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Original Research Report

Functional Properties and Nutrient Composition of Stiff Dough Produced From Composite Flour of Pearl Millet, White Maize and Cassava in Enugu State, Nigeria

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Abstract: The study prepared stiff dough blends from composite flour of pearl millet, white maize, and cassava in three formulations. Data collected for this study was analyzed using mean and standard deviation for the research questions while ANOVA was utilized in testing the hypothesis at 0.05 level of significance. Findings for the proximate compositions of the stiff dough samples revealed that moisture ranges from 10.42% to 10.60%. Ash content was within ranges of 1.10% to 1.34%. Crude fibre content was within ranges of 2.30% to 8.20%. Fats/oil content was from 1.20% to 5.40%. Protein was within ranges of 2.50% to 12.60%. Carbohydrate content was within ranges of 65.58 to 82.15%. The functional properties revealed that the values for bulk density ranged from 0.56cm^3 to 0.69 g/cm^3; water absorption capacity was 186.2%, 170.4% and 150.2%; oil absorption capacity was 160.4%, 154.0% and 132.9%; swelling capacity values were 15.2%, 6.8 % and 5.4% while flour dispersibility values were 68.0 g/g, 52.4 g/g and 44.6 g/g. Home makers can produce stiff dough from composite flour of pearl millet, white maize and cassava for family use thereby reducing consumption of commercially available composite flours. Furthermore, community nutrition education and awareness of the stiff dough can be created to promote consumption and improvement of the general health of the public.

Keywords: Cassava, Functional-properties, Maize, Pearl-millet, Stiff-dough

1. Introduction

Flour is milled from cereal, legume or tuber and commonly used in processing of confectioneries and other foods like noodles, pastas, macaroni and stiff-dough. Olusanya et al. (1990) noted that flour is the powder derived from milling dried grains, tubers, vegetables, seeds, and fruits. Different blends of flour from root crops, legumes, cereals and plantains can be combined to get composite flour. According to Chandra et al. (2015), composite flour refers to mixtures of flour from grains, tubers and cereals rich in starch, protein with or without wheat flour. Composite flours have been used extensively and successfully in the production of baked food products as well as other foods such as pasta, porridge and stiff dough.

Stiff dough is a food prepared from flour that is stirred continuously in boiling water to get a geletinized and homogenous mixture without lumps (Oyango, 2014). Different flours can be used in making stiff dough consumed as traditional foods in various parts of Nigeria such as *Lafu* made from cassava flour in Western Nigeria, *Tuwo* made from rice, millet or maize flour in Northern Nigeria and *nri oka* made from maize flour in South East, Nigeria. The major reason for combining flours in making stiff dough is to enhance the nutrient compositions and functional properties of the food product. The present study produced stiff dough from composite flour of pearl millet, white maize and cassava.

Pearl millet (*Pennisetum glaucum*) is a cereal crop belonging to the grass family, *Graminae*. Pearl millets are small grained cereals. Pearl millet is the most widely grown variety of millet because of its ability to survive in harsh conditions of low rainfall, high temperatures and poor soil fertility. The study utilized white coloured pearl millet variety because of the bright colour needed for improved acceptability of the stiff dough. Tortoe et al. (2019) noted that pearl millet contains sgnificant amounts of protein, fibres and minerals such as zinc and iron as compared to major cereals such as maize or rice. Maize (*Zea mays)* also known as corn has many characteristics common to other grasses of the same family *Poaceae* (*Gramineae*). Maize is a stable food crop consumed in its different products by most households in Nigeria. Major varieties of maize are white and yellow coloured. The major differences between the two varieties of maize are the natural occurring pigment that makes the kernels yellow. Eke-Ejiofor and Mbaka (2018) noted that white maize is genetically and biologically similar to yellow maize with a difference in colour and appearance due to the absence of carotene pigments in the kernel which results in the yellow colour of the grain.

Cassava (*Manihot esculenta c*ranz) of the family *Euphorbiacea*, is a tuberous perenial plant. Cassava can grow at sub optimal climatic conditions and is tolerant of soil infertility, drought stress and can be stored underground for several months after maturation. According to Chilungo (2013), the advantages of cassava as a crop include flexibility in planting and harvesting time, drought tolerance and the ability to grow in low nutrient soils, where others crops and cereals do not grow well. In Nigeria, cassava is the most important root crop. Popular cassava food products in Nigeria are *garri*, *fufu*, *lafun*, starch, tapioca, and cassava flour. The researchers produced stiff dough using cassava flour, white maize flour and white pearl millet and determined the functional property of the stiff dough.

