1.0 Introduction

*Lagenaria siceraria* are gourd is grown in most parts of Nigeria. Gourd seeds (Cucurbitaceae) are versatile and include hundreds of species of vine bearing coiled climbing tendrils and some of the most unusual fruits in the world. Some *Lagenariasiceraria* gourds are grown in Yoruba land mostly for utility purposes [1, 2]. In West Africa, a region where soups are integral to life, egusi melon (*Citrulluslanatus*) seeds are a major soup ingredient and a common component of daily meals. Coarsely ground up, they thicken stews and contribute to widely enjoyed steam dumplings. Some are soaked, fermented, boiled and wrapped in leaves to form a favourite food seasoning. Egusi melon-seed meal is compacted into patties that served as a meat substitute. Despite being a significant foodstuff even by global standard, egusi melon is hardly known to nutritionists outside a few West African Nations. Little nutritional detail on egusi melon oil is readily available to an international readership. Research studies have shown that these seeds contained about 50% oil [3], 42-57% oil [4] and 44-53% oil [5] for seeds cultivated in different bioclimatic regions of Cameroon.

Functional properties are the intrinsic physico-chemical characteristics which may affect the behaviour of food system during processing and storage. Dried seeds of *Lageneriasiceraria* (African wine kettle) and *Citrullus vulgaris* were processed into boiled, roasted, germinated and fermented flour samples. Standard methods were used to determine the functional properties of the processed samples in order to determine the effects of these processing techniques on water absorption capacity (WAC) and oil absorption capacity (OAC), bulk density (BD) and foaming capacity (FC). WAC and OAC of raw *Lageneria siceraria* flour are 2.451±0.164 (g/g) and 6.417±0.369 (g/g) respectively. These values are higher than the WAC and OAC determined for raw *Citrullus vulgaris*. However, these values are generally reduced with processing for the two seed flour samples, except for the higher WAC value of germinated *Citrullus vulgaris*, OAC values of roasted and germinated *Citrullus vulgaris* as well as the higher WAC of fermented *Lageneriasiceraria* seed flours. Fermentation increased the FC of *Lageneriasiceraria*, while roasting, boiling and germination reduced the FC of *Lageneriasiceraria*. However, the foaming stability (FS) of the raw samples of the two seeds are higher than FS of the processed seed flour samples after 2 hours.

**Abstract**

Functional properties are the intrinsic physico-chemical characteristics which may affect the behaviour of food system during processing and storage. Dried seeds of *Lageneriasiceraria* (African wine kettle) and *Citrullus vulgaris* were processed into boiled, roasted, germinated and fermented flour samples. Standard methods were used to determine the functional properties of the processed samples in order to determine the effects of these processing techniques on water absorption capacity (WAC) and oil absorption capacity (OAC), bulk density (BD) and foaming capacity (FC). WAC and OAC of raw *Lageneria siceraria* flour are 2.451±0.164 (g/g) and 6.417±0.369 (g/g) respectively. These values are higher than the WAC and OAC determined for raw *Citrullus vulgaris*. However, these values are generally reduced with processing for the two seed flour samples, except for the higher WAC value of germinated *Citrullus vulgaris*, OAC values of roasted and germinated *Citrullus vulgaris* as well as the higher WAC of fermented *Lageneriasiceraria* seed flours. Fermentation increased the FC of *Lageneriasiceraria*, while roasting, boiling and germination reduced the FC of *Lageneriasiceraria*. However, the foaming stability (FS) of the raw samples of the two seeds are higher than FS of the processed seed flour samples after 2 hours.

**Keywords:** Processing, Melon (egusi) Functional properties, *Lagenaria sicerana* *Citrullus vulgaris* **Corresponding author:** joan.ogundele@fuoye.edu.ng

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Ondo State. The seeds were identified at Forestry Research Institute of Nigeria (FRIN), Ibadan, Oyo State, Nigeria. The seeds were dehusked and further sun dried. The sample were put in polyethylene bags and then in air tight plastic containers and labeled appropriately.

Samples of the seeds were processes into raw dried form, boiled form, fermented form, germinated form and roasted form.

### 2.1.1 Processing of the seeds into Raw Dried Flour (RDF)

Dehusked melon seeds were dried and ground to a very fine flour, packed in a polythene bag and kept in a cool dry place prior to analysis.

### 2.1.2 Processing of the seeds into the Boiled Seed Flour (BSF)

The raw dehusked seeds were boiled with water for 30 minutes. Boiled seeds were put in perforated trays and left to drain off all excess water content and slightly dried in an air oven. The boiled, dried seed were milled into flour samples, packed in a polyethylene bags and kept in a cool dry place [8].

### 2.1.3 Processing of the seeds into the Fermented Seed Flour (FSF)

The seeds were put into a container of water and left to ferment naturally for 3 days. After the end of the 3 days, the fermented seeds were dried in an oven at 50 °C to avoid being burnt off, milled using a grinder to a fine flour, packaged in polyethylene bags and stored in a cool dry place prior to further analysis [8].

