**Quality Evaluation of Steamed Pastes Produced from Blends of Yellow Maize *(Zea mays L.*)*,* Melon (*Cucumis melo L.*) and African Palm Weevil (*Rhynchophorus phoenicis*)**

## Abstract

Proximate compositions, microbial counts and sensory attributes of steamed paste produced from blends of yellow maize (*Zea mays*), melon seeds (*Cucumis melo L.*) and African palm weevil (*Rhynchophorus phoenicis*)were investigated. The slurries of the three raw materials were independently prepared, combined at different ratios that resulted to 12 samples. Each slurry blend was wrapped in aluminum foil and dropped in boiling water to gelatinize and cook to produce steamed paste. The pastes were analyzed for proximate composition, microbial and sensory properties using standard methods. From the results, the proximate compositions were in the following ranges: Moisture (29.30±0.01 to 39.53±0.02%), ash (0.25±0.01 to 1.60±0.01%), fat (5.49±0.01 to13.66±0.02%), crude fiber (1.25±0.01 to 2.50±0.01%), protein (5.91±0.01 to 10.00±0.01%) and carbohydrate (43.40±0.01 to53.10±0.01 %). The results were compared with the reference, 100% Cowpea steamed paste popularly known as moi-moi which had the moisture content of 29.30±0.01% and differed significantly (p <0.05) from steamed paste blend (39.53±0.02%); the fibre content of (1.80±0.01%); and the fat content of 9.89±0.01%. The bacterial count of steamed paste blends ranged from 2.53±0.04 to 5.11±0.13 cfu/g while the reference moi-moi had 3.33±0.12 cfu/g. The fungal count ranged from 1.29±0.08 to 3.42±0.12 cfu/g while the reference sample had 1.44±0.03 cfu/g. The coliform count ranged from 0.00±0.00 to 2.14±0.14 cfu/g. The differences in sensory preferences of the composite steamed paste were not significant (p>0.05) from the 100% cowpea steamed paste and were all very much liked. Conclusively, this study revealed that steamed paste produced from blends of maize, melon and African palm weevil compared favorably with steamed paste of whole cowpea.

**Keywords:** Steamed paste, African palm weevil, Proximate composition, |Microbial counts, Sensory attributes

**1.0 Introduction**

Steamed pastes, a class of food consumed in eastern part of Nigeria especially among the Igbo tribe abound. They include steamed cowpea paste (moi-moi), steamed bambara groundnut paste (Okpa), steamed maize paste (Igbabu oka) and steamed melon seed paste (agbalu atii), among others. These pastes are consumed as breakfast or used for lunch and can be eaten by children, adult and the elderly. The most popular is steamed cowpea paste as it is more frequently consumed. These steamed pastes are usually consumed alone or with other foods such as pap. From the above mentioned steamed pastes, only maize paste is cereal based food product. Like others, pepper, salt, onion and oil form part of the ingredients in the preparation. ‘Igbabu oka’ is low in protein and often consumed without any protein supplement. Supplementing ‘igbabu oka’ with protein base food will significantly improve its nutritional content. Sometimes, steamed maize paste is consumed with bean porridge to improve nutrition. In some traditional setting, maize slurry is blended with fried winged termite and steamed to produce ‘oka nkpu’ in attempt to increase the nutrition and create variety. This is, however, seasonal.

Maize *(Zea mays L., family Poaceae)* is the most important cereal crop after wheat followed by rice in the world and is the first in Sub-Saharan Africa (SSA) where over 80% of the population depends on it as sources of food, income and livelihood (Pardey *et al.,* 2016). In Sub-Saharan Africa (SSA) for example, in South Sudan maize is directly used by millions of people as food, drinks, animal feeds, cooking energy and construction materials (FAO/WFP, 2016). Maize is processed into different products such as starch, corn syrup, sweeteners, oil, beverages, glue, alcohol and fuel ethanol which are important for industrial purposes as well as animal feed (Ranum *et al*., 2014). More importantly, maize has become a model crop for molecular studies which has led to successful breeding and wider adaptation in Africa (Jiao *et al*., 2017). As a result, maize is considered a major crop in modern farming transformation and elevation of food security.

Melon *(Cucumis melo L.)* is an important annual diploid plant belonging to the *Cucurbitaceae* family. It has very high concentration of polyphenols (Ullah *et al.*, 2014) that provide potential health benefits, in particular by supporting the cardiovascular system (Rodríguez-Pérez *et al*., 2013). The seeds of melon have moisture content of 4.5%, crude protein 25.0%, ash 2.4%, crude fat 25.0%, crude fiber 23.3%, and carbohydrates 19.8% ([Yanty](about:blank)*[et al](about:blank)*[., 2008](about:blank)).  analyzed seeds of melon and checked their lipids structure and proximity. According to [Petkova and Antova (2015)](about:blank), melon seeds have 41.6-44.5% fat, 34.4-39.8% proteins, 4.5-8.5% crude fiber, 8.2-12.7% carbohydrates, 3.7-4.2% soluble sugars and 4.6-5.1% minerals. The lipid portions included sterols, tocopherol, and phospholipids. The main fatty acids present in seeds were oleic acid 24.8-25.6% and linoleic acid 51.1-58.5%.

