Evaluation into the proximate and functional properties of modified Bambara (*Vigna subterranea* *(L)* *Verde*) isolate - “ogi” mix

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**ABSTRACT:** The use of plant protein in the formulation of new food products has been the focus of recent research in developing countries, because of the inadequate supplies and shortages of food protein, hence the constant search for under-utilized legumes as new protein sources for use in both functional foods and nutritional supplements. Protein isolates from Bambara groundnut flour was prepared and modified through thermal denaturation. Mix was formulated from fermented maize flour - “ogi” (FMF) and modified bambara isolate flour (MBI) at ratio 12:1 obtained, via linear programming (Corel Quatro pro8), using protein (16%) and fat (9%) as target in the formulation. The FMF, MBI and mix obtained from the mixture of FMF and MBI (FMB) were subjected to proximate composition and functional properties. The incorporation of modified bambara isolate flour (MBI) into fermented maize flour - “ogi”(FMF) resulted in a significant increase (P< 0.05) in the crude protein content, significant improvement in the water absorption capacity (WAC), oil absorption capacity (OAC), foaming capacity (FC) and the least gelation concentration (LGC). The significant increase and improvement in both the proximate and functional properties of the new product may find its relevant application in food systems.

**Keywords:** Bambara flour; isolates; thermal denaturation; fermented maize flour; incorporation.

**INTRODUCTION**

Bambara groundnut (*Vigna subterranea* *(L)* *Verde*) is a pulse mainly used for human consumption. The seeds are consumed either when immature or fully ripe and dry. Bambara groundnuts are rich in protein with a good balance of essential amino acids; it contains 59% carbohydrate, 6 – 12% fat, 24.5% protein (Olaofe et al., 1987). Increased interest in plant proteins for feed and food, led to the isolation of protein from high protein crop. Plant protein isolate can be produced from well established high protein crops such as soybeans; faba beans etc (Bramsnaes and Olsen, 1979). Protein isolate is a dry food ingredient that is made from defatted high protein food material such as Soybeans. It is made up of 90 – 95% pure protein. The protein isolate can be modified in order to improve its functional properties which are intrinsic physicochemical properties that affect the behaviour of protein in food systems during processing, manufacturing, storage and preparation (Kinsella, 1985). The objective of this work was to investigate into the proximate and functional properties of mix formulated from modified Bambara protein isolate and “Ogi”.

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MATERIALS AND METHODS

Bambara groundnut seeds were dehulled using attrition mill, winnowed and oven dried at 50°C, for 4hours. The dry seeds were milled in flour using hammer mill and sealed in a polyethylene bag.

Production of protein isolate
The bambara flour was defatted using n-hexane for 8 hours with soxhlet apparatus. Protein isolate was prepared using the method of Chavan. et al., (2001). The defatted bambara flour was dispersed in distilled water at a ratio 1: 10w/v. it was stirred using a magnetic stirrer for 20 minutes while its pH was adjusted to 12 with 2N NaOH. The stirring continued for another 30 minutes, then centrifuged at 5600rpm for 15 minutes. The supernatant was collected and the residue re – extracted following the same procedure. The supernatant’s protein was precipitated by adjusting the pH to 5 with 1M HCl. The precipitate was removed by centrifugation at 5600rpm for 20 minutes. The precipitate was washed twice with distilled water at a ratio 1: 2w/v and centrifuged to obtain protein isolate (Fig I).

Protein isolates modification
Modification of protein isolate was done by thermal denaturation using the method of Sorgentini et al.; (1995). Aqueous dispersions of the isolate were prepared at the range of 5 – 15% (5%, 8%, 11%, 13%, and 15%) w/w. The dispersions were heat-treated at 80°C and 100°C respectively for 30 minutes, and then cooled overnight at 4°C. Viscous dispersions (at 5% isolate concentration) or gels (at concentrations equal to or greater than 8%) were obtained. Gels were disrupted with a glass rod. Part of the viscous dispersions and disrupted gels were diluted with water to approximately 4% w/w isolate concentration, homogenized at 1500rpm for 1min, and lyophilized. The lyophilized isolate was ground in a mortar to obtain a fine powder – Modified Bambara Isolate (MBI), sample was sealed in a polyethylene bag and stored at 4°C until use. Fig (II).

Production of fermented flour (FMF) – “Ogi,”
Dry wholesome maize grains were steeped in water for 4 days, the fermented maize grain was wet- milled and wet – sieved, the over tails obtained was allowed to settle for 12hrs after which the supernatant was decanted so as to have the maize slurry. The maize slurry obtained was de- watered using a muslin cloth and was further dried in an oven at 50°C for 24hrs. It was milled and packaged in polyethylene sachets, kept at 4°C till use.

