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# Proximate, Microbiological and Sensory Properties of Cookies Made from Blends of African Pear (*Darcryodes edulis*) and Yellow Maize (*Zea mays)* Flours

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**Abstract**

*Consumption of foods high in fats contributes to increased blood fat level which has been linked to cardiovascular diseases. Replacement of shortenings in pastries with plant oils may reduce blood fat. This study evaluates the proximate, microbiological and sensory properties of cookies produced from blends of yellow maize (YMF) and Dacryodes edulis (DMF) flour as well as the functional properties of the flour blends. Cookies were produced from the blends of DMF and YMF. The protein, fibre, fat, ash and carbohydrate contents of DMF were 6.19%, 11.85%, 41.60%, 3.93% and 17.58%, respectively. The protein, fat and ash contents of the blends ranged from 4.67-5.37%, 34.29-39.03% and 2.10-2.96%, respectively. Final viscosity (817.48-333.28 RVU) of the flour blends reduced significantly with the addition of DMF. Except for protein (20.44-22.73%) and fat (20.08-22.03%) contents, the ash (3.03-2.35%), fibre (1.98-1.48%), and carbohydrate (50.12-46.69%) contents of cookies without shortening decreased with increased DMF substitution. Cookies prepared with shortening had higher fat but lower ash, moisture, fibre, protein and carbohydrate contents than those without shortening. The total bacteria, fungi and coliform counts in cfu/g for cookies prepared with and without shortening ranged from $1.0 \times 10^3$-$7.03 \times 10^3$, $1.0 \times$ 10-$1.3 \times 10^3$ and $1.0 \times 10^3$-$6.68 \times 10^3$, respectively. There were no significant differences among the cookies in terms of aroma, crunchiness and overall acceptability. Cookies of good nutritional, microbial and sensory quality could be produced from yellow maize and African pear flour at less than 40% substitution level.*

## 1.Introduction

Cardiovascular diseases are major causes of death globally; accounting for 17.9 million loss of lives annually [1]. Increased blood fats called hyperlipidaemia raises the risk of heart attacks and strokes [2]. Most acute heart attack and stroke events occur as a result of blockage caused by the accumulation of fatty deposits on the lumen of blood vessels around the heart and brain. This prevents the flow of blood to the hearts and brain. High consumption of foods rich in hydrogenated fat may contribute to increased blood fat levels. Trans-fatty acids are formed during the hydrogenation of unsaturated fatty acids and linked to coronary heart disease and cardiovascular diseases [3]. These hydrogenated fats are used to produce margarine, vegetable shortenings and bakery fat. Reduction of hydrogenated fats in food production has been advocated in many countries including the USA, India and Denmark among others [4].

Enormous work has been done on improving the nutritional quality of baked products by replacement or substitution of bakery fats and/or wheat with plant oils and other cereals/legume [5, 6]. However, data on the potentiality of African pear fruit *(Darcryodes edulis)* as an alternative to the conventional bakery fat in maize-based cookies is limited. Secondly, little is known about the effect of adding pear flour on the shelf life of products considering the high perishable nature of African pear. The African pear fruit (APP) also known as native pear, African plum, bush butter or butter fruit [7], *safou* (Cameroun), *atanga* (Gabon) and *ube* (Nigeria) is of the family Burseracae. The pulp of African pear contains a substantial amount of lipids (35-52%) [8, 9] that could serve as a partial or total replacement for shortenings in pastries [5]. The African pear pulp has high oil yield (62%) [10]. African pear is rich in essential fatty acids as well as protein (15.0-20.0%), fibre (2.7-4.0%), vitamins and minerals [11, 12]. The amino acid profile showed leucine (7.68%) as the most occurring amino acid followed by lysine (6.44%) [13] while calcium (5.3-13.0 mg/100g) was the most abundant mineral [8]. The fruit has relatively larger quantity of lipids compared to soybeans and oil palm [9]. The pulp contains about seventy per cent of unsaturated fatty acids [14]. The hexane extract of *Darcryodes edulis* showed a hypoglycaemic and hypolipidaemic effect in diabetic rats [15]. African pear may not only improve the lipid quality of products but the protein quality. This has great significance on the nutritional quality and meeting the nutritional needs of the people. The major edible portion of APP is the fleshy mesocarp termed pulp. It can be taken raw; steamed, boiled or roasted and usually eaten with maize during the wet season.

Maize particularly, the yellow variety is a common staple crop that could be combined with APP to produce composite flour with an excellent nutrient profile. Yellow maize variety possesses carotenoids and xanthophyll [16] and has been considered in various Vitamin A fortification programmes.

Use of APP flour in snack production would not only diversify its utilization but reduce losses due to its high perishable nature. Incorporation of APP into the snack industry would improve nutrition, health and food security.Therefore, this study investigated the proximate and functional properties of the blend of African pear and maize flour as well as the proximate, microbiological and sensory attributes of cookies made from the blend.

## 2.0 Methodology

### 2.1 Materials

Good quality African pear fruits *(Darcryodes edulis)* and yellow maize grains (*Zea mays L.*) were purchased from a local market in Ota, Ogun State, Nigeria.