African palm weevil (*Rhynchophorus phoenicis* is a specie of the genus *Rhynchophorus* belonging to the order *Coleoptera*, family *Curculionidae* referred to as snout beetles due to the possession of snout-like projection being modified into rostrum for feeding (Fogoh *et al*., 2015). FFT *Rhynchophorus* species are distributed along the tropical regions of the world, described species that are having similarities in biology and ecology, in spite of difference in host plants (Miguens *et al*., 2021). Though African palm weevils are pests as they destroy valuable plant materials, the grubs are highly valued delicacies in Western and Niger Delta regions of Nigeria, where they are either eaten raw or after cooking by boiling, roasting or frying while some are used for medicinal purposes (Onyeike *et al*., 2005). Palm grub has shown to be high in crude protein (23.44%), fatty acids, minerals (zinc and iron) and vitamins (thiamine and riboflavin) (Chinweuba *et al*., 2011). Hence, the need to exploit the nutrient potentials of palm grubs in order to bridge the gap between animal protein supply and consumption. The growing occurrence of malnutrition in developing countries is gradually receiving the needed research attention. Increasing world population has markedly increased the demand for full utilization of agricultural products. Production of steamed pastes from the blends of yellow maize *(Zea mays L*.*),* melon *(Cucumis melo L.)* and African palm weevil *(Rhynchophorus phoenicis)* will help to increase vital nutrients, and lower the risk of serious nutrition-related diseases. It is expected to create variety and increase the consumption of African palm weevil which ordinarily is eaten raw, boiled or roasted.

**2.0 Materials and Methods**

**2.1 Sources of raw materials**

Fresh *Zea mays* was bought from Ose-Okwuodu Market in Onitsha, Onitsha North Local Government Area, Anambra State and melon seeds **(***Cucumis melo*) was purchased from Umunkwo in Isiala-Mbano Local Government Area of Imo State, while the African palm weevil (*Rhynchophorus phoenicis*) was obtained from Oba in Idemili South Local Government of Area Anambra State.

**2.2 Experimental Design (by Design Expert version 12)**

The experiment was designed using Mixture Design from Design Expert statistical software version 12, that generated 12 runs. The design key is shown on Table 1. The experiment had a total of twelve (12) runs. The mixture components, A (Maize slurry), B (Melon seed slurry), C (*African palm weevil slurry*) was summed up to 100.

**2.3 Preparation of Maize, Melon and African Palm Weevil Slurries**

The kernels of the *Zea mays* were washed and wet milled with KenwoodSHB-2088 blender at maize-water ratio of 80:10. Melon seed slurry was prepared by blending it with water at the ratio of 80:20 while African palm weevil was blended with water at a ratio of 70:30. The slurries blended in the ratios shown in Table 2.

**2.4 Steamed Pastes Production**

The steamed pastes were prepared using the method of Enwere (2000), with slight modifications. The recipes used are as shown in Table 3. The slurry blends were wrapped in aluminum foil and dropped inside a pot of already boiling water. They were cooked for 15 min, cooled to ambient temperature (32±2o) before preserved in a deep freezer.

**Table 1: Design key**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Components | Unit | Name | Low | High |
| A | G | Maize slurry | 40 | 68.4 |
| B | G | Melon seed slurry | 3 | 30 |
| C | G | *African palm weevil slurry* | 5 | 38.3 |

# **Table 2:** Maize, Melon and African palm Weevil Slurries blend formulation**.**

| **Runs** | **Maize (%)** | **Melon (%)** | **African palm weevils (%)** |
| --- | --- | --- | --- |
| 1 | 47.2 | 30 | 22.7 |
| 2 | 52.7 | 15 | 32.2 |
| 3 | 60.7 | 21 | 18.1 |
| 4 | 55.8 | 29 | 15 |
| 5 | 68.4 | 16 | 15 |
| 6 | 53.22 | 3 | 5 |
| 7 | 60 | 15 | 24.9 |
| 8 | 46.2 | 22.1 | 31.7 |
| 9 | 46.6 | 15 | 38.3 |
| 10 | 40 | 20 | 20 |
| 11 | 53 | 22 | 24.5 |
| 12 | 40  100% Cowpea | 30 | 30 |
| 13 |  |  |

**Table 3:** Recipes for the steamed pastes production

| **Ingredients** | **Quantity** |
| --- | --- |
| Maize/ melon/ APW Slurries blends | 500g |
| Onion | 25g |
| Pepper | 20g |
| Salt | 1.5g |
| Magi cube | 2g |
| Warm water | 100ml |

Source: Enwere (2000)

**2.5 Proximate Analysis of Samples**

Proximate analyses of the samples were carried out using standard methods of AOAC (2010). The analyses carried out were moisture, protein, fat, ash and crude fibre contents. The carbohydrate content of the samples was determined by difference using the formula:

% Carbohydrate = 100 - (% Moisture + Ash + Protein + % Crude fibre + Fat).