Functional properties of food are the physical and chemical changes that occur during food preparation and storage. According to Kiin-Kabari and Eke-Ejiofor (2013), functional properties are those physico-chemical properties of foods that determine their behaviour during processing, consumption and storage. The functional properties of food product include the food products' solubility in water swelling capacity, bulk density, oil and water absorption and flour dispersibility. Functional properties of food products are influenced by the nutrient composition of the food. For example, cassava flour has high bulk density because of the high carbohydrate and fiber content of cassava roots. Currently in the market in Enugu State, there is no composite flour for stiff dough made from a blend of pearl millet, white maize and cassava flour. There is dearth of information on empirical studies on functional properties and nutrient composition of stiff dough from pearl millet, white maize and cassava composite flour, which necessitated the need for this study.

1.1. Statement of Problem

All purpose flour used in the production of confectioneries, bread, pasta and other food products is made from wheat which is imported in Nigeria (Food and Agriculture Organization, FAO, 2014). Durum wheat farming is difficult in Nigeria owing to the high temperature unsuitable for the crop production. As a result, Nigeria depends majorly on imported durum wheat to meet the growing food demands of its large population. Food and Agriculture Organization (FAO) (2021) reported that Nigerian durum wheat importation as at December, 2020 was estimated to be about 17 million metric tonnes, which is equivalent to the entire wheat production by Canada (the third largest producing country). Such importation have led to a huge amount of money on importation taxes and increased retail price of durum wheat flour and its products such as semolina, confectioneries, bread and pasta.

This necessitated the need to prepare composite flour from locally available food products in replacement for wheat flour. Food and Agriculture Organization (FAO) (2014) reported that application of composite flour in food products development would be economically advantageous if the importation of wheat flour could be reduced or even eliminated, and that demand for bread and pastry products would be met by the use of the domestically prepared products instead of wheat. Durum wheat flour which is currently used in the production of flour products and it is often criticized for its gluten content. The most common issue with gluten is the sensitivity or intolerance, which many people face and can cause discomfort or bloating when consumed. High consumption of gluten can also result in celiac disease, which is an extreme intolerance to gluten, or a wheat allergy. Hence, there is a need to produce healthy composite flour for stiff dough from pearl millet, white maize and cassava flour.

1.2.Purpose of the Study

The major purpose of the study was to prepare stiff dough blends from composite flour of pearl millet, white maize and cassava flour. Specifically, the study:

a) Prepared stiff dough samples using 20:30:50 formulations of pearl millet, white maize and cassava (PMC); 20:30:50 formulations of white maize, cassava and pearl millet (MCP); and 20:30:50 formulations of cassava, pearl millet and white maize (CPM).
b) Determined proximate compositions (moisture, ash, protein, fats/oil fibre and carbohydrate) compositions of the stiff dough samples produced using PMC, MCP and CPM formulations of pearl millet, white maize and cassava.
c) Determined the functional properties (bulk density, water absorption capacity, oil absorption capacity, swelling capability and flour dispersibility) of stiff dough produced using PMC, MCP and CPM formulations of pearl millet, white maize and cassava.

1.3.Research Questions

The following research questions guided the study:

a) What are the proximate (moisture, ash, fats/oils, fibre, protein and carbohydrate) compositions of the stiff dough samples produced using PMC, MCP and CPM formulations of pearl millet, white maize and cassava?
b) What are the functional properties (bulk density, water absorption capacity, oil absorption capacity, swelling capability and flour dispersibility) of the stiff dough samples produced

using PMC, MCP and CPM formulations of pearl millet, white maize and cassava?

1.4.Hypothesis

HO_1: There is no significant difference in the proximate compositions (moisture, ash, protein, crude fibre, fats/oils and carbohydrate) of the three formulations (PMC, MCP and CPM) of the stiff dough samples prepared from composite flour of pearl millet, white maize and cassava,

HO_2: There is no significant difference in the mean values of the functional properties (bulk density, water absorption capacity, oil absorption capacity, swelling capacity and flour dispersibility) of the three formulations (PMC, MCP and CPM) of the stiff dough samples produced from composite flour of pearl millet, white maize and cassava.

2. Materials and Methods

2.1. Design of the Study

The study adopted mixed method research design, specifically, research and development (R & D), experimental and descriptive survey research design. R & D was used to prepare the composite flour and stiff dough samples; laboratory experimental tests were used to determine the nutrient composition; while survey research design was used to determine the organoleptic attributes.

2.1.1. Ethics Statement

The study ethical approval was received by the authors from the Faculty of Vocational and Technical Education, University of Nigeria, Nsukka. Informed consent was obtained in writing from participants.