### 2.2 Production of African pear fruit flour

The fruits were immersed in 0.1 % hypochloride solution for twenty minutes, washed and rinsed with distilled water. They were drained and cut into two for easy removal of the seeds. The pericarp was further sliced longitudinally to areas of about150mm$^2$.The sliced portions of the pear mesocarps were spread on a drying board and dried in a Heraeus D-6450 Hanau oven at 50$^o$C for 72 hours. The dried mesocarps were milled into powder [17].

### 2.3 Production of yellow maize flour

Maize flour was produced using the modified method of [18]. The maize grains were cleaned manually by removing the stones, damaged grains and other extraneous materials. The sorted grains were washed, drained and dried in a Heraeus D-6450 Hanau oven at 60$^o$C for 24 hours. The grain were then milled using a disc attrition mill (Agrico Model 2A) to obtain the flour. The flour obtained was sieved (100 ųm mesh size) and then kept in airtight polythene bags for further analysis.

### 2.4 Formulation of blends of African pear and yellow maize flour

The blends were formulated using Random Surface Methodology (RSM). The simple lattice gave the following ratios 80:20, 75:25, 70:30, and 65:35. Kenwood mixer (Model A 900) was utilized to obtain various samples of homogenous blends. Thereafter, the blends were individually packaged in sealed polyethylene bags and kept at room temperature for further analysis.

### 2.5 Production of cookies

Recipe for production of cookies: flour 1000 grams, margarine 100 grams, baking powder 1.8 grams, egg 250 mls, sugar 250 grams, milk 250 mls and pinch of salt. The fat was creamed with sugar to a smooth soft paste and then flour and other ingredients were added to the mixture in a Kenwood mixer (Model A 900) and properly mixed for 5 minutes to get a good consistency. The mixed dough was kneaded gently and rolled out to thickness of 0.5 mm on a pastry board and cut into shapes. The cut dough pieces were placed on a lightly greased pan and baked at 170$^{o}$C for 20 minutes in a laboratory oven (Uniscope SM 9053, Surgifriend Medicals, England). The produced cookies were allowed to cool and then packaged in Ziploc bags.

### 2.6 Chemical Analyses

#### 2.6.1 Proximate Composition

Proximate composition of the blends and cookies (crude protein (CP), fat, fibre, moisture and ash) were determined using methods described by [19].

#### 2.6.2 Pasting properties

The pasting properties of the blends were determined using a Rapid Visco Analyzer (3D+ Newport Scientific Ply. Ltd., Sydney, Australia). Each sample (2.5gram) was weighed into a dry clean canister containing 25 mls of distilled water. A paddle was placed into the canister and both were coupled firmly to the centre of the instrument. The blade was then vigorously joggled up and down through the sample until no flour lumps remained on the water surface or paddle. The measurement cycle was initiated by depressing the motor tower of the instrument and readings were taken.

#### 2.6.3 Functional properties

##### 2.6.3.1 Water/Oil absorption capacity (WAC/OAC)

Water absorption capacity (WAC) and Oil absorption capacity (OAC) of the blends were determined using the adopted method of [20]. One gram of each of the samples was mixed with 10 mls of distilled water and blended for one minute. It was allowed to stand for 30 minutes and then centrifuged at 3000 rpm for 30 minutes at room temperature. The supernatant was decanted. The weight of water or oil absorbed by the sample was calculated and expressed as percentage WAC. The same method was used for oil absorption with the use of oil.

##### 2.6.3.2 Bulk density

The method adopted by [21] was used for the determination of bulk density. Each blend samples were weighed (7 g) into a 50 ml graduated measuring cylinder. The cylinder was tapped gently against the palm until a constant volume was obtained. Bulk density was calculated as the weight of the sample/volume of the sample after tapping.

### 2.7 Microbiological analysis

Microbial analysis was determined according to the method described by [22]. Pour plate method was employed. Sample (1 gram) was aseptically collected and serially diluted to fivefold dilutions in distilled water. Samples of the diluents (0.1 ml) were collected using pippette and aseptically inoculated on sterile petri dishes. Different culture media were prepared using Nutrient Agar (NA), Potato Dextrose Agar (PDA) and Maconkey Agar (MA) for bacterial, fungi and coliform count, respectively according to the manufacturer's instructions. The plates were incubated at 37$^{o}$C at 24 hours and 25°C for 48 hours for bacterial and fungi count, respectively. Total counts of colonies of bacterial, fungi and coliform were calculated as colony forming units.

### 2.8 Sensory evaluation of cookies

Sensory characteristics of the cookies samples were determined using the method described by [23]. Sensory panel (50) was constituted to evaluate the cookies for; taste, aroma, colour, crunchiness and overall acceptability using a 9-point hedonic scale with 9 indicating like extremely and 1 indicating dislike extremely. The panel comprised of staff and students of Federal University of Agriculture, Abeokuta who were trained. They were given fresh water to rinse their mouth after assessing each sample.