Formulation of mix
The proximate composition of modified bambara protein isolate (MBI) and fermented maize flour (FMF) were determined with emphasis on the protein and the fat. The values obtained were subjected to the linear programme known as Corel Quatro pro8 with the aim of formulating a mix from MBI and FMF having protein of 16% and fat of 9% as target. The mix ratio obtained was 1: 12 of modified bambara protein isolate (MBI) to fermented maize flour (FMF). The ‘modified bambara isolate – “Ogi” mix’ FMB – formulated at this ratio was packaged in air – tight polyethylene sachets and stored at 4°C for further analysis.

Determination of proximate and mineral compositions.
Crude protein was determined by Kjedhal method. Moisture and crude fat were determined by the method of AOAC, (1990). Ash content and crude fibre were determined by the method of Kirk and Sawyer (1991). Total carbohydrate was calculated by difference. Mg, K, Na Ca, content of mix was determined using flame photometry method (AOAC, 1990).
Figure 1: Flowchart of production of Bambara protein isolate.
**RESULTS AND DISCUSSION**

**Proximate and mineral composition**
Significant increase was observed in the protein content of FMB compared to fermented maize flour – “Ogi” (FMF), Table 1, the addition of MBI to FMF resulted in 93.6% percentage protein increase of the mix. The percentage protein of the modified bambara protein isolate (MBI) was observed to be 88% which implies that MBI is purely protein. The percentage protein of FMB (21.0%) compared favorably with the targeted value which is 16%.

The incorporation of FMF with carbohydrate content of 88.5% into MBI significantly increase ($P < 0.05$) percentage total carbohydrate of the resulting product FMB having a carbohydrate content of 67.9% compared to MBI (1.8%). A significant reduction ($P < 0.05$) in percentage ash content was observed in FMB with ash content value of 0.4% compared to FMF and MBI with ash contents of 1.6% and 0.7% respectively, this might be as a result of lack of minerals in the isolate since the ash content is a rough estimation of the mineral content of a material.

FMB has a calcium content of 61.0mg/100g (Table 2). To meet the dietary requirement of 800mg/day, it would therefore be necessary to consume about 1.3kg of FMB. Thus the formulated mix FMB is a good source of calcium.

FMB was observed to have lower potassium content (52.9mg/100g) than sodium (61.7mg/...
Proximate and functional properties of modified Bambara isolate - “ogi” mix

100g), this contradicts the report of Olaofe and Sanni (1988) that sodium levels in Nigerian plants foods are generally lower than potassium although, the higher sodium content of FMB may be due to the addition of NaOH during the production of the isolate.

The K/Na ratio of FMB was 0.9. The result cannot cause mineral imbalance in those fed solely on it because it is very close to the recommended value (1) NRC (1989).

The oil absorption capacity (OAC) of FMB was 2.1 g/g, this value was found to be significantly higher at P< 0.05 higher than that of FMF which was 1.0 g/g. The improvement was observed to be as a result of the incorporation of MBI resulting in 54% percentage increase in OAC. The OAC of FMB compares favorably involving dough formulating, sausages, soups. Okezie and Bello (1988).

Table 1: Proximate compositions (%) of modified bambara protein isolate (MBI), fermented maize flour (FMF) and mix (FMB) (Dry matter basis).

<table>
<thead>
<tr>
<th>Samples</th>
<th>Protein</th>
<th>Total Carbohydrate</th>
<th>Ash</th>
<th>Crude fibre</th>
<th>Crude Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMF</td>
<td>1.4c</td>
<td>88.5c</td>
<td>1.6b</td>
<td>0.2c</td>
<td>2.3c</td>
</tr>
<tr>
<td>BMI</td>
<td>88.0a</td>
<td>1.9c</td>
<td>0.7a</td>
<td>0.5b</td>
<td>0.5b</td>
</tr>
<tr>
<td>FMB</td>
<td>21.0b</td>
<td>67.9b</td>
<td>0.4b</td>
<td>2.1a</td>
<td>1.7c</td>
</tr>
</tbody>
</table>

Means separation at 5% level (DMRT); values in a column denoted by different alphabet differ significantly.