The energy value **(**EV**)** was estimated thus: EV = (4 x %Protein) + (4 x %Carbohydrate) + (9 x %Fat).

**2.6 Sensory Evaluation of Samples**

The affective sensory properties were determined using 25 semi-trained panelists drawn from among the staff of St John the Apostle High School, Onitsha Anambra State, Nigeria. They were instructed on the respective terms of the sensory scales and requested to evaluate the colour, taste, appearance, texture and overall acceptability of various steamed pastes using a 9-point Hedonic Scale, in which 9 represents liked extremely, 5 - neither liked nor disliked and 1 - disliked extremely. Presentation of coded samples was done randomly, and portable water was provided for rinsing of mouth to remove after taste in between the respective evaluations (Iwe *et al.,* 2014).

**2.7 Microbial Analysis of Samples**

One gram of steamed paste was aseptically introduced into 9 ml of sterile peptone water and violently shaken to homogenize. Then, a serial dilution was made by pipetting 1 ml of the dispersion into 9 ml peptone water and the dilution continued up to 10-6 dilution. Using sterile pipette, 0.1ml of the appropriate dilutions (10-2) of the samples were pour plated in sterile plates of nutrient agar (NA), and eosine methylene blue (EMB) agar and Sabouraud dextrose agar (SDA) for total viable (bacteria), coliform and fungi counts, respectively. The culture plates were incubated at 35oC aerobically for 24-28 h and 48-72 h for the fungi. Developed colonies on nutrient agar, EMB agar and SDA were counted to obtain total viable, total coliform and total fungi counts as follows:

TBC/TFC/TCC =

Where,

TBC: Total Bacterial Count

TFC: Total Fungi Count

TCC: Total Coliform Count

V: Volume Plated

D: Dilution Factor

10: Dilution constant

**2.8 Statistical analysis:**

The data were subjected to one way analysis of variance (ANOVA) using Statistical package for Social Sciences (SPSS) software version 23.0. Means, where significant, were separated using Duncan’s multiple range of test (DMRT).

**3.0 Results and Discussions**

**3.1 Proximate Composition of Steamed Paste Blends**

The proximate composition of the composite steamed paste of maize, melon and African palm weevilsamples is presented in Table 4. The result showed that the moisture content ranged from 29.30 % to 39.53% with sample 1(39.53%) obtained from blended sample of maize, melon and African palm weevil Igbabu okahaving the highest moisture content while sample 12 (29.30%) obtained for blended sample of maize, melon and African palm weevil Igbabu okaand control have the lowest respectively. The moisture content of moi-moi from this study is within the range of 29.30 % to 39.53% obtained for blended sample of maize, melon and African palm weevil Igbabu oka. The moisture content of the control sample (100% cowpea, 29.30%) differed significantly (p <0.05) from Igbabu okablended sample of maize, melon and African palm weevil (39.53 %). Sample1 of blended sample of maize, melon and African palm weevil has the highest moisture content (39.53%) and differed significantly (p<0.05) from other samples except samples 12 and 4 in which there was slightly difference. Moisture content in a food sample gives an indication of the water content and its total solid content. The high moisture content of Igbabu okamade from blended sample of maize, melon and African palm weevil implies low shelf life, storability and stability of product however, moisture is needed to aid easier mastication, swallowing, refreshing and hydration of the Igbabu okasamples. Moisture content of Igbabu okaobtained from this study is lower when compared with 52.06-55.06% for moi-moi made from cowpea-Asparagus bean flours (Nwosu, 2011). It is also lower than that reported by Ogundele *et al*., (2015) for cowpea/soybean moi-moi (48.36-53.93) %. Moisture content is very essential for life maintenance and analysis as it is one of the most widely used parameter which determines storage-ability and shelf-life of a food product (Okwunodulu *et al.,* 2019). It has also been used as a measure of stability and susceptibility to microbial growth. Crude fiber ranged from 1.25 % to 2.50% with sample 10 (2.50%) obtained for blended sample of maize, melon and African palm weevil Igbabu okahaving the highest moisture content while sample 4(1.25%) obtained for blended sample of maize, melon and African palm weevil Igbabu okahaving the lowest fiber content. The crude fiber content of the Igbabu okaranged from 1.25 % to 2.50%. The highest value was observed in Sample 10 (2.50%) of blended sample of maize, melon and African palm weevil while the control sample (100% cowpea) have (1.80%) which differed significantly (p<0.05) from sample 10 obtained for blended sample of maize, melon and African palm weevil Igbabu okabut slightly with other samples