### 2.1.4 Processing of the seeds into the Germinated Seed Flour (GSF)

The seeds were put into a container of water and left to sprout for the period of 6-7 days. The sprouted seeds were removed and dried in air to remove all water content and was then milled with a grinder to a powdery form. The powdery form was then packaged into a polyethylene bag and kept in a cool dry place for further analysis [8].

### 2.1.5 Processing of the seeds into Roasted Seed Flour (RSF)

The dehusked and dried seeds were roasted in a hot cast iron pan at a temperature of 75-85 °C. Roasting was done to obtain light cream to brown colour. Roasted seeds were milled to a powdery form, packaged in a polyethylene bag and kept in a cool dry place for further analysis [8].

### 2.2 Determination of Functional Properties

#### 2.2.1 Determination of Water Absorption Capacity (WAC)

The WAC of the flour samples were determined by using the procedure described by Sathe et al [9]. 10ml of water was added to 0.5 g of each sample in a beaker, the suspension was then stirred for 5 minutes. The suspension was centrifuged at 3,500 rpm for 30 minutes. The volume of the supernatant obtained was measured in a 10 ml measuring cylinder. The water absorbed by the seed flour was calculated as the difference between the initial water used and the volume of the supernatant obtained after centrifuging. The result was expressed as a percentage of water absorbed by 1 g of the flour.

\[
WAC(g/g)=\frac{\text{weight of water absorbed}}{\text{weight of sample}}
\]  
(1a)

or

\[
WAC(%)=\frac{\text{weight of water absorbed} \times 100}{\text{weight of sample}}
\]  
(1b)

#### 2.2.2 Determination of Oil Absorption Capacity (OAC)

Vegetable oil (Executive Chef Vegetable oil) obtained from JOF local Family Farm Owo, with density of 0.92 g/ml was used was used instead of distilled water as described under section 2.2.1 above for WAC. 1.0 g flour in 10 ml were mixed using stirrer for 5 minutes. The mixture was then centrifuged at 3,500 rpm for 30 minutes. The amount of oil separated as supernatant was measured. The result was expressed as g/g % of oil absorbed [9].

\[
OAC(g/g)=\frac{\text{weight of oil absorbed}}{\text{weight of flour used}}
\]  
(2a)

or

\[
OAC(%)=\frac{\text{weight of oil absorbed} \times 100}{\text{weight of flour used}}
\]  
(2b)

#### 2.2.3 Determination of Bulk Density (BD)

The procedure of Narayana and NarasingaRao [10] was slightly modified and used all the processed samples. A specified quality of the samples of each of the differently processed seed flour was put into already weighed 5ml measuring cylinder (W1). It was gently tapped to eliminate air spaces between the flour in the measuring cylinder and the volume was noted to be the volume of the sample used. The new mass of the sample and measuring cylinder recorded as (W2). Both the volume and mass of the flour
sample were determined. The bulk density was computed as:
\[ BD (g/cm^3) = \frac{W_1 - W_2}{V} \]
where:
- \( V \) = Volume of sample

For each sample the process was repeated at least three times using different sample volume. The measuring cylinder was washed and dried after each determination and flour was not allowed to adhere to cylinder walls [10].

**2.2.4 Determination of Foaming Capacity (FC) and Foaming stability (FS)**

Determination of foaming capacity of the seed flour was carried out according to the method of Coffman and Garcia [11]. Two grams of each sample was whipped with 100 ml distilled water in 250 ml measuring cylinder using GMBN homogenizer at 5,000 rpm. The volume of the mixture before and after whipping were noted and used to compute the foaming capacity, the foaming capacity was calculated as the percentage increase in volume due to whipping at zero time.

\[ FC(\%) = \left( \frac{V_2 - V_1}{V_1} \right) \times 100 \]

Where:
- \( V_1 \) = Initial foam volume
- \( V_2 \) = Final foam volume

The foaming stability was calculated as the percentage increase volume at the specific time interval over a period of 6 hours.

**3.0 RESULTS AND DISCUSSION**

Water Absorption Capacities (WAC) of *Lagenariasiceraria* (Table 1) ranged from 1.607 g/g (Roasted) - 2.661 g/g (Fermented) or (160.70-266.10) % and those of *Citrullus vulgaris* (Table 2) ranges from 1.085 g/g (Roasted) - 1.855 g/g (Germinated) or (108.50-185.5) %. These values are closely related to that reported for WAC reported for some processed fluted pumpkin seeds ranging from 124 to 175 % [12]. Hence, the high WAC of the processed and raw melon seeds makes them good soup thickener as stated by Ogundele and Oshodi, [2]. However, processing generally reduced the WAC of *Lageraniasiceraria* seed flours, except for the fermented *Lageraniasiceraria* seed flour that has a slightly higher WAC of 2.661±0.199 g/g compared with that of the RFS of 2.451±0.164 g/g. This higher value of WAC in FSF may be due to denaturation of the seed proteins [13].