## 3.0 Results and discussion

### 3.1 Proximate composition of the samples

Table 1 shows the proximate composition of the *Dacryodes edulis* (DMF) flour, yellow maize flour (YMF) and blends at different proportions. The protein and ash contents of the samples ranged from 4.67-10.02% and 1.57-3.03%, respectively with the 100% maize flour having the lowest ash and highest protein values. The protein content of 6.19% found in DMF was higher than 1.93%, 4.35% and 5.13% reported by [14, 24, 25], respectively. Other works recorded higher protein values ranging from 11.0-19.2% [9, 26]. These variations in proximate compositions could be due to varietal and analytical difference. The DMF had the highest fat content (41.60%) which was statistically different ($p<0.05$) from other samples. This value is lower than the fat value of 38.0-48% found in other studies [8, 26]. The high-fat content is a desirable quality because it would improve the energy density of products. However, it has implications for the durability of prepared products. The result also shows that DMF had the highest fibre content of 11.85% significantly different from those of maize and composite flours. This indicates that DMF is a good source of dietary fibre. Dietary fibre is needed for healthy colon activities and enhanced digestion. The ash content of the blends increased with the addition of DMF flour to maize flour (1.57-2.96%) indicating that pear supplements mineral in maize flour.

### 3.2 Functional properties of *Dacryodes edulis* flour (DMF), Yellow-Maize flour and their blends

Table 2 presents the effect of DMF flour on the pasting properties of the flour blends. The results revealed that the peak viscosity, final viscosity, trough and set back levels of the flour blends were significantly different ($p < 0.05$). These reduced from 362.00 to 168.00, 817.48 to 333.28, 354.00 to162.13, 465.44 to 171.00 RVU, respectively. The peak viscosity, final viscosity, trough and set back values of 100% YMF were 102.17, 306.87, 83.37 and 222.57 RVU, respectively. On addition of 20% DMF, these values increased significantly and later reduced consistently with higher DMF substitution levels. The viscosity of a cooked starch paste reflects the resistance to a stirring of the gel particles. Peak viscosity has been reported to be closely related to the degree of starch damage [27]. The blends exhibited higher final viscosities than the 100% YMF. This is a desirable quality as it indicated high stability of paste or gel after cooling. The variation in the final viscosity of the blends might be due to the kinetic effect of cooling on viscosity. Notably, DMF did not have a significant effect ($p > 0.05$) on the pasting time while there was a drastic decrease in breakdown viscosity from 218.69 to 8.06 RVU when 20% DMF was added to maize flour. The higher the breakdown viscosity, the lower the ability of the sample to withstand heat and shear stress [28]. The blends had lower breakdown viscosity compared to 100% YMF (218.69). This shows that all the blends might be able to withstand heating and shear stress compared to 100% Yellow maize flour (218.69). The gelatinization temperatures obtained in this study (75-85°C) were above those reported for enriched cassava custard powder (65-74°C) [21]. The pasting temperature indicates the minimum temperature required to cook sample and thus the energy cost. It can be deduced from

Table 4 that the sample from 40% DMF will cook faster (less energy cost and time) than the 20% DMF sample. The bulk density, water absorption capacity and oil absorption capacity of the 100% maize and flour blends ranged between 0.96-1.00 g/ml, 70-175 g/g and 116-178 g/g with the 40:60 (DMF: YMF) sample having the highest WAC and lowest OAC. The WAC increased significantly with increased addition of DMF while OAC decreased consistently from 178 g/g in 100% YMF to 116 g/g in 40:60 (DMF: YMF) sample. The oil and water absorption capacity was negatively correlated, as DMF reduced OAC and increased WAC in all the samples. The WAC values agree with those reported by [27] and [29] but both WAC and OAC values discovered in this study are lower than those found in peanut flour [30]. The reason for these differences may be due to the protein-rich nature of peanuts, a legume, compared to APP. The higher WAC observed as DMF substitution level increased might be due to increased protein and carbohydrate contents after the initial drop. The bulk density of the flour blends were low and ranged from 0.96-1.00 g/ml. Low bulk density of flour blends was also found by [31, 32]. Bulk density is an important measure that determines the heaviness of flour and ease of handling during processing and transportation [33, 34].

### 3.3 Proximate composition of cookies made from the blends without and with the addition of shortening

Tables 3 displays the proximate composition of cookies prepared from the composite flour (DMF and YMF) without shortening while Table 4 shows the result of proximate analysis of cookies made with shortening. It was observed that the ash contents of cookies made with and without shortening reduced significantly with increased quantities of DMF (2.83-2.04%; 3.64-2.35%). This was not expected as increased DMF in flour blends improved the ash contents as shown in Table 1. This occurrence could be attributed to the effect of heat on the dough during baking. This also implies that the mineral content of baked products might be negatively affected. The protein content of cookies prepared without shortening decreased significantly at 20% DMF substitution (23.69 to 20.44%) and thereafter increased whereas for cookies made with shortening protein levels decreased, then increased and reduced again at 35% DMF substitution. The protein values of cookies found in this study (20.44-22.73%) agree with those of the cookies (20.70-21.04%) produced by [6]. Cookies prepared with shortening had higher fat contents but lower ash, moisture, fibre, protein and carbohydrate contents compared to those prepared without shortening. From the findings of this study, it can be inferred that the use of DMF in cookie production bestows good protein and mineral quality.