The range of crude fibre content obtained from this study is higher than 0.75% -0.83% for cowpea/Asparagus bean flour moi-moi reported by Nwosu (2011). It also compares well with 1.38%-1.65% for cowpea/maize flour moi-moi reported by Akusu *et el*., (2012). The increase in fibre content of the moi-moi samples is desirable as fibre is needed for easy passage of waste by expanding the inside walls of the colon. It also helps to reduce the problem of constipation and lowers blood cholesterol level (Wardlaw *et al*., 2002). This indicates that the blended sample of maize, melon and African palm weevil Igbabu okawhen consumed will help to reduce the health problems associated with low fibre. Crude fiber generally increases transit time through the gut, slow emptying of the stomach and slow glucose absorption (Awuchi, 2019). Ash ranged from 0.25 % to 1.60% with sample 10 (1.60%) have the highest ash content while sample 4 (0.25%) obtained for blended sample of maize, melon and African palm weevil Igbabu oka having the lowest ash content, fat ranged from 5.49% to 13.66% with sample 5(13.66%) obtained for blended sample of maize, melon and African palm weevil Igbabu okahaving the highest fat content while sample 12 (5.49%) have the lowest fat.

# **Table 4: Proximate Compositions of Steamed Pastes from Maize-Melon-African Palm**

# **Weevils blends**

| **Runs** | **Formulation**  **Maize: Melon: APW** | **Protein**  **(%)** | **Fibre**  **(%)** | **Ash**  **(%)** | **Protein**  **(%)** | **Fat**  **(%)** |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 47.2: 30: 22.7 | 39.58a±0.02 | 1.53h±0.01 | 0.57h±0.02 | 7.92z±0.01 | 6.51k±0.02 |
| 2 | 52.7: 15: 32.2 | 29.41L±0.02 | 2.01c±0.01 | 1.01c±0.01 | 9.71c±0.01 | 13.46b±0.01 |
| 3 | 60.7: 21.2 : 18.1 | 34.61e±0.01 | 1.43j ±0.01 | 0.45k±0.01 | 7.84j±0.01 | 10.1f± 0.01 |
| 4 | 55.8 :29.2: 15 | 38.02c±0.02 | 1.25L±0.01 | 0.25m±0.01 | 7.52L±0.02 | 8.03j± 0.01 |
| 5 | 68.4 : 16.15: 15 | 31.02z±0.02 | 1.33k±0.00 | 0.34L±0.01 | 7.56k±0.01 | 13.66a±0.02 |
| 6 | 53.22: 3: 24.5 | 34.42f±0.02 | 1.70g±0.01 | 0.76f±0.01 | 8.00h±0.01 | 10.23e±0.01 |
| 7 | 60: 15: 24.9 | 30.50j±0.01 | 1.53h±0.01 | 0.53z ±0.01 | 8.81f±0.01 | 13.45b±0.01 |
| 8 | 46.2: 22.1 :31.7 | 35.00d±0.01 | 1.95d±0.01 | 0.97d±0.01 | 9.50d±0.01 | 8.35z±0.03 |
| 9 | 46.6: 15: 38.3 | 30.00k±0.00 | 2.20b±0.01 | 1.21b±0.01 | 9.89b±0.01 | 12.78c±0.01 |
| 10 | 40: 20: 20 | 33.01h±0.01 | 2.50a±0.01 | 1.60a±0.01 | 10.00a±0.01 | 9.30h ±0.01 |
| 11 | 53: 22.3: 24.5 | 34.00g±0.01 | 1.50z±0.01 | 0.50j±0.01 | 8.40g±0.01 | 10.62d±0.02 |
| 12 | 40: 30: 30 | 29.30m±0.01 | 1.90e±0.01 | 0.80e±0.17 | 9.30e±0.01 | 5.49L ±0.01 |
| 13 | 100% Cowpea | 29.30m±0.01 | 1.80F±0.01 | 0.69g±0.01 | 5.91m±0.01 | 9.89a±0.01 |
|  | LSD | 0.04174 | 0.06039 | 0.02049 | 0.02006 | 0.09748 |

Values are mean ± standard deviation of triplicate determinations. Values in the same column bearing different superscripts differed significantly (p ≤0.05).