FMF - Fermented maize flour – “Ogi
MBI - Modified Bambara Protein Isolate
FMB - Mix

Table 2: Mineral Composition (mg/100g) of modified bambara protein isolate, fermented maize flour and mix

<table>
<thead>
<tr>
<th>Samples</th>
<th>Mg</th>
<th>K</th>
<th>Na</th>
<th>K/Na</th>
<th>Ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMF</td>
<td>91.7</td>
<td>71.6</td>
<td>57.8</td>
<td>1.2</td>
<td>72.8</td>
</tr>
<tr>
<td>MBI</td>
<td>97.7</td>
<td>67.8</td>
<td>94.1</td>
<td>0.7</td>
<td>57.9</td>
</tr>
<tr>
<td>FMB</td>
<td>68.3</td>
<td>52.9</td>
<td>61.7</td>
<td>0.9</td>
<td>61.0</td>
</tr>
</tbody>
</table>

Functional properties
The incorporation of MBI into FMF resulted in significant increase (P< 0.05) in water absorption capacity (WAC) of FMB (Table 3). The WAC of 5.0g/g reported for FMB was found to be higher than values of, 0.6g/g, 3.4 g/g, 1.4 g/g respectively reported for sodium caseinate, soy protein isolate and dried white egg protein isolate (Mohammed et al., 1999). Water absorption capacity is a useful indication of whether flour or isolates can be incorporation into aqueous food formulation especially those with value of 1.5g/g reported for soy protein isolate Summer et al. (1980).

FMB has a higher emulsion capacity EC (46.7%) than FMF (44%). He percentage increase was found to be 5.8%. The EC of FMB was found to be higher than 8.1% reported for breadnut protein isolate (Oshodi et al., 1999) but less than values of 75.1%, and 48.1% respectively reported for sunflower protein isolate and chickpea protein isolate (Lin et al., 1974; Clement et al., 1988).

The least gelation concentration (LGC) ranges from 6% in FMF to 18% in MBI. The lower the
LGC, the better the gelation properties of the protein ingredient. The value of 16% reported for FMB in this study compares favourably with value of 14% and 18% respectively reported for lupin and cowpea flour (Sathe and Salunkhe, 1981; Abbay and Ibeh, 1988). FMB may therefore serve as a good binder and provide consistency in food preparations such as semi – solid beverages like “Kunun – Zaki” (Adeyemi and Umar, 1994).

Table 3: Functional properties of Modified Bambara protein isolate, Fermented Maize flour “Ogi” and Mix

<table>
<thead>
<tr>
<th>Property</th>
<th>FMF</th>
<th>MBI</th>
<th>FMB</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAC (glg)</td>
<td>1.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.0&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>OAC (glg)</td>
<td>1.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>FC (%)</td>
<td>ND</td>
<td>92</td>
<td>ND</td>
</tr>
<tr>
<td>FS (%)</td>
<td>ND</td>
<td>75</td>
<td>ND</td>
</tr>
<tr>
<td>EC (%)</td>
<td>44&lt;sup&gt;c&lt;/sup&gt;</td>
<td>50&lt;sup&gt;c&lt;/sup&gt;</td>
<td>47&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>LGC (%)</td>
<td>6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>18&lt;sup&gt;c&lt;/sup&gt;</td>
<td>16&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Means separation at 5% level (DMRT); values in a row denoted by different alphabet differ significantly.

<table>
<thead>
<tr>
<th>Property</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WAC</td>
<td>Water absorption Capacity</td>
</tr>
<tr>
<td>OAC</td>
<td>Oil absorption Capacity</td>
</tr>
<tr>
<td>FC</td>
<td>Foaming Capacity</td>
</tr>
<tr>
<td>FS</td>
<td>Foaming Stability</td>
</tr>
<tr>
<td>EC</td>
<td>Emulsion Capacity</td>
</tr>
<tr>
<td>LGC</td>
<td>Least Gelation Concentrate</td>
</tr>
<tr>
<td>ND</td>
<td>Not Determined</td>
</tr>
</tbody>
</table>

CONCLUSIONS

The modified bambara isolate- “ogi” mix (FMB) produced is a rich source of protein, having a protein content of 21.0%. This could be attributed to the addition of modified bambara protein isolate, the mix therefore would be adequate to prevent protein energy malnutrition in people fed on it as their main protein source.

The K/Na ratio of FMB was 0.9. The result cannot cause mineral imbalance in those fed solely on it because it is very close to the recommended value (1) NRC (1989).

The water absorption capacity of FMB (5.0g/ g) was not expected to be higher than that of the MBI (4.6g/g). This may therefore imply that it is not only protein that takes part in water absorption (Hermason, 1979). This WAC enables it therefore to find relevance in food formulations such as baked goods and soups. The WAC values are observed to be higher than corresponding OAC values. Low fat-binding capacity of protein suggests the presence of more hydrophilic groups than hydrophobic on the surface of the protein molecules (Chavan et al., 2001). The availability of lipophilic groups may contribute to higher binding of fat to proteins (Lin et al., 1974).

No foam was detected in FMB and FMF. The poor foaming capacity of these samples may be due to the presence of excessive protein-protein interactions which form aggregates that are detrimental to foam formation. Kinsella et al., (1985).

The mix developed can therefore be consumed as a sole diet and can also find relevance as ingredients in other food formulations.
REFERENCES