### 3.4 Microbial evaluation of the cookies made from the different blends

The microbial counts after one, two and three months period of storage of the cookies are presented in Table 5 and 6. The total bacteria count in cookies made from 100% YMF remained 1.0 x $10^3$ cfu/g after two months of storage and increased slightly to 1.1 x $10^3$ cfu/g three months after. However, bacteria were not detected in cookies made from 100% YMF without shortening till the second (1.0 x $10^3$) and third month (1.1 x $10^3$). The total bacteria counts(TBC) for both cookies prepared with and without shortening ranged between $1.0 \times 10^3$ cfu/g and $7.03 \times 10^3$ cfu/g. The highest bacteria count was found in cookies with shortening made from 40% DMF while the lowest bacteria count was obtained in cookies without shortening made from 25% DMF. At the end of three months, cookies without shortening made from 25% DMF remained the one with the lowest TBC (1.0 x $10^3$ cfu/g) which actually decreased from 1.8 x $10^3$ cfu/g at the second month. Adding shortening to 40% DMF increased the TBC by 67.5% and 250% by the second and third month, respectively compared to 9% and 36% in those without shortening. Fungi were detected more in cookies made without shortening compared to those with shortening. The fungi count ranged from $1.0 \times 10$ cfu/g to $1.3 \times 10^3$ cfu/g with the highest counts recorded for cookies without shortening (20% DMF) while the lowest counts ($1.0 \times 10$ cfu/g) were observed in cookies with shortening baked from 35% DMF. Fungi were not detected in cookies with shortening baked from 20 and 25% DMF. The recommended limit for yeast and mould in food is $10^5$ cfu/g (WFP, 2012). A range of $1.0 \times 10^3$ to $6.68 \times 10^3$ cfu/g of coliforms was found. Coliforms were not detected in the cookies prepared without shortening except in those made from 40% DMF only after the first month. No coliform was found in the cookies with shortening made from 20% and 25% DMF till the third month. Presence of coliforms in food samples suggests the presence of other enteric pathogenic microorganisms and poses risk to public health. Microbial analysis showed that the levels of each microorganism increased with time. The quality of a product is also assessed through microbial evaluation. High microbial count affects the shelf life of a product. They are usually responsible for the deterioration and spoilage of food [35]. It was also observed that the inclusion of shortening influenced the presence of microorganisms. From the result of this study, all samples were within the microbial limit (standard) of less than $10^6$ cfu/g of ready to eat food product (ICMSF, 2002). However, the counts for cookies with shortening were much higher than cookies without shortening. This is because fat encourages the growth of microorganism.

### 3.5 Sensory properties of the cookies produced from DMF: YMF flour blends

Table 7 shows the result of the sensory characteristics of the cookies. The cookies differed slightly from each other in all the sensory characteristics studied. Increase in DMF did not affect the sensory properties of the cookies. This finding is not in agreement with that of [36] who reported that the increase in substitution level of cashew nut in cookies resulted in a significant decrease in the sensory attribute. Similar findings were made by [37]. There were no significant differences among the cookies in terms of aroma, crunchiness and overall acceptability. The best-preferred cookie in terms of colour and taste was that prepared from 20% DMF.

**Table 1:** Proximate composition of the *Dacryodes edulis* flour (DMF), maize flour (YMF) and their blends

| Treatments | Moisture (%) | Ash (%) | Fat (%) | Crude fibre (%) | Protein (%) | Carbohydrate (%) |
|---|---|---|---|---|---|---|
| 100:0 | $3.91^e$ | $3.93^a$ | $41.60^a$ | $11.85^a$ | $6.19^b$ | $17.58^d$ |
| 0:100 | $10.17^a$ | $1.57^e$ | $4.45^e$ | $3.21^e$ | $10.02^a$ | $80.85^a$ |
| 20:80 | $10.20^a$ | $2.10^d$ | $34.29^d$ | $4.38^d$ | $4.67^d$ | $68.61^c$ |
| 25:75 | $9.30^b$ | $2.44^c$ | $36.08^c$ | $4.98^{cd}$ | $5.02^{cd}$ | $69.38^{bc}$ |
| 30:70 | $8.82^c$ | $2.56^c$ | $38.27^b$ | $5.03^{cd}$ | $5.12^{cd}$ | $69.91^b$ |
| 35:65 | $8.42^c$ | $2.59^c$ | $38.07^b$ | $5.16^c$ | $5.34^c$ | $70.01^b$ |
| 40:60 | $7.74^d$ | $2.96^b$ | $39.03^b$ | $6.05^b$ | $5.37^c$ | $70.16^{ba}$ |

Means with different superscripts arranged vertically are significantly different ($p$ <0.05).
DMF=*Dacryodes edulis* flour: YMF=Yellow maize flour, 100:0=100%DMF, 0:100=100%YMF, 20%DMF:80%YMF, 25%DMF:75%YMF, 30%DMF:70%YMF, 35%DMF:65%YMF, 40%DMF:60%YMF

