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EFFECT OF MALTING AND POPPING ON THE QUALITY PARAMETERS OF POPCORN

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ABSTRACT: *This study was aimed at investigating the effects of germination (malting) and popping on the quality parameters of popcorn with a view to improving the quality parameters of popcorn. Four different samples of malted popped corn flour (MPM), malted popcorn flour (MME), popped corn flour (PME), and raw popcorn maise flour (OME) were produced using different processing procedures. The material (Popcorn seed) was obtained from the local market in Ile-Ife. The popcorn seeds were sorted and soaked in water for 6 hours. The grains were spread on trays lined with cloth and kept wet by frequent water spraying every morning and evening for 2 days. The germinated popcorn kernel was washed and sun-dried. Part of the dried popcorn was milled, some were popped and milled, and part of the germinated corn was popped using the popping machine. The samples were analysed using standard methods for their physical, functional, Pasting Properties, proximate minerals, total dietary fibre, and sensory evaluation. The analysis showed that samples' bulk density reduced during popping; malted popped maise flour exhibited the highest values for WAC, OAC and for all the pasting parameters. The malting process increased the mineral content in the popped corn grains. All the samples were acceptable to the panellists. The study concluded that malting influenced the quality parameters of the samples, and the study established the fact that malted grain could be popped.*

KEYWORDS: *Popcorns, Malting, Bulk Density, Water Absorption, Oil Absorption Capacity.*

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INTRODUCTION

For the majority of people in Africa, including Nigeria, maise is the most important cereal. Depending on the endosperm, corn kernels made of maise can be white, yellow, red, blue, or variations of those colours. Zea mays, however, have been used to classify any cultivated plants used for food, feed, or industrial purposes (Ijarotimi and Keshinro, 2011). Flint corn (Zea mays indurata), dent corn (Zea mays identata), flour or soft corn (Zea mays amylacea), and popcorn are the most significant kinds of maise (Zea mays everta).

Popcorn is made from maise that has been exposed to dry heat and is one of the most widely consumed, flexible, and healthy snacks. Popcorn offers a wide range of nutritional advantages, such as dietary fibre, protein, and B vitamins (Donkeun *et al*., 2000). The nutritional analysis of popcorn revealed that it included 61.0-67.9% starch, of which 27.0-28.5% was amylase, 8.1-10.5% crude protein, 0.07-0.23% reducing sugars, and 3.8-4.6% crude fat (Donkeun *et al*., 2000). Additionally, popcorn is a very cost-effective grain that offers a simple approach to increasing the amount of fibre in your diet (Schneider, 2014).

The process of malting involves turning insoluble starch into soluble sugar using the enzyme amylase, which produces a thinning effect. During malting, this thinning process has a significant nutritional impact (Ikujenlola *et al*., 2013). Malting and fermentation could increase the quantity and quality of their proteins and decrease anti-nutritional elements that might have an impact on how well their nutrients are used and the health of consumers (Oluwamukomi *et al*., 2003). Both carbohydrates and proteins are partially broken down during malting to improve digestibility (Ram *et al.*, 1979). Additionally, amylases are developed, reducing gelled starch viscosity (Brandtzaeg *et al.*, 1981). Malting has improved the colour and flavour character (Rooney and Waniska, 2000).

MATERIALS AND METHODS

Materials

The material used is popcorn maise (*Zea mayz everta*). The material was obtained from the local market in Ile-Ife. All chemicals used were of analytical grades.

Methods

Production of germinated popcorn

After being sorted, the popcorn seeds were submerged in water for six hours. The grains were placed on cloth-lined trays and frequently sprayed with water each morning and evening for two days.

Production of Germinated popcorn flour and Germinated popped popcorn Flour

The germinated popcorn kernel was cleaned and allowed to air dry. For sensory evaluation, some of the dry popcorn was milled, some popped and milled, and some germinated corn was also popped. The unit process for making germination-assisted popcorn is depicted in Fig. 1. After being popped into a popping machine with vegetable oil added; the popcorn was ground. The process for making popped corn is depicted in Fig. 2 as a unit operation.

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Various Samples

Four different samples were produced and assessed in this study.