having the highest value (1.60%) which differed significantly (p<0.05) from the control (100% cowpea) having (0.69%). Ash content is an indication of minerals that are contained in the product. Ash content from this study correlates well with 0.67-0.91% for cowpea and Asparagus flour moi-moi reported by Nwosu (2011). Protein ranged from 5.91 to 10.00% with sample 10 obtained for blended sample of maize, melon and African palm weevil Igbabu oka(10.00%) having the highest protein content while control (100% cowpea) have the lowest (5.91%).Protein content of the Igbabu okaand moi-moisamples ranged between 5.91-10.00% with control (100% cowpea) (5.91%) recording the lowest while blended sample of maize, melon and African palm weevil have the highest value of (10.00%). All the samples from blended samples of maize, melon and African palm weevil differed significantly (p<0.5) from the control (100% cowpea). There was a significant difference (p<0.05) in the protein content of the Igbabu oka and moi-moi samples with 100% cowpea moi-moi significantly lower (p<0.05) than others. The decrease in protein content could be attributed to the low protein content of cowpea (5.91%) which is plant protein as compared with animal protein (African Palm Weevil) in the blended Igbabu okaformulation. Protein is needed in the diet as it is essential for growth, development and survival of human beings. It also works in synergy with minerals to enhance growth, provide energy, repair, and regulate body processes Okwunodulu *et al*. (2019). Protein content obtained from this study compares well with the study of (Ogundele *et al*. 2015) who reported protein content of 4.40-11.60% for moi-moi made from cowpea and soybean flour blends. It is also close to the study of (Agbara *et al*. 2018) who reported 4.72-10.32% for differently processed moi-moi samples. The fat content ranged from 5.49 to 13.66%. The Igbabu okasamples differed slightly (p<0.05) with blended sample 5 of maize, melon and African palm weevil having the highest value (13.66%) and control (100% cowpea) sample having the low value (9.89%). Fat content of Igbabu okaobtained from this study is lower than 16.50-21.81% for moi-moi produced from cowpea and maize flour blends (Akusu *et al*., 2012). Ogundele *et al.* (2015) reported 1.91-4.06% for cowpea/soybean flour moi-moi formulations. These differences could be due to the variation in recipes used. According to Wardlaw (2004) the presence of fat in diet shows that such diets is a source for fat soluble vitamins such as vitamins A, D, E and K. Carbohydrate content ranged from 43.40 to 53.10% with control (100% cowpea 53.10%) having the highest carbohydrate content while sample 12 obtained for blended sample of maize, melon and African palm weevil Igbabu okahave the lowest (43.40 %) . The carbohydrate content of the samples ranged from 43.40 to 53.10% both in Igbabu okablended sample of maize, melon and African palm weevil and the control (cowpea) respectively. The control sample (100% cowpea) have the highest carbohydrate value of (53.10%) and blended sample 12 of maize, melon and African palm weevil having lowest value of (43.40%) showing significant difference of (p<0.5). Carbohydrate content of Igbabu okaobtained from this study is higher than 15.87-34.72% reported by Akusu *et al*., (2012) for cowpea/maize flour moi-moi. It is slightly lower than 54.71-59.37% reported by Nwosu. *et al*. (2014) for African yam bean and cowpea flour blend moi-moi. These differences could also be due to the variation in recipes used. High carbohydrate in diets is of advantage as it provides the energy needed to do work (Ijeh., *et al*. 2010). However, low carbohydrate content diets are also of advantage for diabetic patients that need very low carbohydrate content in their diets.

**3.2 Sensory attributes of the Igbabu oka Samples**

The sensory composition of the Igbabu okasamples is presented in Table 5.The color of the Igbabu okasamples ranged from 6.92 – 8.00. The result showed that the control sample (100 % cowpea) with the value of (8.00) have no significantly (p<0.05) from the rest of the samples from blended sample of maize, melon and African palm weevil which ranges from 6.92-7.72. Control sample (100% cowpea) had the highest score of 8.00 ± 1.73 for color as judged by the semi-trained panelists while samples 11 and 12 from blended sample of maize, melon and African palm weevil had the least score of 6.92 respectively and they were slightly liked according to 9-point hedonic scale. The taste of the Igbabu oka and moi-moias presented in Table 4 showed that the score ranged from 7.72–8.08 the result shows that control sample (100%) have the highest score of 8.08 comparing it to the other samples from blended sample of maize, melon and African palm weevil with the scores in the range of 7.52 to 8.08. The texture of the Igbabu oka and moi-moisamples ranged from 7.20 - 8.16. Control samples (100% cowpea) with the highest score of 8.16 while the blended samples of maize, melon and African palm weevil ranges from 7.20 – 8.08, showing no significantly (p<0.05). They were moderately liked according to 9-point hedonic scale. The appearance of the Igbabu okaand moi-moi samples ranged from 7.20 – 7.96, the control sample (100% cowpea) and sample 1 from blended sample of maize, melon and African palm weevil have the same score of 7.96 and other samples of the blended sample of maize, melon and African palm weevil ranges from 7.20-7.88, showing no significantly (p<0.05). They were moderately liked according to 9-point hedonic scale. The overall acceptability of the Igbabu oka and moi-moi samples ranged from 7.32 – 8.20, the control sample (100% cowpea) and sample 1 from blended sample of maize, melon and African palm weevil have the scores of 8.16 and 8.20 respectively and other samples of the blended sample of maize, melon and African palm weevil ranges from 7.32-7.96, showing no significantly (p<0.05). The mean sensory scores of Igbabu oka and moi-moi produced from blended sample of maize, melon and African palm weevil and the control (cowpea) respectively is shown in Table 5. From the results, it was observed that there was no significant difference (p>0.05) between the 100% cowpea moi-moi and all the other samples from blended sample of maize, melon and African palmweevil (Igbabu oka). This could be due to the judges were used to steamed paste formulated from both cowpea and maize. The results from this study differs with studies of Ogundele *et al.* (2015) who reported a decrease in sensory scores of moi-moi made from cowpea and soybean as substitution of cowpea with soybean increased. Based on the sensory results, steamed paste produced from blended sample of maize, melon and African palm weevil can substitute cowpea in steam paste preparation as there was acceptability in colour, appearance, taste and texture.