2.2. Area of the Study

The study took place at the Faculty of Vocational and Technical Education, University of Nigeria, Nsukka.

2.3.Population and Sample

The population for the study was 354 which consisted of 98 lecturers and 256 post graduate students in the Faculty of Vocational and Technical Education, University of Nigeria, Nsukka. Sample size for sensory evaluation was 50 respondents which comprised of 15 lecturers and 35 post graduate students. Purposive sampling technique was used to select the 50 sensory evaluation panelists from the population who are available at the time of evaluation.

2.4. Instrument for Data Collection

The 9-point hedonic scale was the instrument used for data collection. The 9- point hedonic scale was subjected to face validation by five experts. Two from the Department of Home Economics and Hospitality Management Education, one from the Department of Agriculture Education and two from Nutrition and Dietetics Department. All validates were from the University of Nigeria, Nsukka. Data for this study were collected in two phases which included determination of proximate compositions and organoleptic attributes of the stiff dough samples.

2.5. Data Collection Technique and Study Procedure

The materials used to produce the stiff dough samples included composite flour of pearl millet, white maize and cassava which were obtained from dried pearl millet, dried white maize grains and fresh cassava roots. All the materials were purchased from Ogige market in Nsukka, Enugu State. The processing of the composite flour used in the production of the stiff dough samples were done at the laboratory in the Center for Lion Gadgets and Technology, University of Nigeria, Nsukka. The Center for Lion Gadgets and Technology was chosen because they have the needed processing equipment.

2.5.1. Sample Preparation: The samples were prepared using the following processes below. The processing of the pearl millet, white maize and cassava into flour samples was done at the Center for Lion Gadgets and Technology, University of Nigeria, Nsukka.

2.5.2. Processing of Pearl Millet: Dried pearl millet grains (5 kg) were processed by adapting the production method by Olapade et al. (2010). The grains were picked to remove all impurities, washed, drained and then dried in cabinet drier at $50^{o}C$ for 6 hrs, then milled into flour using hammer mill, sieved by passing it through 0.2 mm mesh and packaged until ready for use.

2.5.3. Processing of White Maize: Dried white maize grains (5 kg) were processed by adapting the production method by Mohammed et al. (2012) with slight modifications. The maize were picked to remove impurities, washed, drained, then dried in cabinet drier at $50^{0}C$ for about 6 hrs, milled into flour using hammer mill. Then it was sieved by passing through 0.2 mm mesh and then packaged until use.

2.5.4. Processing of Cassava: Fresh Cassava (10 kg) was processed by adapting the production methods by Akingbala et al. (2005) with slight modifications. The cassava tubers were peeled to remove the outter layer, washed in clean water and grated with a motorized grater. It was put in a washed clean sack and presses using manual screw press, then sundried. Safety of the grated cassava was ensured by using a sack washed in sterile water and it was sun dried in a drying cabinet with net covers. When completely dried, it was milled into flour using a disc-attrition mill and sieved with a sifter 250µ m screen, then, the flour was packaged until use.

2.5.5. Flowchart of the Processes Procedure: The processing procedure for preparation of composite flour for stiff dough from pearl millet, white maize and cassava is shown in 1