Sample A- raw popcorn

Sample B- sprouted popcorn

Sample C- sprouted popped corn

Sample D- popped corn

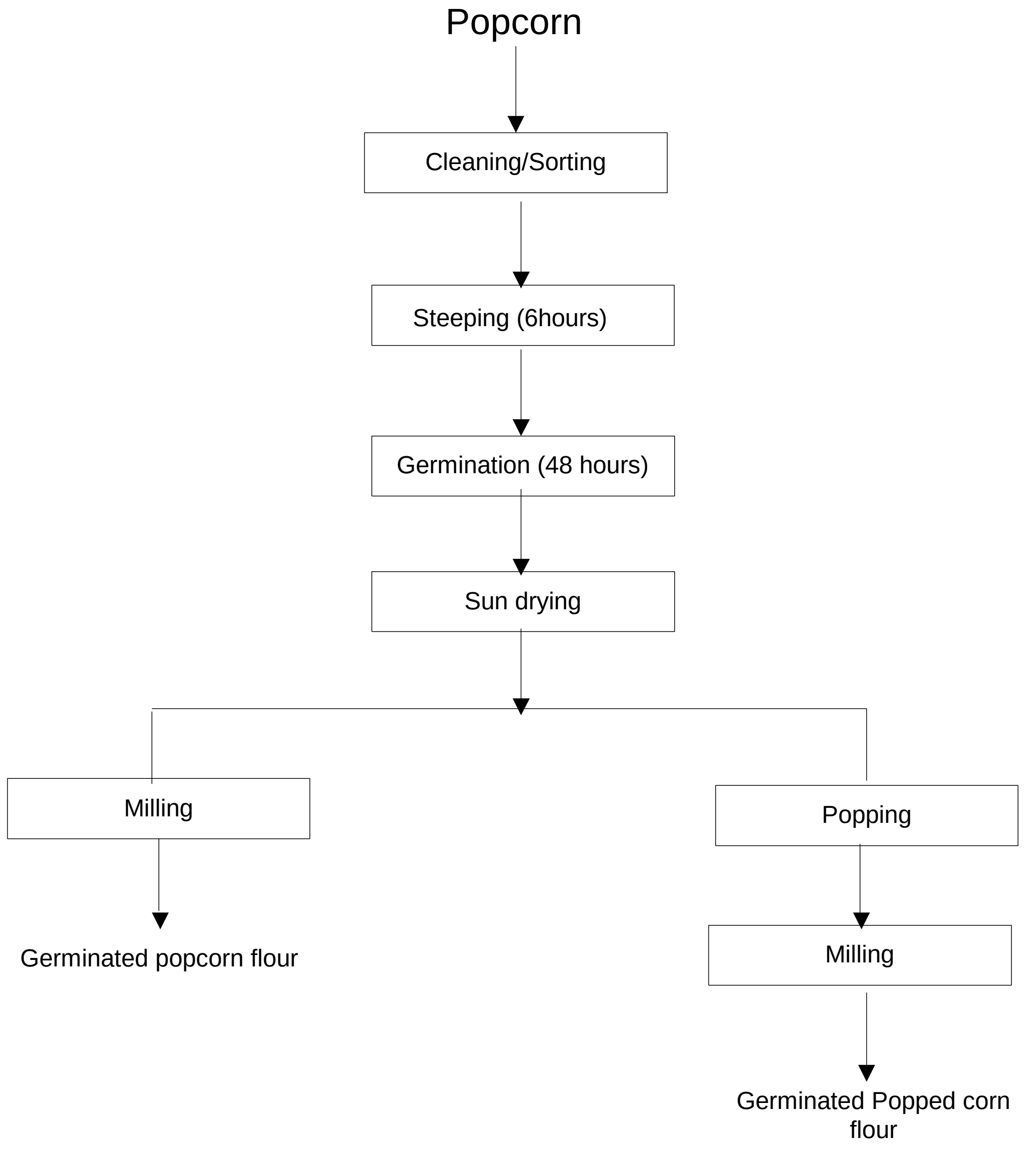

Fig 1: Production of Germinated popcorn flour and Germinated popped popcorn Flour

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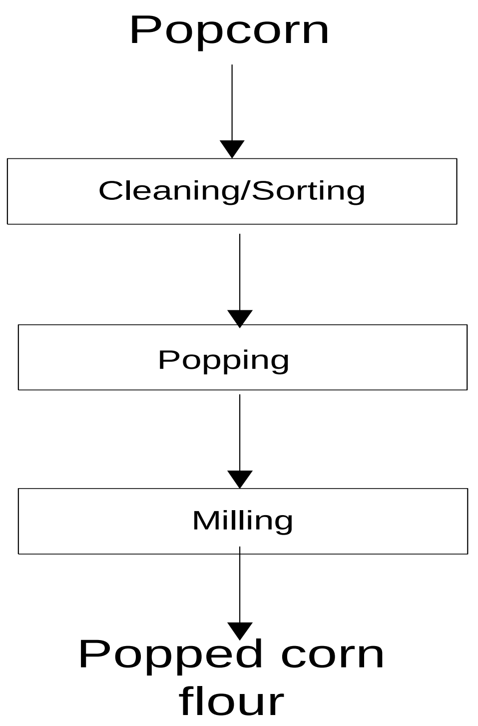

Fig. 2 Production of Popped Corn Flour

Functional Properties Determination

The bulk density was computed utilising the Okezie and Bello method (1988). To quantify water absorption, a modified version of Sathe & Salunkhe's method was utilised (1997). The method proposed by Lin and Zayas (1987) was used to evaluate oil absorption capability. The approach outlined by Akpapunam and Markakis in 1981 was used to calculate the reconstruction index. The method developed by Sathe and Salunkhe (1981) was used to calculate the gelling concentration suspension examples. In order to test dispersibility, 10 g of the sample materials were added to 100 ml of water in a measuring cylinder, and the mixture was allowed to settle. The dispersibility was calculated as the amount of time it took for all the particles to settle inside the cylinder.

Resistant Starch Determination.

To express the results on a dry weight basis, samples were dried in an air oven at 100 °C until the weight was constant. The AOAC technique was used to measure TDF (AOAC 1990). Protein and starch were removed from the samples by first gelatinising them with a heat-stable amylase (pH 6, 100 °C, 30 min), followed by enzymatic digestion with protease (pH 7.5, 60 °C, 30 min) and amyloglucosidase (pH 6, 0 °C, 30 min). TDF was precipitated with ethanol, and the residue was then cleaned, dried, and weighed. Protein and ash corrections were made to the results. Amyloglucosidase was incubated with each sample for 30 or 60 minutes; three analyses of each treatment were carried out after 30 minutes of amyloglucosidase incubation.

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Pasting Properties Determination

The pasting properties of flour and the diets were assessed using a fast visco analyser (Newport Scientific Pty Ltd. Warriewood NSW 2120, Australia) linked to a computer (PC) running the Windows operating system via a USB port.