**Table 5: Sensory Composition (%) of the Igbabu oka samples from maize, melon and African palm weevil**

| **Sample** | **Formulation**  **Maize: Melon: APW** | **Colour** | **Appearance** | **Taste** | **Texture** | **Overall acceptability** |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 47.2: 30: 22.7 | 7.64a±1.70 | 7.96a±1.42 | 8.04a±1.17 | 8.08a±1.65 | 8.16 a±1.06 |
| 2 | 52.7:15:32.2 | 7.72a±1.38 | 7.88a±1.53 | 7.72a±1.72 | 7.56a±1.75 | 7.76 a±1.56 |
| 3 | 60.7:21.2:18.1 | 7.60e±1.25 | 7.60a ±1.58 | 7.56a±1.50 | 7.68a±1.34 | 7.72 a±1.51 |
| 4 | 55.8:29.2:15 | 7.28a±1.72 | 7.72 a±1.30 | 7.72a±1.30 | 7.72±1.62 | 7.84 a±1.67 |
| 5 | 68.4:16.15:15 | 7.56a±1.70 | 7.40a±1.22 | 7.64a±1.28 | 7.20a±1.63 | 7.32 a±1.86 |
| 6 | 53.22:3:24.5 | 7.44a±1.87 | 7.40a±1.55 | 7.52a±1.50 | 7.52a±1.50 | 7.96 a±1.30 |
| 7 | 60:15:24.9 | 7.48a±1.35 | 7.52a±1.38 | 7.56a±1.75 | 7.40a±1.44 | 7.84 a ±1.34 |
| 8 | 46.2:22.1:31.7 | 7.64a±1.22 | 7.76a±1.53 | 7.56a±1.66 | 7.40±1.97 | 7.48 a±1.44 |
| 9 | 46.6:15:38.3 | 7.48a±1.93 | 7.84a±1.34 | 7.52a±1.44 | 7.24a±1.73 | 7.88 a ±1.61 |
| 10 | 40:20:20 | 7.32a±1.70 | 7.64a±1.84 | 8.08a±1.15 | 7.84a±1.37 | 7.60a±1.60 |
| 11 | 53:22.3:24.5 | 6.92a±2.01 | 7.20 a±1.41 | 7.56a±1.58 | 7.68a±1.51 | 7.84a±1.67 |
| 12 | 40:30:30 | 6.92a±2.01 | 7.52a±1.63 | 7.72a±1.56 | 7.84a±1.79 | 7.96 a±1.45 |
| 13 | 100 % whole  Cowpea moi-moi | 8.00a±1.73 | 7.96a±1.39 | 8.08a±1.35 | 8.16a±1.17 | 8.20 a±1.41 |

Values are mean ± standard deviation of triplicate determinations. Values in the same column bearing different superscripts differed significantly (p ≤0.05).