**Table 2:** Pasting and functional properties of the flour blends

| Treatments DMF:YMF | Peak Viscosity (RVU) | Through (RVU) | Break Down (RVU) | Final Viscosity (RVU) | Setback (RVU) | Pasting Time (min) | Pasting Temperature ($O^C$) | Bulk density ($g/mm^3$) | Water Absorption capacity(g/g) | Oil absorption capacity (g/g) |
|---|---|---|---|---|---|---|---|---|---|---|
| 100:0 | 137.00$^f$ | 43.04$^g$ | 93.86$^b$ | 50.62$^g$ | 7.05 ±$^g$ | 1.88$^c$ | 52.74$^e$ | 1.02$^a$ | 85$^e$ | 104$^e$ |
| 0:100 | 102.17$^g$ | 83.37$^f$ | 218.69$^a$ | 306.87$^f$ | 222.57$^e$ | 5.83$^b$ | 95.22$^a$ | 1.00$^a$ | 70$^e$ | 178$^a$ |
| 20:80 | 362.00$^a$ | 354.00$^a$ | 8.06$^d$ | 817.48$^a$ | 465.44$^a$ | 6.86$^a$ | 85.48$^a$ | 0.96$^{ab}$ | 103$^d$ | 156$^b$ |
| 25:75 | 269.00$^b$ | 263.00$^b$ | 6.15$^e$ | 618.56$^b$ | 454.75$^b$ | 6.80$^a$ | 85.09$^b$ | 0.98$^{ab}$ | 134$^c$ | 148$^b$ |
| 30:70 | 251.00$^c$ | 240.29$^c$ | 12.09$^c$ | 518.34$^c$ | 277.42$^c$ | 6.57$^a$ | 80.41$^c$ | 0.96$^{ab}$ | 143$^c$ | 132$^c$ |
| 35:65 | 221.00$^d$ | 215.37$^d$ | 4.93$^f$ | 464.58$^d$ | 248.45$^d$ | 6.90$^a$ | 80.00$^c$ | 0.98$^{ab}$ | 169$^{ab}$ | 127$^c$ |
| 40:60 | 168.00$^e$ | 162.13$^e$ | 5.57$^e$ | 333.28$^e$ | 171.44$^f$ | 6.59$^a$ | 75.09$^d$ | 1.00$^a$ | 175$^a$ | 116$^d$ |

Means with different superscripts arranged vertically are significantly different ($p$ <0.05).
DMF=*Dacryodes edulis* flour, YMF=Yellow maize flour, 100:0=100%DMF, 0:100=100%YMF, 20%DMF:80%YMF, 25%DMF:75%YMF, 30%DMF:70%YMF, 35%DMF:65%YMF, 40%DMF:60%YMF

**Table 3:** Proximate composition of cookies made from the blends without the addition of shortening

| Treatments (DMF:YMF) | Moisture (%) | Ash (%) | Fat (%) | Crude fibre (%) | Protein (%) | Carbohydrate (%) |
|---|---|---|---|---|---|---|
| 100:0 | 5.71$^a$ | 2.05$^f$ | 24.46$^a$ | 1.20$^e$ | 21.70$^d$ | 44.88$^e$ |
| 0:100 | 4.49$^d$ | 3.64$^a$ | 21.45$^c$ | 2.21$^a$ | 23.69$^a$ | 44.51$^e$ |
| 20:80 | 4.35$^e$ | 3.03$^b$ | 20.08$^d$ | 1.98$^b$ | 20.44$^e$ | 50.12$^a$ |
| 25:75 | 4.42$^e$ | 2.99$^c$ | 21.58$^c$ | 1.89$^b$ | 20.64$^e$ | 48.46$^b$ |
| 30:70 | 4.57$^c$ | 2.86$^c$ | 21.85$^b$ | 1.78$^c$ | 21.48$^d$ | 47.45$^c$ |
| 35:65 | 4.64$^{bc}$ | 2.67$^d$ | 21.99$^b$ | 1.54$^d$ | 22.04$^c$ | 47.11$^{cd}$ |
| 40:60 | 4.70$^b$ | 2.35$^e$ | 22.03$^b$ | 1.48$^d$ | 22.73$^b$ | 46.69$^d$ |

Means with different superscripts arranged vertically are significantly different ($p$ <0.05).
DMF=*Dacryodes edulis* flour: YMF=Yellow maize flour, 100:0=100%DMF, 0:100=100%YMF, 20%DMF:80%YMF, 25%DMF:75%YMF, 30%DMF:70%YMF, 35%DMF:65%YMF, 40%DMF:60%YMF

**Table 4:** Proximate composition of cookies made from the blends with the addition of shortening

| Treatments (DMF:YMF) | Moisture (%) | Ash (%) | Fat (%) | Crude fibre(%) | Protein (%) | Carbohydrate (%) |
|---|---|---|---|---|---|---|
| 100:0 | 4.28[a] | 1.95[e] | 52.46[a] | 0.21[e] | 19.10[d] | 34.88[e] |
| 0:100 | 2.62[c] | 2.83[a] | 37.45[e] | 2.14[a] | 20.49[a] | 30.93[e] |
| 20:80 | 2.47[d] | 2.73[b] | 42.08[d] | 1.96[b] | 18.84[d] | 44.31[a] |
| 25:75 | 3.32[b] | 2.49[c] | 42.58[d] | 1.87[b] | 19.40[c] | 32.72[b] |
| 30:70 | 3.26[bc] | 2.36[c] | 46.85[c] | 1.78[c] | 19.82[b] | 34.64[c] |
| 35:65 | 2.23[e] | 2.23[d] | 46.99[c] | 1.13[d] | 18.46[e] | 34.27[cd] |
| 40:60 | 2.40[d] | 2.04[e] | 48.03[b] | 1.18[d] | 18.97[d] | 39.48[d] |