Proximate Composition Determination

The product's moisture, protein, crude fat, and crude fibre contents were assessed in accordance with the guidelines provided by AOAC in 2000.

Mineral Content Determination

The Atomic Absorption Spectrophotometric technique was used to conduct the analysis for the important minerals elements (Fashakin *et al.*, 1991).

Total Dietary Fibre Determination

To measure total dietary fibre (TDF), soluble dietary fibre (SDF), and insoluble dietary fibre (IDF), the Total Dietary Fibre Assay Kit (TDF-100A; Sigma-Aldrich, St. Louis, Missouri, USA) based on the enzymatic-gravimetric method published in the AOAC (AOAC, 2000) was used. The defatted samples were gelatinised using heat-stable amylase (A 3306) in this procedure. Additionally, samples will undergo enzymatic digestion with protease (P 3910) and amyloglucosidase (A 9913) to eliminate the sample's protein and starch content. Filtration was used to recover dietary fibre that was insoluble. With the use of ethanol, soluble dietary fibre was precipitated and filtered.

Sensory Evaluation Determination

The Larmond (1977) and Ikujenlola (2010) methods assessed the samples' sensory qualities.

RESULT AND DISCUSSION

Functional Properties

The functional properties of the various samples of popcorn maise with different processing methods are shown in Table 2.

The bulk density of the samples ranged between 0.16-0.6 g/ml. The result showed that the bulk density of the raw popcorn flour (OME) samples 0.64 g/ml reduced during popping (popped maise flour PME) to 1.63 g/ml, while malted popcorn flour (MME) had the highest bulk density of 0.67 g/ml, which also reduced to 0.38 g/ml in malted popped maise flour (MPM). According to Peleg and Bagley (1983), the combined impacts of interconnected parameters, such as the strength of the attractive inter-particle forces, particle size, and number of contact points, determine bulk density. It is a reflection of the weight that the sample can support when permitted to rest on top of one another. Where packing poses a serious challenge, low bulk density in food is desired (Ikujenlola, 2008).

The WAC ranged from 106.67-150. The result showed that popped maise flour (PME) sample had the highest WAC of 150, and malted popped maise flour (MPM) had the lowest WAC of

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106.67). The term "water absorption capacity" (WAC) refers to a product's capacity to bind to water in a situation where water is scarce Ikujenlola and Fashakin's (1999). The amount of water that the diet absorbs and binds depends on how many hydrophilic amino acids and polysaccharide components are present (Otegbayo *et al*., 2006). The OAC of the samples ranged from 50-130. The popped maise flour (PME) sample had the highest OAC of 130, and the malted popped popcorn maise flour MPM sample had the lowest OAC of 50. The raw popcorn flour (OME) had 110, which increased on popping. The malted popcorn flour (MME) had 110, which decreased on popping. The result is not in accordance with the findings of Padmashree *et al*. (1987) and Adetuyi *et al.* (2009), which showed an increase in OAC of malted base blends.

Table 2: Functional properties (100/g) of the various samples of popcorn maise with different processing method

Parameters	MPM	MME	PME	OME
Water absorption	106.67±5.77	113.33±5.77	150±10 .00	143.33±5.77
Bulk density	0.38± 0.02	0.68±0.06	0.16±0.06	0.64±0.06
Oil absorption	50±0.00	110±10.00	130.00±0.00	110.00±10.00
Reconstitution index	37.00±0.00	53.5±0.86	5.33±0.57	42.00±0.00
Resistant starch	1.21±0.02	1.16±0.07	1.17±0.07	1.23± 0.01
Dispersability	77.17±0.57	73.17±0.29	72.17±0.76	71±0.5

Data are mean values of duplicate determination ± standard deviation. Sample MPM: Malted popped popcorn Data Data are mean values of duplicate determination ± standard deviation. Sample MPM: Malted popped popcorn Data are mean values of duplicate determination ± standard deviation. Sample MPM: Malted popped popcorn maise flour Sample MME: Malted popcorn maise flour Sample PME: Popped popcorn maise flour Sample OME: Raw Popcorn maise flour

The reconstitution index of the samples ranged from 35-53.5 g/ml. The malted popcorn flour (MME) had the highest value of 53.5 g/ml, and the lowest was for popped maise flour sample (PME), which was 35 g/ml. The result showed that malting increased the reconstitution index, and the reconstitution index reduced after popping.

The resistant starch of the product is shown in Table 2. The result ranged from 1.17-1.23 g/100g. The raw popcorn maise flour (OME) had the highest RS of 1.23 g/100g, and malted popped maise flour (MPM) had an RS of 1.21 g/100g, followed by popped maise flour (PME) which had an RS of 1.17 g/100g, while malted popcorn maise flour sample MME had RS of 1.16 g/100g.It was observed that the RS decreased in the malted and popped samples while the malted popped sample had a slight increase in the RS.

The result for the dispersibility of the flour samples is shown in Table 2. The result ranges from 71-77.5, with malted popped popcorn maise flour MPM sample recording the highest value and ordinary popcorn maise flour (OME) recording the lowest value. Flour dispersibility gives

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the indication of particle suspensibility in water, which is a useful functional parameter in various food product formulations (Mora-Escobedo *et al.*, 1991).

The Least gelatin concentration of the sample is shown in Table 3. The LGC of the samples ranged from 7% to 20%. According to Akintayo *et al.* (1999), the lower the least Gelation Concentration (LGC), the better the gelling ability of the flour. The result showed that all the samples had partial gelation to 5% except for the malted popped flour, which had partial gelation at 7%. These samples compared favourably with those reported for African yam bean (16 to 20%) by Abbey and Ayuk (1991), raw cowpea flour (Abbey and Ibeh, 1988) and winged bean flour (Sathe *et al.,* 1982). However, lower values were recorded for several *Phaseolus* species and lablab beans by Chau and Cheung (1998) and Deshpande *et al*. (1982). Sathe *et al.* (1981) also reported a least gelation concentration of 12% for black gram flour.