**3.3 Microbial Counts of Steamed Paste from Yellow maize*,* Melon - African Palm Weevil Blends**

The results of the microbial load of the Igbabu okaandmoi-moi are shown in Table 6. The total bacteria load of moi-moi and Igbabu oka produced from blended sample of maize, melon and African palm weevil ranged from 2.65 ± 0.26 to 4.31 ± 2.01 x 105CFU/g. Moi-moi made from 100% of cowpea the control sample had bacteria count of 3.33 def ± 0.12 x 105 CFU/g. The study showed that the total bacteria count of moi-moi and Igbabu oka does not significantly differed (p> 0:05). The mean value for fungal of moi-moi and Igbabu oka varied from 1.29 e±0.08 to 3.47 a±0.36 x 105CFU/g with the moi-moi made from 100% of cowpea the control sample had the score of 1.44 ± 0.03 x 105CFU/g while the Igbabu oka produced from blended sample of maize, melon and African palm weevil ranged from 1.29± 0.08 to 3.47± 0.36 x 105CFU/g the study revealed that moi-moi made with 100% of cowpea the control sample and sample of blended sample of maize, melon and African palm weevil and does not significantly differed (p> 0:05).The mean value for coliform count of moi-moi and Igbabu oka varied from 0.00 ±0.00 to 1.38±0.05 x 105 CFU/g with the moi-moi made from 100% of cowpea the control sample having the score of 1.11 e±0.01CFU/g while samples 1, 3 and 12 of Igbabu oka produced from blended sample of maize, melon and African palm weevil ranged from 1.12 ef±0.02 CFU/g, 1.12 e±0.03CFU/g and 1.10 e±0.00CFU/g respectively while other samples from the blended sample of maize, melon and African palm weevil ranged from 0.00-1.31 CFU/g. The study revealed that moi-moi made with whole cowpea and that of (Igbabu oka) blended sample of maize, melon and African palm weevil for coliform does not significantly differed (p> 0:05) for the whole cowpea and the blended sample of maize, melon and African palm weevil .

**Table 6: Microbial Counts of Steamed Paste from Yellow maize*,* Melon - African Palm Weevil Blends (cfu/g)**

| **Samples** | **Formulation**  **Maize: Melon: APW** | **Bacterial count** | **Fungal count** | **Coli form count** |
| --- | --- | --- | --- | --- |
| 1 | 47.2: 30: 22.7 | 3.35def±0.12 | 1.56 e±0.06 | 1.12ef±0.02 |
| 2 | 52.7:15:32.2 | 3.21ef± 0.17 | 2.19 d±0.12 | 1.16de±0.04 |
| 3 | 60.7:21.2:18.1 | 3.50d± 0.18 | 2.70 b±0.20 | 1.12 e±0.03 |
| 4 | 55.8:29.2:15 | 4.22c± 0.11 | 2.61bc±0.11 | 1.31bc±0.01 |
| 5 | 68.4:16.15:15 | 5.11a± 0.13 | 3.47 a±0.05 | 1.38b±0.05 |
| 6 | 53.22:3:24.5 | 3.19ef±0.02 | 1.29 e±0.08 | 1.25cd±0.03 |
| 7 | 60:15:24.9 | 4.63b± 0.16 | 3.42e±0.12 | 2.14 a ±0.14 |
| 8 | 46.2:22.1:31.7 | 3.09f± 0.11 | 2.37cd±0.10 | 0.00 f±0.00 |
| 9 | 46.6:15:38.3 | 2.65g± 0.26 | 3.47 a±0.36 | 0.00f ±0.00 |
| 10 | 40:20:20 | 7.32a±1.70 | 7.64a±1.84 | 8.08a±1.15 |
| 11 | 53:22.3:24.5 | 2.53g± 0.04 | 2.12d±0.11 | 1.20cde±0.08 |
| 12 | 40:30:30 | 4.31c ± 2.01 | 2.58bc±0.08 | 1.10 e±0.00 |
| 13 | 100g whole  Cowpea moi-moi | 3.33def ±0.12 | 1.44e±0.03 | 1.11e±0.01 |

**4.0 Conclusion**

This study revealed that Igbabu oka produced from blended mixture of maize, melon and African palm weevil can compete favorably with moi-moi produced from whole cowpea (control). Analytically, there was significant difference in all the parameters (ie, proximate, sensory and microbial analysis) of the moi-moi and Igbabu oka (the blended and the control), thus indicating that Igbabu oka produced from blended mixture of maize, melon and African palm weevils is acceptable. This study also showed that the Igbabu oka samples produced from blended mixture of maize, melon and African palm weevil is nutritionally balanced and provides adequate energy to the body. From this study, production of Igbabu oka from blends mixture of maize, melon and African palm weevil should be encouraged as whole yellow maize, melon and African palm weevils are readily available and affordable.

**Reference**

Akusu, O. and Kin-Kabari, D.B.(2012). “Protein Quality and Sensory Evaluation of Moin-moin Prepared from Cowpea/Maize Flour Blends”. *African Journal of Food Science* 6.3: 47-51.

Apata, D. and Ologhobo A.D.(1994) “Biochemical Evaluation of Some Nigerian Legume Seeds”. *Food Chemistry* 49: 333-338.

ASARECA(2014). Maize lethal necrosis disease in Africa: past, present and planned initiatives. ASARECA. 17(9): 1-8.

Awuchi, C. G. (2019). Proximate composition and functional properties of different grain flour composites for industrial applications. *International Journal of Food Sciences* 2(1), 43- 64.

Enwere, N.J. (1998).“Foods of plant Origin”. *Afrobis Publications limited Nsukka, Nigeria* pp.24-76.