Means with different superscripts arranged vertically are significantly different ($p < 0.05$).
DMF=*Dacryodes edulis* flour, YMF=Yellow maize flour, 100:0=100%DMF, 0:100=100%YMF, 20%DMF:80%YMF, 25%DMF:75%YMF, 30%DMF:70%YMF, 35%DMF:65%YMF, 40%DMF:60%YMF

**Table 5:** Microbial evaluation of cookies produced from blends of *Dacryodes edulis* mesocarp flour (DMF) and Yellow maize flour (YMF)

| Treatments (DMF: YMF) | After 1 month At room temperature Cfu/g x $10^3$ | | | After 2 months At room temperature Cfu/g x $10^3$ | | | After 3 months At room temperature Cfu/g x $10^3$ | | |
|---|---|---|---|---|---|---|---|---|---|
| DMF: YMF | TPC | TCC | TFC | TPC | TCC | TFC | TPC | TCC | TFC |
| 100:0 | 1.00 | 1.20 | - | 1.00 | 1.50 | 1.00 | 1.30 | 1.82 | - |
| 0:100 | 1.00 | 2.40 | - | 1.00 | 3.20 | - | 1.10 | 4.80 | - |
| 20:80 | 2.00 | - | - | 2.76 | - | - | 3.20 | 1.25 | - |
| 25:75 | 4.12 | - | - | 4.07 | - | - | 5.02 | 1.10 | - |
| 30:70 | 1.64 | 1.04 | 1.00 | 2.78 | 2.20 | 1.00 | 3.04 | 3.50 | 1.00 |
| 35:65 | 1.00 | 5.80 | 1.00 | 1.20 | 6.02 | 1.00 | 2.00 | 6.68 | 1.10 |
| 40:60 | 2.00 | - | - | 3.35 | 1.10 | - | 7.03 | 1.85 | - |

Means with different superscripts arranged vertically are significantly different ($p < 0.05$).
DMF=*Dacryodes edulis* flour: YMF=Yellow maize flour, 100:0=100%DMF, 0:100=100%YMF, 20%DMF:80%YMF, 25%DMF:75%YMF, 30%DMF:70%YMF, 35%DMF:65%YMF, 40%DMF:60%YMF. TPC = Total plate count, TCC= Total coliform count, TFC= Total fungi count

**Table 6:** Microbial evaluation of cookies in cfu/g produced from blends of *Dacryodes edulis* mesocap flour (DMF) and Yellow maize flour (YMF) without shortening

| Treatments (DMF: YMF) | After 1 month At room temperature cfu/g x $10^3$ | | | After 2 months At room temperature cfu/g x $10^3$ | | | After 3 months At room temperature cfu/g x $10^3$ | | |
|---|---|---|---|---|---|---|---|---|---|
| DMF: YMF | TPC | TCC | TFC | TPC | TCC | TFC | TPC | TCC | TFC |
| 100:0 | - | - | 1.00 | 1.60 | - | 1.00 | 1.00 | - | 1.00 |
| 0:100 | - | - | - | 1.20 | - | - | 1.00 | - | - |
| 20:80 | 1.10 | - | 1.00 | 1.00 | - | 1.30 | 1.20 | - | 1.30 |
| 25:75 | 1.30 | - | 1.09 | 1.80 | - | 2.00 | 1.00 | - | 3.0 0 |
| 30:70 | 1.10 | - | 1.63 | 1.40 | - | 3.00 | 2.00 | - | 3.48 |
| 35:65 | 1.20 | - | 1.30 | 1.10 | - | 2.00 | 2.00 | - | 2.60 |
| 40:60 | 1.10 | 1.0 | 1.00 | 1.25 | - | 1.20 | 1.50 | - | 1.20 |

Means with different superscripts arranged vertically are significantly different ($p$ <0.05).
DMF=*Dacryodes edulis* flour: YMF=Yellow maize flour, 100:0=100%DMF, 0:100=100%YMF, 20%DMF:80%YMF, 25%DMF:75%YMF, 30%DMF:70%YMF, 35%DMF:65%YMF, 40%DMF:60%YMF. TPC = Total plate count, TCC= Total coliform count, TFC= Total fungi count

**Table 7:** Sensory properties of the cookies

| **Treatment DMF:YMF** | **QUALITY ATTRIBUTES** | | | | |
|---|---|---|---|---|---|
| | **Colour** | **Taste** | **Aroma** | **Crunchiness** | **Overall Acceptability** |
| **100.0** | $7.37^{a}$ | $7.37^{ab}$ | $7.33^{a}$ | $7.17^{a}$ | $7.77^{a}$ |
| **0.100** | $7.66^{ab}$ | $7.49^{ab}$ | $6.97^{a}$ | $7.09^{a}$ | $7.56^{a}$ |
| **20:80** | $8.06^{b}$ | $7.80^{b}$ | $7.67^{a}$ | $6.99^{a}$ | $7.63^{a}$ |
| **25:75** | $7.37^{a}$ | $7.23^{a}$ | $7.57^{a}$ | $7.10^{a}$ | $7.77^{a}$ |
| **30:70** | $7.53^{ab}$ | $7.60^{ab}$ | $7.67^{a}$ | $7.20^{a}$ | $8.02^{a}$ |
| **35:65** | $7.63^{ab}$ | $7.40^{ab}$ | $7.37^{a}$ | $7.27^{a}$ | $7.63^{a}$ |
| **40:60** | $7.23^{a}$ | $7.47^{ab}$ | $7.70^{a}$ | $7.00^{a}$ | $7.80^{a}$ |