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Raw (RDF)</th>
<th>Boiled (BSF)</th>
<th>Roasted (RSF)</th>
<th>Fermented (FSF)</th>
<th>Germinated (GSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Absorption Capacity (WAC) g/g</td>
<td>2.451±0.164</td>
<td>1.637±0.577</td>
<td>1.607±0.539</td>
<td>2.661±0.199</td>
<td>1.734±0.276</td>
</tr>
<tr>
<td>Oil Absorption Capacity (OAC) g/g</td>
<td>6.417±0.369</td>
<td>5.430±0.646</td>
<td>3.803±0.284</td>
<td>5.852±0.430</td>
<td>6.314±0.286</td>
</tr>
<tr>
<td>Bulk Density (BD) g/ml</td>
<td>0.502±0.241</td>
<td>0.459±0.144</td>
<td>0.509±0.019</td>
<td>0.521±0.057</td>
<td>0.482±0.006</td>
</tr>
</tbody>
</table>

The OAC of *Lagenaria siceraria* (Table 1) ranged from 3.803 g/g (Roasted) - 6.417 g/g (Raw) or (380.3 to 641.7) % and those of *Citrullus vulgaris* (Table 2) ranged from 4.622 g/g (Boiled) to 5.393 g/g (Roasted) or (462.2 - 539.3) %. These values are close to the values reported for processed Breadnut, cashewnut and fluted pumpkin seed flours of the defatted flours ranges between 336.36-414.26; 268.75-327.08; and 316.77 - 423.15 percent respectively [14].
Table 2: Effect of Processing on Some Functional Properties of *Citrullus vulgaris* Seed Flours.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Parameter</th>
<th>Raw</th>
<th>Boiled</th>
<th>Roasted</th>
<th>Fermented</th>
<th>Germinated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water Absorption Capacity (WAC) g/g</td>
<td>1.509±0.167</td>
<td>1.367±0.472</td>
<td>1.085±0.940</td>
<td>1.490±0.306</td>
<td>1.855±0.210</td>
</tr>
<tr>
<td></td>
<td>Oil Absorption Capacity (OAC)g/g</td>
<td>4.627±0.379</td>
<td>4.622±0.226</td>
<td>5.393±0.745</td>
<td>4.630±0.392</td>
<td>5.332±0.468</td>
</tr>
<tr>
<td></td>
<td>Bulk Density (BD)g/ml</td>
<td>0.411±0.037</td>
<td>0.503±0.009</td>
<td>0.446±0.052</td>
<td>0.407±0.053</td>
<td>0.426±0.043</td>
</tr>
</tbody>
</table>

The Bulk Density of *Lagenariasiceraria* (Table 1) ranged from 0.459 g/g (Boiled) - 0.521 g/g (Fermented) and those of *Citrullus vulgaris* (Table 2) ranged from 0.407 g/g (Fermented) - 0.503 g/g (Boiled). The Bulk Density of full fat and defatted breadnut, cashewnut and fluted pumpkin seed flours ranges between 0.45-0.68 g/ml; 0.34-0.47 g/ml and 0.33-0.55 g/ml respectively while that of the defatted breadnut, cashewnut and fluted pumpkin seed flours.

Table 3: Foaming Capacity/Stability for *Lageraniasiceraria* Seed Flours after 2 Hours.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Foam capacity and stability (ml/ml) with time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Raw</td>
<td>12.00</td>
</tr>
<tr>
<td>Boiled</td>
<td>4.00</td>
</tr>
<tr>
<td>Roasted</td>
<td>10.00</td>
</tr>
<tr>
<td>Fermented</td>
<td>19.15</td>
</tr>
<tr>
<td>Germinated</td>
<td>6.00</td>
</tr>
</tbody>
</table>

Table 4: Foaming Capacity & Stability for *Citrullus vulgaris* Seed Flours after 2 Hours.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Foam capacity with time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Raw</td>
<td>23.40</td>
</tr>
<tr>
<td>Boiled</td>
<td>8.89</td>
</tr>
<tr>
<td>Roasted</td>
<td>4.00</td>
</tr>
<tr>
<td>Fermented</td>
<td>20.93</td>
</tr>
<tr>
<td>Germinated</td>
<td>12.00</td>
</tr>
</tbody>
</table>

In conclusion processed *Citrullus vulgaris* has higher foaming capacity and better foaming stability than processed *Lagerania siceraria*. The results obtained shows that water is readily absorbed in the boiled seed of *Lagerania siceraria* than than the boiled form of *Citrullus vulgaris* based on the Water Absorption Capacity.

**4.0 CONCLUSION**

In conclusion processed *Citrullus vulgaris* has higher foaming capacity and better foaming stability than processed *Lagerania siceraria*. The results obtained shows that water is readily absorbed in the boiled seed of *Lagerania siceraria* than than the boiled form of *Citrullus vulgaris* based on the Water Absorption Capacity.
Fig. 1: Foaming capacity of (1) *Lageraniasiceraria* and (2) *Citrullus vulgaris* seedflours.

References