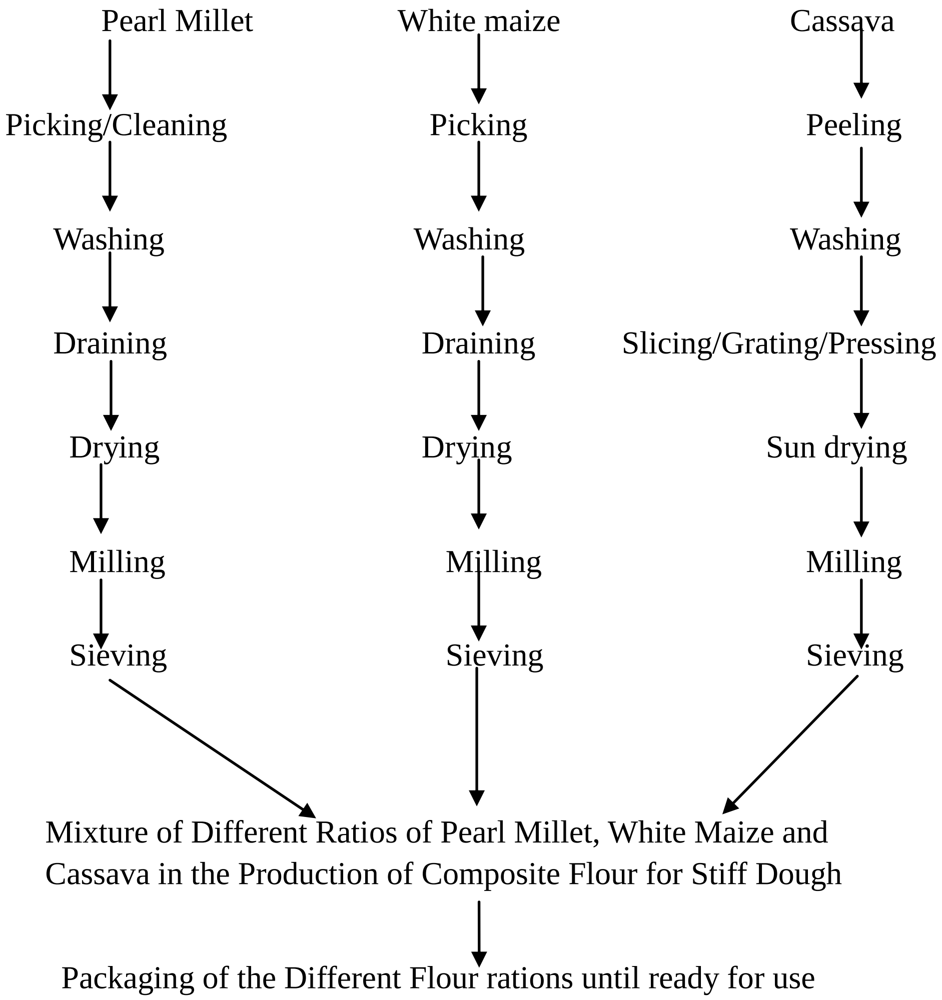

Fig 1: Flow chart for the processing of composite flour for stiff dough from pearl millet, white maize and cassava

2.5.6. Coding of the Composite Flour Samples: The composite flour samples for the three samples of stiff dough from pearl millet, white maize and cassava were formulated and coded as follows:

- Sample A was PMC = 20:30:50 of pearl millet, white maize and cassava,
- Sample B was MCP = 20:30:50 of white maize, cassava and pearl millet
- Sample C was CPM = 20:30:50 of cassava, pearl millet and white maize

Proximate Analysis Procedure: The nutrient composition (moisture content, protein, fats/oil, crude fibre, ash content) of the drink samples were determined using the method described by Association of Official Analytical Chemists (AOAC) (2010). Carbohydrate composition was determined by difference.

2.5.7. Functional Properties Determination: The bulk density, swelling capacity, was determined as described by Emmambux and Taylor (2013). The flour dispersibility, water and oil absorption capacity were determined by the method described by Eke-Ejiofor and Oparaodu (2019).

2.6. Data Analysis Technique

Data collected were analyzed using mean and standard deviation for research questions and ANOVA for testing the hypothesis at 0.05 level of significance. All data were analyzed using Statistical package for Social Sciences (SPSS) version 25.

3. Results and Discussion

3.1. Research Question 1: What are the proximate (moisture, ash, fats/oils, fibre, protein and carbohydrate) compositions of the stiff dough samples produced using PMC, MCP and CPM formulations of pearl millet, white maize and cassava?

Table 1: Proximate Compositions (Moisture, Ash, Fats/Oils, Crude Fibre, Crude Protein and Carbohydrate) of the Stiff Dough Samples

Sample	Moisture (%)	Ash (%)	Crude Fibre (%)	Fats (%)	Protein (%)	Carbohydrate (%)
PMC	10.51	1.34	2.3 0	1.20	2.50	82.15
MCP	10.42	1.10	8.2 0	5.40	10.40	65.58
CPM	10.60	1.29	3.0 0	4.60	12.60	67.91

Key: PMC = Pearl Millet (20%), White Maize (30%) and Cassava (50%); MCP = White Maize(20%), Cassava (30%) and Pearl Millet (50%); CPM = Cassava (20%), Pearl Millet (30%) and White Maize (50%).

3.2. Hypothesis 1: There is no significant difference in the proximate (moisture, ash, fats/oils, fibre, protein and carbohydrate) compositions of the three formulations (PMC, MCP and CPM) of the stiff dough samples produced from composite flour of pearl millet, white maize and cassava.