Table 3 Least Gelation Concentration of the various samples of popcorn maise with different processing methods.

Characteristics	MPM	MME	PME	OME
1%	+-	+-	+-	+-
3%	+-	+-	+-	+-
5%	+-	+-	+-	+-
7%	+-	++	++	++
9%	++	++	++	++
11%	++	++	++	++
13%	++	++	++	++
15%	++	++	++	++
17%	++	++	++	++
20%	++	++	++	++

Sample MPM: Malted popped popcorn maise flour Sample MME: Malted popcorn maise flour Sample PME: Popped popcorn maise flour Sample OME: Raw Popcorn maise flour ++: Total gelation, +-: Partial gelation

Pasting Characteristics

The pasting characteristics of the various samples are presented in Table 4. From the table, it is shown that the final viscosity ranged between 120.25 and 250.00 RVU for the samples. The highest final viscosity was recorded for malted popped maise flour MPM 250.00 RVU, and raw popcorn flour (OME) recorded the lowest final viscosity mean score of 120.25 RVU. It thus indicates that malted popped maise flour MPM will require more water to form a low-viscosity gruel during reconstitution. The implication of this is that the caloric value of the gruel per unit volume will be low compared to raw popcorn which has low viscosity (Ikujenlola and Fasakin, 2005). This will encourage the addition of more solid. The decrease in viscosity could be attributed to the action of hydrolysing enzymes (amylases) that were produced during malting (Ayernor and Ocloo, 2007). The relatively high peak viscosity of malted popped maise flour MPM might be related to the proportion of starch in the diet, the ratio of amylose to

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amylopectin and the resistance of the starch granules to swelling. The presence of other non-starchy constituents in the other diets may contribute to the peak viscosity.

The values obtained for the setback viscosity ranged from 73.42 to 182.75, with malted popped maise flour MPM recording the highest value, while raw popcorn maise flour (OME) recorded the lowest value for setback viscosity. Set back viscosity of starch-based foods has been correlated with the texture of various food products. It has also been reported that a low setback is an indication that the starch has a low tendency to retrograde or undergo syneresis during freeze-thaw cycles (Ikujenlola and Fashakin, 2005).

Limpisit and Jindal (2005) define the pasting temperature as the temperature that indicates an initial decrease in the viscosity of food substances when heated. From Table 4, the samples had pasting temperatures of about 85 ^{0}C. The pasting temperatures of the samples were higher than the gelatinisation temperature of 70.5 ^{0}C reported for Ogi (fermented corn) flour by Oluwamukomi *et al.* (2005); 66.7 ^{0}C and 67.2 ^{0}C for white and red sweet potato flours reported by Osundahunsi *et al*. (2003). The pasting temperature provides an indication of the minimum temperature required to cook a given sample and also indicates energy costs.

The peak time for pasting of the flour samples ranged from 5.33 to 5.49 minutes which shows that the time recorded by all the samples for pasting differed slightly.

Table 4: Pasting characteristics of the various samples of popcorn maise with different processing methods.

Characteristics	MPM	MME	PME	OME
Peak 1	69.92	66.08	62.75	50.33
Trough 1	67.25	62.08	60.58	46.83
Breakdown	2.67	4.00	2.17	3.50
Final viscosity	250.00	235.42	230.83	120.25
Setback	182.75	173.33	170.25	73.42
Peak time	5.42	5.45	5.49	5.33
Pasting temperature	85.25	85.45	85.60	85.46

Sample MPM: Malted popped popcorn maise flour Sample MME: Malted popcorn maise flour

Sample PME: Popped popcorn maise flour Sample OME: Raw Popcorn maise flour

Proximate composition

The result of the proximate composition of various samples of popcorn maise with different processing methods is shown in Table 5.

The product's protein content ranged from 9.35 to 88.85%. The results indicate that the protein content of popped popcorn maise flour (PME) is slightly lower than that of raw popcorn maise flour (OME), which had the highest protein content of 9.35%. This may be because the seed coat of popped popcorn maise contains less protein than the endosperm (MacMasters *et al*., 1971) and is removed during popping. Malted popped maise flour (MPM) had the lowest protein level after popping, with malted popcorn flour (MME) having the highest at 8.96%. The loss of low molecular weight nitrogenous substances during the soaking and washing of

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the grains may cause changes in protein concentrations during malting. According to Pelembe *et al*. (2002), the breakdown of storage proteins from the kernel causes an increase in the amount of free-amino nitrogen in roots and shoots during germination. Reduced protein content in malted samples may be due to this, which is the most likely explanation.

Table 5 Proximate composition of the various samples of popcorn maise with different processing methods.

