), UC= Undehulled cowpea 20 minutes soaking, SDC= Dehulled partially germinated (36 h) cowpea, SUC= Not dehulled partially germinated (36 h) cowpea, 16DC= Dehulled 16h steeped cowpea, 16UC= Undehulled 16h steeped cowpea, 16DC+MD= Dehulled 16h steep cowpea plus dehulled maize (DM), 16UC+MD= Undehulled 16 hours steep cowpea plus dehulled maize (DM). ND-Not detected.

Functional properties of the differently processed cowpea flour

The water absorption capacities (WAC) of the differently processed cowpea flour varied significantly from 73.13%-143.57%. The least water absorption was observed in the control (DC) thereafter increased significantly to peak levels of 143.57% for SDC and 142.98% for 16DC+DM, both were not significantly different. WAC followed the patterns of protein content levels in the flours wherein the control had the least and thereafter increased in others accordingly. Flours which have high WAC have more hydrophilic constituents such as polysaccharide and protein have both hydrophilic and hygrophobic nature [35]. Although WAC and OAC obtained were lower than values reported by Appcah *et al.* [36] but Owuamana *et al.* [6] similarly reported that WAC and OAC of Sprouted cowpea flour (167% and 106.7%) are greater than unsprouted flour(128% and 94.7%), values which are comparable**.** Higher water absorption reduces slurry solidification time to form gel and formation of watery moimoi with high perishability. Therefore, cowpea flour high WAC are not desirable for moimoi preparation but high QAC flour is desirable for flavor enhancement and tenderness. The bulk densities (0.437-0.584g/ml) were low and insignificantly (P>0.05) the same except the partially germinated cowpea flours which had the least bulk densities. Low bulk density indicates low solid content of slurry therefore large quantity of flour must be added before viscous slurry is formed. Steeping and germination reduced the bulk density of the cowpea flour. The pH values indicated that cowpea flour slurry were slightly basic, significantly varied from 7.79-8.47. Nwakaudu *et al.* [37] reported comparable pH values (6.69-7.62) for cowpea flour. Acidic pH is known to inhibit bacteria proliferations and desired for longer shelf stability. Bulk densities(0.63-0.69g/ml), WAC(0.63-132%) and OAC(0.48-140%) reported by Iwe *et al*. [38] for brown cowpea are comparable to values obtained in this study.

Table 4: pH and Water Absorption Capacities of cowpea flour for moi-moi Preparation

Moimoi	pH	Water Absorption Capacity (%)	Oil Absorption Capacity	Bulk density
DC	8.47^{a}	74.13^{d}	65.23^{d}	0.561^{a}
UC	8.35^{ab}	100.04^{c}	84.33^{c}	0.558^{a}
SDC	7.89^{b}	143.57^{a}	126.45^{a}	0.448^{b}
SUC	7.79^{c}	139.41^{b}	119.06^{b}	0.437^{c}
16DC	7.88^{b}	136.39^{b}	120.11^{b}	0.549^{a}
16UC	7.81^{b}	138.38^{b}	118.55^{b}	0.541^{a}
16DC+MD	7.85^{b}	142.98^{a}	126.24^{a}	0.584^{a}
16UC+MD	7.79^{c}	137.01^{b}	117.29^{b}	0.581^{a}

Values are mean of triplicate determinations, Means within the same column with similar superscripts are not significantly different (P<0.05). DC= Dehulled cowpea 20 minutes soaking (control), UC= Undehulled cowpea 20 minutes soaking, SDC= Dehulled partially germinated (36 h) cowpea, SUC= Not dehulled partially germinated (36 h) cowpea, 16DC= Dehulled 16h steeped cowpea, 16UC= Undehulled 16h steeped cowpea,16DC+MD= Dehulled 16h steep cowpea plus dehulled maize (DM), 16UC+MD= Undehulled 16 hours steep cowpea plus dehulled maize (DM).

Mineral contents

The mineral contents of the various moimoi significantly (P<0.05) varied as follows (mg/100g): Fe, 0.46-1.07; Ca, 35.67-73; Mg, 1.19-2.01; K, 3.28-9.80 and P, 1.05-2.98 and were generally low, perhaps due to leaching that occurred during steeping, sprouting, dehulling which led low.

Table 5: Mineral contents (mg/100g) of the differently moimoi samples

MoiMoi	Fe	%RDA (15mg)	Ca	%RDA (1000g)	Mg	%RDA (350mg)	K	%RDA (3500mg)	P	%RDA (1000mg)
DC	0.46^{g}	3.06	73.00^{a}	7.30	2.01^{a}	0.57	9.80^{a}	0.28	2.98^{a}	0.30
UC	1.07^{a}	11.33	47.68^{f}	4.77	1.88^{b}	0.54	8.60^{c}	0.25	1.78^{c}	0.18
SDC	1.45^{b}	9.66	50.67^{d}	5.07	1.19^{f}	0.34	8.00^{e}	0.23	1.87^{b}	0.19
SUC	0.72^{h}	4.80	35.67^{h}	3.57	1.27^{f}	0.36	9.00^{b}	0.26	1.05^{e}	0.11
16DC	0.82^{d}	5.47	48.67^{e}	4.87	1.60^{e}	0.46	6.10^{g}	0.17	1.72^{e}	0.17
16UC	1.04^{c}	6.93	53.33^{b}	5.33	1.37^{e}	0.39	8.30	0.24	1.56^{d}	0.16
16DC+MD	0.51^{f}	3.40	54.67^{c}	5.47	1.61^{e}	0.46	3.28^{h}	0.09	1.88^{b}	0.19
16UC+MD	0.77^{e}	5.13	42.33^{g}	4.27	1.47^{d}	0.42	7.70^{f}	0.22	1.92^{b}	0.19