Table 2: Analysis of Variance (ANOVA) of the Proximate Compositions (Moisture, Ash, Fats/oils, Fibre, Protein and Carbohydrate) of the Stiff Dough

Proximate Compositions	**SSb**	**SSw**	**MSb**	**MSw**	**F**	**Sig.**	**Decision**
Moisture	0.03	0.00	0.01	0.00	99.27	0.002	S
Ash	0.06	0.00	0.03	0.00	36.13	0.008	S
Fats & Oil	20.11	0.00	10.05	0.00	14715.53	0.000	S
Crude Fibre	41.20	0.00	20.60	0.00	11445.77	0.000	S
Protein	112.56	0.00	56.27	0.00	11250.70	0.000	S
Carbohydrate	324.85	0.01	162.42	0.00	26627.56	0.000	S

Key: NS = Not Significant, S = Significant, df = Degree of Freedom, dtb = 2, dfw = 3, F = calculated value of ANOVA using SPSS, SSb = Sum of Squares between groups, SSw = Sum of Squares within groups, MSb = Mean of Squares between groups, MSw = Mean of Squares within groups, level of Significance = 0.05

3.3. Research Question 2: What are the functional properties (bulk density, water absorption capacity, oil absorption capacity, swelling capability and flour dispersibility) of the stiff dough samples produced using PMC, MCP and CPM formulations of pearl millet, white maize and cassava?

Table 3: Functional Properties (Bulk Density, water absorption capacity, oil absorption capacity, swelling capability and flour dispersibility)) of the Stiff Dough Samples

Sample	**Bulk Density** g/cm3	**WAC** %	**OAC** %	**Swelling Capacity** g/g	**Flour Dispersibiliy** %
PMC	0.56	186.2	160.4	15.2	68.0
MCP	0.66	170.4	154.0	6.8	52.4
CPM	0.69	150.2	132.8	5.4	44.6

Key: PMC = Pearl Millet (20%), White Maize (30%) and Cassava (50%); MCP = White Maize(20%), Cassava (30%) and Pearl Millet (50%); CPM = Cassava (20%), Pearl Millet (30%) and White Maize (50%); WAC = Water Absorption Capacity, OAC = Oil Absorption capacity.

3.4. Hypothesis 2: There is no significant difference in the mean values of the functional properties (bulk density, water absorption capacity, oil absorption capacity, swelling capability and flour dispersibility) of the three formulations (PMC, MCP and CPM) of the stiff dough samples produced from composite flour of pearl millet, white maize and cassava.

Table 4: Analysis of Variance (ANOVA) of the Functional Properties of the stif Dough Samples

Functional Properties	SSb	SSw	MSb	MSw	F	Sig	Decision
Bulk Density	0.01	0.00	0.00	0.00	185.33	0.001	S
WAC	1306.08	0.00	635.04	0.00	2612.68	0.000	S
OAC	836.26	0.01	418.13	0.00	1115.44	0.000	S
Dispersibility	562.01	0.01	281.02	0.01	2097.24	0.000	S
Swelling Capacity	112.34	0.00	56.17	0.00	2407.21	0.000	S

Key: NS = Not Significant, S = Significant, df = Degree of Freedom, dtb = 2, dfw = 3, F = calculated value of ANOVA using SPSS, SSb = Sum of Squares between groups, SSw = Sum of Squares within groups, MSb = Mean of Squares between groups, MSw = Mean of Squares within groups, level of Significance = 0.05

Table 1 contains the proximate compositions of the three samples of stiff dough. The results revealed that CPM had highest amount of moisture with a value of 10.60%, PMC had 10.51% while MCP had 10.42%. In agreement with the findings, Basirat et al. (2021) reported similar values ranging from 9.83% to 10.41% for moisture content. Also, Ilelaboye and Ogunsina (2018) reported similar values of moisture content ranging from 6.54% to 11.20% in a study on proximate composition, functional properties and sensory evaluation of stiff dough (Amala) prepared from Okara fortified plantain-sorghum flours. The high moisture content of the stiff dough samples can be attributed to the ingredients used in the production.

Findings showed that in the ash content, PMC had 1.34%, CPM had 1.29% and MCP had 1.10%. In support of the findings, Basirat et al. (2021) reported similar values ranging from 1.52% to 1.71% for ash content. In contrary, Ukom et al. (2018) reported higher ash content values ranging from 1.50% to 2.40% in a study on the effect of processing on the proximate, functional and anti-nutritional properties of cocoyam flour. Findings showed that for crude fibre content, MCP had higher value of 8.20, CPM had 3.00% and PMC had 2.30%. In line with the findings, Ikujenlola and Ogunba (2018) reported similar crude fibre values ranging from 3.55% to 5.79% while Basirat et al. (2021) reported lower crude fibre values ranging from 0.56 to 0.81 for crude fibre content. Findings indicated that in Fats/Oil content, MCP contains highest value of 5.40%, CPM had 4.60% while PMC had 1.20%. In agreement with the findings, Eke-Ejiofor and Beleya (2017) reported similar fat content ranging from 3.13% to 4.48% in a study on maize spiced ogi (Gruel). However, Basirat et al.