% composition	MPM	MME	PME	OME
Protein	8.85± 0.007	8.96±0.007	9.19± 0.014	9.35±0.007
Fat	3.23±0.014	3.56± 0.028	3.64± 0.007	3.3 ± 0.014
Ash	2.07 ± 0.014	2.13± 0.014	2.08±0.014	2.04± 0.014
Crude fibre	1.77 ± 0.04	1.89±0.04	1.67±0.04	1.6 ± 0.04
Carbohydrate	73.44±0.05	72.89± 0.07	73.16 ± 0.05	73.28 ±0.00
Moisture content	10.65± 0.014	10.58± 0.007	10.27± 0.014	10.44± 0.007
Energy value (kCal)	358.19±0.24	359.42±0.00	362.24±0.00	360.2±0.099

Data are mean values of duplicate determination ± standard deviation. Sample MPM: Malted popped popcorn maise flour Sample MME: Malted popcorn maise flour Sample PME: Popped popcorn maise flour Sample OME: Raw Popcorn maise flour

The fat content varied from 3.23 to 3.64%. The outcome revealed that the malted popped maise flour (MPM) had the lowest fat level at 3.23%, and the popped maise flour (PME) had the highest fat content at 3.64%. According to previous research, cereals' fat content is higher on the outer seed coat, leading to higher fat content in unprocessed samples (MacMasters *et al*., 1971). During the germination of seeds, lipids are hydrolysed, and fatty acids are oxidised. The hydrolysed products do not build up in the seed. Still, glycerol enters the carbohydrate pool, and fatty acids are oxidised via oxidation, which causes the amount of fat in the beer to drop during malting (Mayer and Mayber 1963).

Ash content provides a clue as to the samples' mineral makeup. The samples' ash contents ranged from 2.04 to 2.13%. The highest ash content value was found in the malted popcorn flour (MME), and the lowest ash content value was found in the raw popcorn flour (OME), which had 2.04%.

The products crude fibre content ranged from 1.60 to 1.98%. The fibre content of the malted popcorn flour sample (MME) was 1.89%, while that of the raw popcorn flour (OME) was 1.60%. Compared to raw popcorn flour, the fibre content of the maise rose in the malted and popped samples. It has been reported that the endosperm blows up during popping, and a limited cell wall rupture occurs in the enlarged endosperm. The seed coat is partially lost during this procedure, which may explain why popped samples have less fibre than raw samples (Hulse *et al*., 1980). Additionally, it was noted that the malting procedure caused a large

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reduction in neutral detergent fibre due to cell wall disintegration during sprouting (Aisien, 1982).

The moisture content of the products ranged between 10.27 and 106 %. Malted popped maise flour (MPM), with a moisture content of 10.65%, had the greatest level, while popped maise flour (PME) had the lowest at 10.28%. The outcome demonstrated that popping for raw maise decreased the grain's moisture content while malting increased it. Additionally, the moisture content of popcorn also affects how much it pops; up until a certain point, the volume increases with more moisture, after which it decreases with more moisture. (Haught *et al*., 1976; Lin and Anantheswaran, 1988).

The percentage of carbohydrates ranged from 72.87 to 73.44%. The maximum amount was found in the malted popped maise flour (MPM) sample and the lowest was found in the malted popcorn flour (MME), at 72.89%. According to Gokavi and Malleshi (2000), during germination, partial amylopectin degradation occurs, and the content of amylose rises, both of which contribute to the total carbohydrates. The increase in carbohydrate content was caused by popped seeds being concentrated more with endosperm, which contributes 94% of the starch to the kernel. During germination, the starch content drops while the amount of soluble carbohydrates rises (Opoku *et al*., 1983).

The range of the energy content was 358.19 to 362.24 kCal. The popped maise flour sample (PME) has the highest caloric content at 362.24 kCal, while the malted popped maise flour (MPM) sample has the lowest at 358.19 kCal. The amount of protein, carbohydrates, and fat determines the energy value of samples.

Mineral Composition

The mineral composition of the products is presented in Table 6. The maximum amount, 114.37–119.56 mg/100g of potassium, was discovered. The malted popped maise flour (MPM) had the highest potassium concentration (119.56 mg/100g), which declined after popping. The potassium level in the raw popcorn maise was 116.63 mg/100g, and it decreased during popping. The outcome demonstrated that popping decreased potassium content, whereas malting raised potassium content. Potassium is a vital mineral for the body and is involved in cellular and electrical processes. In reality, because it has a very slight electrical charge, it is also regarded as an electrolyte. Together, potassium and sodium control the water and acid-base balance in the tissues and blood. A sodium-potassium pump is also produced, which aids in producing muscle contractions and controlling the heartbeat. For the entire sample, the mineral content increase with the malting and popping processes done on the sample.

The iron content ranges from 1.07 to 1.22 mg/100g. For the formation of blood, iron is necessary. It facilitates the movement of oxygen throughout the body. The range for calcium content was between 5.23–5.42 mg/100g. The findings indicated that malting increased the samples' calcium content while popping decreased it. The development of sturdy bones and teeth depends on calcium. Magnesium levels in the samples ranged from 29.65 to 38.37 mg/100g, and the results showed that both malting and popping boosted magnesium levels. Magnesium is the most prevalent ion in plant cells, and a lack of it can cause irregular development, problems with the neurological and central systems, and issues with how the body processes fat. It is required for the body's more than 300 separate enzyme systems (Nieman *et al*., 1992).

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The products are quite high in phosphorus, with phosphorus contents ranging from 68.68 to 86.26 mg/100g. The results demonstrated that both malting and popping enhanced phosphorus contents. To develop strong bones and teeth, phosphorus interacts closely with calcium. It is advised to consume 1,000 mg of phosphorus each day. According to Shuto *et al*. (2009), the average daily intake for men and women in the US is 1,495 mg and 1,024 mg, respectively.The phosphorus deficiency can lead to loss of appetite, general weakness and muscle pain.

The lowest of the entire mineral is sodium which ranges from 0.38-0.56 mg/100g; the result showed that the sodium content increased with both malting and popping.

Table 6 Mineral composition of various samples of popcorn maise with different processing methods.