Means with different superscripts arranged vertically are significantly different ($p$ <0.05).
DMF=*Dacryodes edulis* flour: YMF=Yellow maize flour, 100:0=100%DMF, 0:100=100%YMF, 20%DMF:80%YMF, 25%DMF:75%YMF, 30%DMF:70%YMF, 35%DMF:65%YMF, 40%DMF:60%YMF

## 4.0 Conclusion

In conclusion, cookies of good nutritional, microbial and sensory quality could be produced from yellow maize and African pear flour at less than 40% substitution level. Total replacement of shortening or baking fat with African pear flour is therefore recommended in cookie production.

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**Conflict of interest**
The authors have no conflict of interest to declare.

## Reference

[1] F. Sanchi-Gomar, C. Perez-Quilis, R. Leischik and A. Lucia (2016). Epidemiology of coronary heart disease and acute coronary syndrome. Ann. Transl. Med, Soc, Vol. 4, pp. 256
[2] J. Su-Min, C. Seulggie, K. Kyuwong, M.K Sung, L. Gyeongsil, Y. Seong et al (2018). Effect of change in total cholesterol levels on cardiovascular disease among young adults. J. of American Heart Association, 7
[3] MP Iqbal (2014). Trans fatty acids – a risk factor for cardiovascular disease. Pak. J. Med. Sci, Vol. 30(1), pp.194-197
[4] M.M Wilczek, R. Olszewski and A. Krupienicz (2017). Trans-fatty acids and cardiovascular disease: Urgent need for legislation. Cardiology, Vol. 138, pp.254-258
[5] C.M.F Mbofung, T. Silou and I. Mouragadja (2002). Chemical characterization of Safou (*Dacryodes edulis*) and evaluation of its potential as an ingredient in nutritious biscuits. Forest, Trees and Livelihoods, Vol. 12, pp. 105-117
[6] O.F Osundahunsi, K.T Seidu and O.V Oyerinde (2010). The potential of African pear (*Dacryodes edulis*) as an ingredient in plantain-based composite cookies. Nutrition and Food Science, Vol. 40 (1), pp. 39-48
[7] P. Anegbeh, V. Okafor, C. Usoro, Z. Tchoundjeu, R.R.B Leakey and K. Schreckenberg (2005). Domestication of *Dacryodes edulis*: Phenotypic variation of fruit traits from 100 trees in southeast Nigeria. New Forests, Vol. 29(2), pp. 149-160
[8] B.R.L Kadji, F.M.T Kone, A.E Sika and S. Dabonne (2016). Physico-chemical properties of Safou (*Dacryodes edulis*) fruits grown in Côte d'Ivoire. J. Appl. Biosci, Vol.105, pp.10103 –10110
**[9]** R. Sueli, O.S Ebenezer de, Edy Sousa de Brito. (2018). Safou- Dacryodes edilis In: Sueli et al. (eds). Exotic Fruits Reference Guide. Academic Press, USA. pp. 377-381