(2021) reported higher fat values ranging from 5.30% to 6.88% in a study on quality assessment of Tuwo made from maize flour modified with cassava starch. The higher value of fat content reported by Basirat et al. (2021) can be attributed to the ingredients used in the preparation of the composite flour.

Findings revealed that for protein content, CPM had highest value of 12.60%, MCP had 10.40% while PMC had low value of 2.50%. In agreement with the findings, Akoja and Coker (2018) reported higher protein values ranging from 10.56% to 21.93% in stiff dough made from wheat-okra flour samples. However, Idowu et al. (2013) reported lower protein values ranging from 1.31% to 5.7% in a study on quality assessment of Stiff dough (Amala) produced from three varieties of sweet potatoes. Findings showed that for carbohydrate content, PMC had highest value of 82.15%, CPM had 67.91% while MCP had 65.58%. The result indicated that PMC contains highest carbohydrate value of 82.15% which is as a result of high carbohydrate content of cassava being a tuberous crop. In relation to the study, Basirat et al. (2021) in a study on quality assessment of Tuwo made from maize flour modified with cassava starch reported similar values ranging from 69.53 to 74.89 for carbohydrate content. However, Akoja and Coker (2018) reported lower carbohydrate content ranging from 42.56% to 56.45% in a study on wheat-okra flour. The lower carbohydrate content reported by Akoja and Coker's study can be attributed to the ingredients used in the preparation of the composite flour. Test of hypothesis 1 revealed that there is a significant difference in the proximate compositions (moisture content, ash content, protein content,, fats and oil, crude fibre and carbohydrate) composition of the three stiff dough samples.

Table 3 contains the functional properties of the three stiff dough samples. From the findings, CPM contain the highest bulk density of 0.69 g/cm3 which aligns with the report of sample values ranging from 0.70g/cm3 to 0.74g/cm3 recorded by Basirat et al. (2021). Also in line with the findings on bulk density, Bolarin et al. (2018) reported similar values of cocoyam flour bulk density ranging from 0.67g/cm3 to 0.72g/cm3. The bulk density of flours implies physical attributes considered when determining weight of flours as it affects the packaging of the sample.

Findings on the water absorption capacity, revealed that PMC had a value of 186.2%, followed by MCP with 170.4% and CPM with 150.2%. High water absorption capacity of a flour sample facilitates the usage in the formulation of food products such as stiff dough and bakery products. In relation to the findings, Basirat et al. (2021) reported similar water absorption capacity ranging from

121.31% to 245.76%. Contrary to the findings, Meka and Igbabul (2019) reported lower values ranging from 5.09g to 9.04g for water absorption capacity for composite flours made from yellow maize, soybeans and jackfruit seeds.

Findings on the oil absorption capacity of the stiff dough samples indicated that PMC was recorded highest with 160.4%, MCP had154.0% while CPM had 132.9%. Oil absorption capacity is the ability of flour to physically bind with fat. Aremu et al. (2008) stated that oil absorption capacity entails the process by which flour protein physically binds with fat through capillary attraction. Aremu et al. further noted that oil absorption capacity is potentially useful in structural food interaction especially in flavour retention, improvement and extension of shelf life of baked products, soup mixes and stiff dough. Contrary to the findings, Meka and Igbabul (2019) reported lower oil absorption capacity ranging from 1.36g/g to 2.26g/g. Findings on the swelling capacity of the stiff dough samples indicated that PMC had 15.2%, MCP had 6.8 % while CPM had 5.4%. Swelling capacity can be described as the ability of starch to imbibe water and increase in size. Similar to the findings on CPM (5.4%), Adedeji and Tadawus (2019) reported swelling capacity values ranging from 5.44% to 5.95% in a study on maize-baobab pulp flour. Also, Moses and Jeremiah (2019) reported swelling capacity values ranging from 11.50% to 14.50% in a study on yam flours. Contrary to the findings, Ukom et al. (2018) reported lower swelling capacity values ranging from 1.26% to 2.00% in study on cocoyam flours.