Minerals(mg/100g)	MPM	MME	PME	OME
Calcium	5.23±0.01	5.45±0.04	5.16±0.02	5.36±0.01
Iron	1.23±0.014	1.07±0.021	1.16±0.007	1.06±0.007
Magnesium	38.37±0.07	34.32±0.035	33.28±0.085	29.66±0.007
Sodium	0.56±0.07	0.47±0.07	0.42±0.007	0.38±0.007
Potassium	116.34±0.014	119.56±0.014	114.47±0.007	116.64±0.007
Phosphorus	86.26±0.014	84.47±0.007	77.73±0.014	68.68±0.007

Data are mean values of duplicate determination ± standard deviation. Sample MPM: Malted popped popcorn maise flour Sample MME: Malted popcorn maise flour Sample PME: Popped popcorn maise flour Sample OME: Raw Popcorn maise flour

Dietary fibre

According to the findings, popped corn flour (PME) and raw popcorn flour (OME) both contained the same amount of total dietary fibre, 4.86%. The outcome demonstrated that malting decreased the amount of fibre in popcorn. In addition, the malted maise flour (MME) contained 4.64%, which was marginally lower than the 4.65% found in the malted popped maise flour (MPM). A low-fibre diet is one that has fewer than 2-3 grams of fibre per serving, while a moderate-fibre diet has 3-4 grams of fibre per serving. A high-fibre diet contains at least 5 grams of fibre per serving, and a good source of fibre has 2.5 to 4.9 grams per serving.

According to a Mayo Clinic review from 2011, a high-fibre diet can prevent diverticular disease (Tarleton and Diabase, 2011). For people with diabetes, eating foods that contain soluble fibre can help control or lower the level of sugar in their blood and decrease the need for insulin. Insoluble fibre does not dissolve in water and includes cellulose, lignin, and the rest of the hemicelluloses. Whole grains, wheat, and corn fibre, among other examples, are good sources of insoluble.

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Table 7 Total dietary fibre of flour samples

Parameters	MPM	MME	PME	OME
Soluble Fibre	1.385 ± 0.01	1.29 ± 0.01	1.4 ± 0.01	1.36 ± 0.01
Insoluble fibre	3.25±0.01	3.36 ± 0.01	3.45 ± 0.02	3.5 ± 0.01
TotalDietary Fibre	4.64 ± 0.01	4.65 ± 0.00	4.86 ± 0.01	4.86 ± 0.01

Data are mean values of duplicate determination ± standard deviation. Sample MPM: Malted popped popcorn maise flour Sample MME: Malted popcorn maise flour Sample PME: Popped popcorn maise flour Sample OME: Raw Popcorn maise flour

Sensory Evaluation

Table 8 displays the findings of sensory analysis of popcorn samples processed using various techniques in comparison to the control (commercial sample MBO). The results showed that the Control (commercial sample MBO) had the highest mean score for appearance, colour, and aroma. This difference between the Control and malted popped maise (MPM) was significant at the 5% level but not significant when compared to popped popcorn maise (OME).

When compared to the two other samples, malted popped popcorn (MPM) and Control (commercial sample MBO), the popcorn maise popped (OME) had the highest mean and demonstrated a significant difference at the 5% level for crunchiness. Although the crunchiness means for the Control (commercial sample MBO) is higher than that of malted popped popcorn maise (MPM), there is no discernible difference between the two samples at the 5% level.

The three samples significantly differ in flavour, with the Control sample (commercial sample MBO) having the highest mean and malted popped popcorn (MPM) having the lowest. The Control (commercial sample MBO) had the greatest mean for overall acceptability. It demonstrated a significant difference at the 5% level when compared to malted popped popcorn (MPM) and popcorn maise popped (OME). When compared to malted popped popcorn (MPM), the popcorn maise popped (OME) sample had the second highest mean value. However, there was no discernible difference at the 5% level. The sample that was most favoured was the Control (commercial sample MBO).

Table 8 Sensory evaluation of popcorn samples

Properties	MPM	OME	MBO
Appearance	3.8b	5.1ab	6.3a
Colour	3.4b	5.2ab	6.2a
Crunchiness	5.2ab	6..4a	4.0b
Taste	3.5c	4.9b	6.6a
Aroma	4.3b	5.0ab	6.3a
Overall Acceptability	4.4b	5.2b	6.4a

Any two means in the same row not followed by the same letter are significantly different at the 5% level. Sample MPM – Malted popped popcorn Sample OME – Popcorn maise popped Sample MBO – Control (commercial sample)

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CONCLUSION

Conclusion: Malting did not degrade the quality of the popcorn, and malted popcorn can provide high-quality popped corn. In popcorn maise, malting raised the levels of Sodium, phosphate, calcium, potassium, iron, and magnesium. According to the study, malting enhanced the maise's quality.

REFERENCES

Abbey, B.W. and Ayuk, E.J. (1991) Functional properties of African yam bean flour (*Sphenostylis sternocarpa*). *Nigeria Journal of Nutrition and Science,* 12: 44-46.

Abbey, B.W. and G.O. Ibeh. (1988) Functional properties of raw and heat-processed cowpea (Vignaunguiculata) flour. *Journal of Food Science,* 53: 1775-1777.

Abiose, S. H. and A.V. Ikujenlola (2014) Comparison of chemical composition, functional properties and amino acids composition of quality protein maise and common maise (Zea may L). *African Journal of Food Science and Technology,* 5: 81-89.