AOAC. “Official Methods of Analysis, Association of Official Analytical Chemist”(2000). 18th Edition Washington DC. USA..

FAO/WFP (2016). crop and food security assessment mission to South Sudan. Special Report. Retrieved from http://www.fao.org/docrep/012/ak346e/ak346e00.

Ijeh, I. I., Ejike, E. C., Nkwonta, O. M. and Njoku, B. C. (2010). Effect of traditional processing techniques on the nutritional and phytochemical composition of African (Treculia Africana) seeds. *Journal of Applied Sciences and Environmental Management, 14*(4), 169-173.Available at[: https://doi.org/10.4314/jasem.v14i4.63314.](https://doi.org/10.4314/jasem.v14i4.63314)

Isabirye B. E. and Rwomushana I. (2016). Current and future potential distribution of maize chlorotic mottle virus and risk of maize lethal necrosis disease in Africa. J. Crop Protect. 5(2):215-228.

Islam A., Mak, M., Rasul, G., Bashar, K. and Fatema-Tuj-Johora, C. (2015). Rice research: Open access development of component lines (CMS, maintainer and restorer lines) and their maintenance using diversed cytosources of rice. Rice Res. 3(3):37[. https://doi.org/10.4172/2375-4338.1000140](https://doi.org/10.4172/2375-4338.1000140)

Iwe, M.O. (2014). Current Trends in Sensory Evaluation of Foods. Revised Edition. Rojoint Communication Services Ltd. Uwani Enugu, Nigeria, 144-145.

Jiao, Y., Peluso, P., Shi, J., Liang, T., Stitzer, M. C., Wang, B., Campbell, M. S. and Stein J. C.(2017). Improved maize reference genome with single-nucleotide technologies. Nature. 546(7659):524-527. <https://doi.org/10.1038/nature22971>

Mignens, P, Bokaeian, M, Gholamreza, K. and Malihe, R. (2014). Evaluation of antioxidant and antibacterial activity on *Citrullus colocynthis* seed extract. Bulletin of Environment, Pharmacology and Life Sciences, 3(5):59-62.

Nwosu, J.N. (2011) “Proximate Composition and Acceptability of Moinmoin made from Cowpea (Vigna unguiculata) and Asperagus Beans seed (*Vigna sesquipedahs*)”. *World Rural Observation*,3.3:1-5.

Ogundele, G.F., Ojubanire, B.A and Bamidele, O.P. (2015). Proximate Composition and Organoleptic Evaluation of Cowpea (*Vigna uguculata*) and Soybean (*Glycine max*) Blends for the production of Moi-moi and Ekuru (steamed cowpea paste). J. of Experimental Biology and Agricultural Sciences,3(2) :207-212.

Okwunodulu, I.N., Nwaorienta, C., Okwunodulu, F.U., Onuorah, C.C., Ndife, J. and Ojimelukwe, P. (2019). Impart of different packaging materials on some physicochemical and acceptability of moimoi prepared from cowpea (*Vigna unguiculata*). *Acta Scientific Nutritional Health*, 3(9): 60-71.

Osuji CM., (2012). “Effect of Soy Flour and Maize Flour Addition on Phase Separation in Moi-moi from Soaked Cowpea (*Vigna unguiculata*) and Cowpea Flour from Different Cowpea Varieties”. *Nigerian Food Journal*,30.2: 33-37.

Petkova, Z. and Antova. G. (2015). Proximate composition of seeds and seed oils from melon (*Cucumis melo* L.) cultivated in Bulgaria*. Cogent Journal of Food and Agriculture*, 1(1); 1018779.  <https://doi.org/10.1080/23311932.2015.1018779>

Rodríguez-Pérez, C., Quirantes-Piné, R., Fernández-Gutiérrez, A., and Segura-526 Carretero, A. (2013). Comparative characterization of phenolic and other polar compounds in Spanish melon cultivars by using high-performance liquid chromatography coupled to electrospray ionization quadrupole-time of flight mass spectrometry. *Food Research International,* 54 (2):1519–1527.

Ullah, N., Zahoor, M., Ali, F., and Khan, S. K. (2014). A review on general introduction to medicinal plants, its phytochemicals and role of heavy metal and inorganic constituents. *Life Science Journal,* 11, 520–527.

Wardlaw, G. M., and Kessel, M. W.(2002). Perspectives in nutrition, McGraw Hill New York, 5th ed., pp. 162-452.

Yanty, N.A.M., Lai, O.M. A. Osman, K.L. and Ghazali, H.M. (2008). Physicochemical properties of *Cucumis melo* var. *inodorus* (honeydew melon) seed and seed oil. Journal of Food Lipids, 15(1): 42-55. <https://doi.org/10.1111/j.1745-4522.2007.00101.x>