Findings on the flour dispersibility showed that PMC had highest value of 68.0 g/g, MCP had 52.4 g/g while CPM had 44.6 g/g. Dispersibility is an indicator of good water absorption capacity of flours. Eke-Ejiofor and Okparaodu (2019) noted that dispersibility of flours gives an indication of the suspension of particles in water, which is associated with fine particle size. Hence, the finer the particle, the more percentage of dispersibility. This implies that the high percentage of 68.0 g/g recorded in PMC sample can be attributed to the high ratio of cassava flour in the sample. In support of the findings, Kacou et al. (2018) reported dispersibility values ranging from 62.85% to 73.80% in a study on functional properties of cassava flour blends. Test of hypothesis 4 showed that there is a significant difference in the functional properties of the stiff dough samples. Based on the findings of the study, we draw the implication that home makers can produce healthy composite flour of different compositions of pearl millet, white maize and cassava and use as stiff dough for family consumption thereby reducing consumption of commercially available composite flours for stiff dough. Also, the composite flour of pearl millet, white maize and cassava can be made available in large quantities for commercial purpose by unemployed graduates and local food producers. Based on the findings of the study, suggestions for further studies included carrying out another study using different varieties of millet such as finger millet, foxtail millet or proso millet, as alternative to pearl millet in the production of composite flour for stiff dough. Thereafter, the proximate, mineral, vitamin and functional property would be determined.

4. Conclusion

Based on the findings of the study, it can be concluded that stiff dough can be prepared from composite flour of white maize, pearl millet and cassava in different proportions. The proximate compositions of the stiff dough samples indicated that the samples contain appreciable composition of moisture content, ash, crude fibre, fats/oil, protein and carbohydrate contents. The functional properties of the stiff dough samples revealed that the samples have high dispersibility and swelling capacity, are soluble in water and oil, with high bulk density (weight). Hence, the functional properties indicates that the stiff dough samples would be appropriate for making stiff dough. However, MCP containing formulations 20:30:50 of white maize, cassava and pearl millet is considered most amostly for containing highest fibre of 8.20% and fat of 5.40%. It also contains least carbohydrate of 65.58% and lease ash. The protein content of 10.40% is also appropriate.

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Conflict of Interest

The authors declare that there is no conflict of interest.

Author Contributions

FNO and UGO conceptualized the idea. FNO and UGO designed the study. FNO and UGO prepared the stiff dough samples, planned and organised the organoleptic evaluation exercise and collated the data from the laboratory. FNO and UGO analyzed the data. FNO and UGO approved the final draft of the manuscript.

Data Availability Statement

The original contributions presented in the study are included in the article. Further enquiries can be directed to the corresponding author.

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References

Adedeji, O.E. & Tadawus, N. (2019). Functional properties of maize flour (Zea mays) and stability of its paste (Tuwo) as influenced by processing methods and baobab (Adansoniadigitata) pulp inclusion. *Ukrainian Journal of Food Science, 7*(1), 8-12. http://doi.org/10.24263/2310-1008-2019-7-1-7

Akingbala, J.O., Oyewole, O.B., Uzo-Peters, P.I., Karim, R.O. & Bacuss-Taylor, G.S.H. (2005). Evaluating stored cassava quality in Gari production. *Journal of Food, Agriculture and Environment, 3*(1), 75-80.

Akoja, S.S. & Coker, O.J. (2018). Physicochemical, functional, pasting and sensory properties of wheat flour biscuit incorporated with okra powder. *International Journal of Food Science and Nutrition, 3*(5), 64-70.

Aremu, M.O., Olaofe, O., Akintayo, E.T. & Adeyeye, E.I. (2008). Foaming, water absorption, emulsification and gelation properties of Kersting's groundnut (Kerstingiella geocarpa) and bambara groundnut (Vigna subterranean) Flours as influenced by neutral salts and their concentrations. *Pakistan Journal of Nutrition, 7*(1), 194-201. https://doi.org/10.3923/pjn.2008.194.201

Association of Official Analytical Chemists (AOAC). (2010). Official Methods of Analysis, Association of Analytical Chemists. 19th ed. AOAC.

Basirat, A.O.S., Idowu, O.A. & Olanrewaju, D.F. (2021). Quality assessment of "Tuwo" (maize dumpling) made from maize flour modified with maize and cassava starch. *Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT), 15*(6), 15-29.

Bolarin, F.M., Olotu, F. B., Saheed, A. & Afolabi, R.A. (2018). Effect of processing methods on the functional properties of cocoyam flour. *International Research Journal of Natural Sciences, 6* (1), 13-17.

Chandra, S., Singh, S. & Kumari, D. (2015). Evaluation of functional properties of composite flours and sensorial attributes of composite flour biscuits. *Journal of Food Science and Technology, 52*(6), 3681–3688. https://doi.org/10.1007/s13197-014-1427-2

Chilungo, S. (2013). Physicochemical properties and baking qualities of baked wheat products supplemented with cassava and pigeon pea flours. (Master's Thesis), Michigan State University.