Adetuyi, F.O., Badejo O.F., Ikujenlola A.V. and Omosuli S.V. (2009) Storage influence on the functional properties of malted and unmalted maise (Zea mays L ssp mays) and soybean (Glycine max L Merrill) flour blends. *African Journal of Food Science and Technology,* 3(2): 056–060

Akintayo, E.T. and Oshodi A.A. (1999) Effect of pH on functional properties of cereal flour. *Food chemistry,* 66:51-56

Akpapunam, M.A. and Dedeh, S.S. (1995) Traditional lactic acid fermentation, malt addition and quality development in maise-cowpea weaning blends. *Food Nutrition Bulletin,* 16: 75-80

Aisien, A.O. (1982) Enzymic modification of sorghum endosperm during seedling growth and malting. *Journal of Science, Food and Agriculture,* 35:754–759

Ayernor, G.S. and Ocloo, F.C.K. (2007) physicochemical changes diastasis activity associated with germinated paddy rice (PSB.RC 34). *Africa Journal of food science,* 1:37-41.

AOAC (2000) Official Methods of Analysis. (17th Edition). Association of Analytical Chemists. Gaithersburg, Maryland, USA.

Badifu, G.I.O. and Ebegonye, G.M. (1999) Effect of germination on chemical, physical and functional properties of defatted flour of melon kernel. *Journal of food science,* 36(1):63- 66

Chau, C.F. and Cheung, P.C.K. (1998) Functional properties of flours prepared from three Chinese indigenous legume seeds. *Food Chemistry,* 61: 429-433.

Deshpande, S.S., Sathe, S.K., Cornforth, D. and Salunkhe D.K. (1982) Effect of dehulling on functional properties of dry bean (Phaseolus Vulgaris L) flours. *Cereal Chemistry,* 59: 396-401

Donkeun, P., Kenneth, G.D.A., Stermitz, F.R. and Maga, J.A. (2000) Chemical composition and physical characteristics of unpopped popcorn hybrids. *Journal of Food Composition A Analysis,* 13(6): 921-934.

Dreyer, J.J. (1968) Biological assessment of protein quality: Digestibility of protein in certain *Foodstuffs South Africa Medical Journal,* 42: 1304-1313.

Fashakin, J.B. (1994) Trends in weaning food. Paper presented at NIFST Western zone conference, held at Obafemi Awolowo University, Ile-Ife.

Article DOI: 10.52589/AJAFS-VBDT3NDZ
DOI URL: https://doi.org/10.52589/AJAFS-VBDT3NDZ

Flemming S.E, Sosulski F.W. and Hamon N.W (1975) Gelation and thickening phenomenon of vegetable protein products. *Journal of Food Science,* 40: 805-807.

Gokavi S.S., and Malleshi N.G. (2000) Malting characteristics of a few Indian wheat and chickpea varieties. *Journal of Food Science and Technology*, 37:586–591.

Grzesiuk, S. and Kulka, K. (1981) Physiology and Biochemistry of Grains (in Polish). PWRiL, WarsawHaught, C. G., Lien, R. M., Hanes, R. E. and Ashman, R. B. (1976) *Physical Properties of Popcorn. TASAE*, **19:** 168.

Hulse, J. H. Laing, E. M. and Pearson, O. E. (1980) Sorghum and millets: Their composition and nutritive Value. Academic Press, London.

Ijarotimi S.O. and Keshinro O.O. (2011) Determination of Amino Acid, Fatty Acid, Fatty Acid, Mineral, Functional and Choking Properties of Germinated and Fermented Popcorn (Zea mays everta) Flour. *European Journal of Food Research & Review*, 1(2): 102-122, 2011.

Ikujenlola, V. A. and Fashakin, J. B. (2005) The physic-chemical properties of a complementary diet prepared from vegetable diets. *Journals of Food Agriculture and Environment,* 13: 3 and 4: 23 – 26.

Ikujenlola, A.V. (2010). Effects of malting and fermentation on the nutritional qualities of complementary foods produced from maise varieties and soybean grains. Unpublished PhD Thesis Obafemi Awolowo University, Ile-Ife, Nigeria.

Ikujenlola, A.V. and Adurotoye, E.A. (2014) Evaluation of Quality Characteristics of NighNutrient Dense Complementary Food from Mixtures of Malted Quality Protein Maise (Zea mays L.) and Steamed Cowpea (Vignaunguiculata*): Journal Food Process Technology*., 5:1

IITA (2001). International Institute of Tropical Agriculture, Ibadan, Oyo State. Annual Report on Maise Production Khawar Jabran, Zahid Ata and Muhammad Farooq. Maise: Cereal with a Variety of Uses. DAWN

Kulkarni, K.D., Kulkarn, D.N. and Ingle, U.M. (1991) Sorghum malt-based weaning Formulations. Preparation, functional properties, and nutritive value. *Food Nutrition Bulletin,* 13: 322-327

Labuza, T.P. and Lewick, P.P. (1978) Measurement of gel water - binding capacity by Capillary

Lin, Y. E. and Anantheswaran, R. C. (1988) Studies in Popping of Popcorn in a Microwave Oven. *Journal of Food Sci*ence, **53:** 1746- 1749.

Limpisut, P. and Jindal, V.K. (2005) Comparison of Rice Flour Pasting Properties Using Brabender Viscoamyyylograph and Visco Analyser for evaluating cooked Rice Texture. Starch/Staerke, 54350-357.

MacMasters, M.M., Hinton, J.J.C., Bradbury, D. (1971) Microscopic structure and composition of the wheat kernel. In: Pomerang Y(ed) Wheat: Chemistry and Technology, 2nd edn. *American Association of Cereal Chemists*, St Paul, pp 51–113.