Values are mean of triplicate determinations, Means within the same column with similar superscripts are not significantly different (P<0.05). DC= Dehulled cowpea 20 minutes soaking (control), UC= Undehulled cowpea 20 minutes soaking, SDC= Dehulled partially germinated (36 h) cowpea, SUC= Not dehulled partially germinated (36h) cowpea, 16DC= Dehulled 16h steeped cowpea, 16UC= Undehulled 16h steeped cowpea, 16DC+MD= Dehulled 16h steep cowpea plus dehulled maize (DM), 16UC+MD= Undehulled 16 hours steep cowpea plus dehulled maize (DM).

Sensory Evaluation

Variation in the sensory attributes of the various moi-moi was significant (P<0.05), measure on a 9-point Hedonic scale, appearance, taste, aroma, mouth feel, and overall acceptability varied from 6.52-8.08, 6.50-8.5, 6.16-8.08, 6.50-8.17 and 6.92-7.83. The control moimoi (DC), being the traditionally form in which moimoi is consumed in Nigeria consistently received the highest appreciation from the test panelist receiving the highest scores in all the attributes tested, other trailed behind, the least scores were given to the moi-moi from sprouted cowpea flour. The appearance of the dehulled samples received higher scores than the undehulled, the least being the sprouted dehulled, and the brownish tinge was the cause of the lower scores. Sprouted moimoi received the least test scores (6.55,SDC), the control had the highest, the cowpea-maize moimoi had higher scores, the aroma scores varied from 6.16-8.08, the least being the 16-h steeped dehulled (16DC) because of fermentation aroma due to long steeping which was not diminished by dehulling and maize flour addition. Mouth feel scores of the moimoi were high except the moimoi from sprouted cowpea (6.59 and 6.50), the slight sweet taste did not appeal to the panelists. The dehulled received higher mouth feel scores than the undehulled, the values varied from 6.50 to 8.17. the overall acceptability of the various moimoi were high except moimoi made from sprouted cowpea and undehulled 16 h cowpea flours, the rest received higher scores with the control and cowpea- maize moimoi leading. The lower scores for moi-moi for moi-moi other than traditional moi-moi is simply the human natural resistant to change and adaptation to the new even when the new had better nutritional value, the taste buds need gradual adaptation to the new.

Table 6: Scores of Sensory Evaluation of differently processed Moi-Moi samples

Moi-Moi	Appearance	Taste	Aroma	Texture (Mouthfeel)	Overall Acceptability
DC	8.08^{a}	8.25^{a}	8.08^{a}	8.17^{a}	7.83^{a}
UC	7.50^{b}	6.83^{d}	7.33^{c}	6.68^{c}	7.25^{b}
SDC	7.33^{b}	6.55^{e}	7.17^{bc}	6.59^{c}	6.92^{c}
SUC	6.52^{c}	6.92^{d}	6.58^{d}	6.50^{c}	6.83^{c}
16DC	7.42^{a}	7.56^{b}	7.42^{b}	7.50^{b}	7.33^{ab}
16UC	6.58^{c}	6.66^{e}	6.16^{f}	6.80^{c}	6.83^{c}
16DC+MD	7.31^{b}	7.50^{b}	7.08^{bc}	7.75^{b}	7.42^{ab}
16UCC+MD	7.01^{c}	7.25^{cd}	6.75^{d}	7.92^{ab}	7.50^{ab}

Values are mean of triplicate determinations, Means within the same column with similar superscripts are not significantly different (P<0.05). DC= Dehulled cowpea 20 minutes soaking (control), UC= Undehulled cowpea 20 minutes soaking, SDC= Dehulled partially germinated (36 h) cowpea, SUC= Not dehulled partially germinated (36 h) cowpea, 16DC= Dehulled 16h steeped cowpea, 16UC= Undehulled 16h steeped cowpea, 16DC+MD= Dehulled 16h steep cowpea plus dehulled maize (DM), 16UC+MD= Undehulled 16 hours steep cowpea plus dehulled maize (DM).

Conclusion

Reduction of the time spent on food preparation is associated with urbanization therefore the need to provide nutritive ready-to-cook cowpea flours for moimoi preparation. Sprouted cowpea flour increased the nutritive value of the moimoi, and improved the water and oil absorption capacities of the flours although detrimentally in this case. This improvement exceeded the gain obtained with the use of steeped cowpea flour or the later supplemented with maize flour which instead reduced the nutrient density of the moimoi except carbohydrate. Moimoi made from dehulled cowpea flours had lower nutritive value than the undehulled and was responsible for the lower sensory scores. Steeping overnight and/or sprouting led to reduction in carbohydrate contents which in turn produced moimoi with reduced dietary energy suitable for weight-watchers and patients with dysfunctional carbohydrate metabolism. Although these treaments reduced the overall acceptability scores of the moimoi however produced moimoi with the best nutrient profile.

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