[10] N.U Arisa and O.C Aworh (2008). Effects of refining on quality attributes of African pear (*Dacryodes edulis)* oil. J. of Food Processing and Preservation, Vol. 32, pp. 946-950
[11] N.C Onuegbu, M.U Nwuka, M. Ojukwu and N.O Kabu (2016). Nutritional properties of African Pear Seed and Performance of defatted cake in poultry feed formulations. J. of Animal Res and Nutr, Vol.1(2), pp. 9
[12] O.M Akusu, G.O Wordu and C. Obiesie (2018). Changes in physicochemical properties of table spreads produced from African pear (*Dacryodes edulis*) pulp during storage. Int. J. of Food Sci. and Nutr. Eng, Vol. 8(4), pp. 87-94
[13] C.U Ogunka-Nnoka, P.U Amadi, P.U Ogbonna and P.O Ogbegbor (2017). Assessment of the protein quality and mineral bioavailability of *Dacryodes edulis* seed and seed coat mixture. J. of Sci. Res and Reports, Vol. 14(1), pp. 1-1
[14] I. A Ajayi and O. Adesanwo (2009). Comparative study of the mineral element and fatty acid composition of *Dacryodes edulis* pulp and seed. World J. Agric. Sci, Vol. 5, pp. 279-283
[15] C. A Okolo, V.C Ejere, C.O Chukwuka, I.I Ezeigbo, D. D Nwibo and A.N Okorie (2016). Hexane extract of Dacryodes edulis fruits possesses anti-diabetic and hypolipidaemic potentials in Alloxan diabetes of rats. Afr. J. Trad. Complementary Altern. Med, Vol. 13(4), pp. 132-144
[16] N.M.A Nassar and R. Ortiz (2009). Cassava Genetic Resources: Manipulation for crop improvement. Plant breeding reviews, Vol. 31, pp. 247-275
[17] S. A Ndindeng, A. Zachée, W. Noé, F.A Ngome, S.A Njebu, M.A Delphine, N.L Walter et al. (2012). Valorisation of *Dacryodes edulis* Fruit (Safou) through improved drying procedures, packaging and processing. Frontiers in Science, Vol. 2(6), pp. 250-255
[18] M. K. Bolade, M. A. Usman, A.A Rasheed, E.I Benson and I. Salifou (2002). Influence of hydrothermal treatment of maize grains on the quality and acceptability of *tuwonmasara* (traditional maize gel). Food Chemistry, Vol. 79, pp. 479-483
[19] AOAC (2005). Association of Official Analytical Chemist. Official methods of analysis of the association of the Official Analytical Chemists, Washington DC
[20] G.I Onwuka (2005). Food analysis and instrumentation; theory and practice. Naphthali Prints, Lagos, Nigeria
[21] O.O Alake, J.M. Babajide, A.A Adebowale and M.A Adebisi (2016). Evaluation of Physico-chemical properties and sensory attributes of cassava enriched custard powder. Cogent Food and Agric, 2, pp. 1- 14
[22] ICMSF (2002). International Commission on Microbiological Specifications for foods. Microorganisms in Foods 7. Microbiological Testing in Food Safety Management. Kluwer Academic/Plenum Publishers. New York, USA
[23] M.O. Iwe (2007) Current trends in sensory evaluation of food. Rojoint Comm Service, Enugu. pp. 46-47
[24] U.J Ogoloma, K.W Nkpaa, J.O Akininwo and A.A Uwakwe (2013). Proximate, phytochemical and mineral elements composition of some edible fruits grown in oil-producing communities of Rivers State, Nigeria. J. of Environ Sci, Toxicology and Food Technol, Vol. 5(2), pp. 38-46
[25] M. Duru, C. Amadi, A. Ugbogu, A. Eze and B. Amadi (2002). Phytochemical, vitamin and proximate composition of Dacryodes edulis fruit at different stages of maturation. Asian J. of Plant Sci. and Res, Vol. 4, pp. 437-441
[26] N.C Onuegbu and N.C Ihediohanma (2008). Some proximate analysis of African pear. J. Appl. Sci. Environ. Manage, Vol. 12(1), pp. 83-85

[27] A.A Adebowale, S.A Sanni and F.O Oladapo (2008). Chemical, functional and sensory properties of instant yam breadfruit flour. Nig. J. of Food Sci, Vol. 26(1)
[28] K.O Adebowale, B.I Owolabi, O.O Olayinka and O.S Olajide (2005). Effect of heat moist treatment and gannealing on the Physico-chemical properties of red sorghum. Afr. J. of. Biotechnol, Vol. 4, pp. 928–933
[29] V.F Abioye, B.I Ade-Omowaye, O.G Babarinde and M.K Adesigbin (2011). Chemical, Physico-chemical and sensory properties of soy-plantain flour. Afr. J. of Food Sci, Vol. 5(4), pp. 176 – 180
[30] O.C Afam-Anene and L.N Onuoha (2006). Nutritional and Functional Properties of Sesame. Nig. J. Nutr. Sci, Vol. 27(1), pp. 16-21
[31] A.O Elkhalifa, B. Schiffler and R. Bernhardt (2005). Effect of fermentation on the functional properties of sorghum flour. Food Chemistry, Vol. 92(1), pp.1-5
[32] F.C Nelson-Quartey, F.K Amagloh, I Oduro and W.O Ellis (2007). Formulation of an infant food based on breadfruit (*Artocarpus altilis*) and breadnut (*Artocarpus camansi*). Acta Horticulturae, Vol. 757, pp. 212-224
[33] T. A Shittu, O.O Lasekan, L.O Sanni and M.O Oladosu (2001). The effect of drying methods on the functional and sensory characteristics of pupuru - a fermented cassava product. ASSET, Vol. 1(2), pp. 9-16
[34] J.A Adejuyigbe, E.T Otunola, E. AAkande, I.F Bolarinwa and F.M Oladokun (2009). Some properties of flour obtained from the fermentation of tiger nut (*Cyperus esculentus*) sourced from a market in Ogbomoso, Nigeria. Afr. J. of Food Sci, Vol.3(2), pp. 51-55
[35] O.A Olaoye, A.A Onilude and O.O Oladoye (2007). Breadfruit flour in biscuit making. Afr. J. of Food Sci, pp. 20-23
[36] M.C Ojinnaka and F.U Agubolum (2013). Nutritional and Sensory properties of cashew nut-wheat based cookies. American J. of Food and Nutr, Vol. 3(3), pp. 127-134
[37] F. M Abu-Salem and A.A Abou-Arab AA (2011). Effect of supplementation of Bambara groundnut (*Vigna subterranean L.*) flour on the quality of biscuits. Afr. J. of Food Sci, Vol. 5(7), pp.376-383