Mora-Escobedo, R., Lopez, O.P. and Lopez, G.F.G. (1991) Effect of germination on the rheological and functional properties of amaranth seeds. Lebensm Wiss Technol**.,** 24: 241-244.

Mosha, A.C. (1994) Nutritional improvement of sorghum by germination technology; In*: Food Science and Technology challenges for Africa towards the year 2000 Moravatsanga LT and JRN Taylor (eds).* Proceedings of the ECSAFOST Food Science and Technology conference, 12-16th September, Victoria Falls, Zimbabwe, University of Zimbabwe: 162-174.

Article DOI: 10.52589/AJAFS-VBDT3NDZ
DOI URL: https://doi.org/10.52589/AJAFS-VBDT3NDZ

Nasser, A. G., Abdel – Hamied, A. A. and El – Naggar, E. A. (2008) Effects of citrus by – products on the chemical. Rheological and organoleptic characteristics of biscuits. *World Journal of Agriculture Science* 4: 5, 612 – 616.

Nieman, D.C., L.M. Johnanssen, J.W. Lee, and K. Arabatzis (1992) Infectious episodes in runners before and after and loss Angeles. Marathon. *Journal Sports Medicine and Physical Fitness* 3:316-328

Nissreen Abu-Ghannam and McKenna B. (1997) Hydration kinetics of red beans. *Journal of Food Science*, 62(3): 520-523.

Okezie, B.O. and A.E. Bello, (1988) Physicochemical and functional properties of winged bean flour and Isolate compared with soy isolate. *Journal of Food Science*, 53:450-455.

Okoli, G.E. (1998) Socio Psychologies Factors and Educational Aspiration of Women in Cross River State. (Unpublished M.Ed. Thesis, Unical).

Oluwamukomi, M.O., Eleyemi A.F., Enujiugha, V.N. and S.O. (2003). Nutritional, Physicochemical and sensory evaluation of sorghum and cowpea-based weaning formulation. *Nigeria Food Journal,* 21: 11 – 17.

Oluwamukomi, M. O., Eleyinmi, A. F., Enujiugba, V. M. (2005) Effect of Soy Supplementation and its Stage of Inclusion in the quality of Ogi-a Fermented Maise Meal. *Food Chemistry,* 55: 1, 1 – 6.

Opoku, A.R., Osagie, A., Ekperigin, M.M. (1983) Changes in the major constituents of millet (Pennisetum americanum) during germination. *Journal of Agriculture and Food Chemistry,* 31:507–509.

Osundahunsi, O. F., Fagbemi, T. N., Kesselman, E. and Shimoni, E. (2003) Comparison of the physicochemical properties and pasting characteristics of flour and starch from red and white sweet potato cultivars. *Journal of Agricultural Food Chemistry,* 51: 2232 – 2236.

Otegbayo, B. O., Aina, J. O., Asiedu, R. and Bokanga, M. (2006) Pasting characteristics of fresh yams (*Dioscorea spp*) as indicators of textural quality in major food products "pounded yam". *Food Chemistry,* 99: 663 – 669.

Padmashree, T.S., L. Vijayakshmi and J. Puttaraj, (1987) Effect of traditional processing on functional properties of cowpea (Vigna Catjang). *Journal of Food Science Technology,* 24: 221-224.

Peleg, M. and E.B. Bagley, (1983) Physical Properties of Foods. AVI Pub. Co, Westport, CN. Pelembe, L.A.M., Dewar, J. and Taylor J.R.N. (2002) Effect of malting conditions on pearl millet malt quality. *Journal Institute of Brewing,* 108:7–12

Rooney, L. W. and Serna-Saldivar S. O. (1987) *Food Uses of Corn: Chemistry and Technology*. American Association of Cereal Chemists, St. Paul, MN.

Sathe and Salunkhe (1981) Investigations on winged bean [*Psophocarpus tetragonolubus* (L.) DC] protein and antinutritional factors. *Journal of Food Science,* 46, 1389.

Sathe, S.K., Desphande, S.S. and Salunkhe, D.K.(1982a**)** Functional properties of lupin seed (*Lupinusmutabilis*) protein and protein concentrates. *Journal of Food Science*, 47: 491-497.

Sathe, S.K., Deshpande, S.S., Salunkhe, D.K. (1982) Functional properties of winged bean (Psophocarpus tetragonolobus, L) proteins. *Journal of Food Science,* 47: 503-506.

Shuto, E., Taketani, Y., Tanaka, R., Harada, N., Isshiki, M., Sato, M., Nashiki, K., Amo, K., Yamamoto, H., Higashi, Y., Nakaya, Y. and Takeda, E. (2009) Dietary phosphorus acutely impairs endothelial function. *Journal of America Society of Nephrol,* 20 (7):150412.

Article DOI: 10.52589/AJAFS-VBDT3NDZ
DOI URL: https://doi.org/10.52589/AJAFS-VBDT3NDZ

Tarleton, S. and Dibaise, J. K. (2011) Low-residue diet in diverticular disease: Putting an end to a myth. *Nutrition in clinical practice: official publication of the American Society for Parenteral and Enteral Nutrition* 26:2, 137–42.

Wilton, P., Larry, R., Beuchat, K., Dixon, P. (1997) Functional properties of cowpea (*Vigna unguiculata*) flour as affected by soaking, boiling and fungal fermentation. *Journal of Food Science*, 45: 480-486.

Article DOI: 10.52589/AJAFS-VBDT3NDZ
DOI URL: https://doi.org/10.52589/AJAFS-VBDT3NDZ