Eke-Ejiofor, J, & Oparaodu, F.O. (2019). Chemical, functional and pasting properties of flour from three millet varieties. *Research Journal of Food and Nutrition, 3*(3), 15-21. https://doi.org/10.47672/ajfsn.739

Eke-Ejiofor, J. & Beleya, E. A. (2017). Chemical, mineral, pasting and sensory properties of spiced Ogi (Gruel). *American Journal of Food Science and Technology, 5* (5), 204-209. https://doi.org/10.12691/ajfst-5-5-6

Eke-Ejiofor, J. & Mbaka, V. (2018). Physicochemical, pasting and sensory properties of food blends of maize, yellow cassava and sweet potato starch, defatted soybean and groundnut flour. *American Journal of Food Science and Technology, 6*(1), 42-49. https://doi.org/10.12691/ajfst-6-1-7

Emmambux, M.N. & Taylor, J.R.N. (2013). Morphology, physical, chemical, and functional properties of starches from cereals, legumes, and tubers cultivated in Africa – review. *Starch*, 65(9-10), 715-729. https://doi.org/10.1002/star.201200263

Food and Agricultural Organisation (FAO). (2014). Wheat production. https://www.faostat.fao.org

Food and Agriculture Organization (FAO) (2021). Statistical database, statistical division. https://www.faostat.fao.org/html.

Idowu, O.A, Olaoye, O.A, Sogotemi, C.M. & Ajayi, B. (2013). Quality assessment of flours and Amala produced from three varieties of Sweet Potato Ipomea batatas. *International Journal of Food and Nutritional Sciences, 2*(4), 1-9.

Ikujenlola, A.V. & Ogunba, O.B. (2018). Potential Complementary food from quality protein maize (Zea mays L.) Supplemented with Sesame (Sesamum indicum) and Mushroom (Oudemansiellaradicata). *Journal of Nutrition and Food Sciences, 8*(3), 1-7.

Kacou, M.A., Ekissi, G.S.E., Ebbah-Djedji, B.C., N'zue, B. & Kouame, P.L. (2018) Assessment of functional properties of flours from seven blends of cassava (Manihot esculenta Crantz) consumed in Cote d'Ivoire. *International Journal of Current Microbiology and Applied Sciences, 7*(10), 815-826. https://doi.org/10.20546/ijcmas.2018.710.090

Kiin-Kabari, D.B & Eke-Ejiofor, J. (2013). Physico-chemical and sensory properties of cakes and cookies produced from composite flours of wheat and plantain. *Wudpecker Journal of Food*

Technology, 1(1), 9-13.

Meka, B.D. & Igbabul, J.I. (2019). Chemical and functional properties of composite flours made from yellow maize, soybeans, and jackfruit seed. *International Journal of Research and Innovation in Applied Science (IJRIAS), 4*(11), 57-63

Mohammed, A.B., Ayanlere, A.F., Ibrahim, U. & Muhammed, A.L. (2012). Economic analysis of maize production in Ogori/Magongo Local Government Area of Kogi State, Nigeria. *International Journal of Agricultural Science, Research and Technology, 2*(3), 111-115.

Olapade, A.A., Aworh, O.C. & Oluwole, O.B. (2010). Quality attributes of biscuits from acha (digitariaexilis) flour supplemented with cowpea (Vigna unguiculata) flour. *African Journal of Food Science and Technology, 2*(9), 198-203.

Olusanya, J.O., Eyis, O., Anfani-Joe, M.E., Ogunjide, L.O. & Egbuchulam, B. (1990). *Foods and Nutrition for Secondary Schools, Books 1-3*. Ibadan: University Press.

Onyango, C. (2014). Physical properties of dried milled maize meals and their relationship with the texture of thin and thick porridge. *African Journal of Food Science, 8*(8), 435-443. https://doi.org/10.5897/AJFS2014.1185

Tortoe, C., Akonor, P.T., Hagan, L., Kanton, R.A.L., Asungre, P.A. & Ansoba, E.Y. (2019). Assessing the suitability of flours from five pearl millet (Pennisetum americanum) varieties for bread production. *International Food Research Journal, 26*(1), 329-336.

Ukom, A.N, Richard, C.P. & Abasiekong, S.K. (2018). Effect of processing on the proximate, functional and anti-nutritional properties of cocoyam (XanthosomaMaffa (Scoth)) Flour. *Official Journal of Nigerian Institute of Food Science and Technology, 35*(2), 9-17.

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