Some Quality and Micro-structural Characteristics of Soup Enriched with Debittered *Moringa Oleifera* Seeds Flour

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Abstract Soup enriched with debittered moringa seeds flour (DBMS) was investigated for its quality and micro-structural characteristics following appropriate standard procedures reported in literatures. The results showed that soup sample enriched with 0.5% of DBMS had the highest overall sensory score for acceptability and its protein content was 4 g/100 g more than that of the control. Scanning electron micrographs showed soup sample enriched with DBMS as a dense, continuous agglomerated protein strands of irregular sizes and shapes. As the addition of DBMS increased, the viscosity and the body of the soup increased; the lightness "L" colour value of the soup reduced and the total colour difference (ΔE) increased. Enrichment of soup with DBMS promotes the use of moringa seeds as a protein ingredient; especially in the tropics where it is fast gaining acceptance as human food.

Keywords: soup, debittered moringa seeds, microstructure, sensory properties


1. Introduction

Awareness regarding the consumption of moringa products as food and nutriceutical keeps spreading in the tropics [1,2,3]. India leads the world’s moringa seeds production with about 1.3 million metric tonnes produced over 380 km² land area. Major producing areas are in Andhra Pradesh, Karnataka and Tamil Nadu States [4]. Virtually all parts of moringa plant, from the leaves and flowers to the immature pods and kernels have been found useful for different industrial, medicinal and food purposes. In India, Thailand and the Philippines, moringa tree is commonly grown in home gardens and the leaves and immature pods are sold in the local markets as soup ingredient [5]. The oldest known use of moringa seeds flour is as substitute for aluminium sulphate (alum) in domestic water clarification [6]. The leaves have been explored as a feedstock for biogas production, organic manure, bio-pesticide and livestock feeds [5,6,7]. Moringa leaves and seeds are particularly rich in tocopherols, lutein, carotene, proteins, vitamins, minerals and essential sulfur amino acids which are rarely found in daily diets [5,8,9]. On the other hand, Ferreira et al. [10] associated the long lasting bitter and sugary taste of moringa seeds to the presence of alkaloids, saponins, cyanogenic glucosides and glucosinolates. On this note, Ogunsina and Radha [11] successfully documented a non-chemical heat-assisted process for debittering and detoxifying moringa seeds and compared the functional properties of defatted and debittered moringa seeds flour with that of defatted soybean flour. The study revealed that debittered moringa seeds flour shows higher emulsification, foaming and gelation properties than soybean. Oliveira et al. [9] and Vasconcelos et al. [12] also found that the lipid content of moringa seed is higher than that of soybean and the oleic acid-rich moringa seed oil compares favourably with olive oil in terms of thermal, frying and oxidative stability [13]. In another baseline study, Ogunsina [14] found that debittered and roasted moringa kernels have a peanut-like aroma and taste. An investigation of the physicochemical and functional properties of full fat and defatted moringa kernels flour showed that it is a good source of vegetable protein for functional food products [8]. Consequently, Ogunsina et al. [15] studied the quality characteristics of bread and cookies enriched with debittered *Moringa oleifera* seeds flour (DBMS). It was found that bread with 10% DBMS flour and cookies with 20% DBMS grits had more protein, iron and calcium. It was submitted that incorporating moringa seeds in baked food products is a means of boosting nutrition in Africa and Asia where moringa is largely grown and malnutrition is prevalent [15]. Based on the foregoing, it is expected that future demand for moringa products will continue to increase in many regions of the world [7].

The preparation and consumption of soup as human food accompaniment must have begun around the time cooking of foods was invented [16]. A soup is typically prepared as a concoction of ingredients including pepper, tomatoes, onions, meat/fish, seasonings, spices and vegetables combined with other liquids or slurries; cooked
together until an acceptable consistency, blend and desired
taste are achieved. Sometimes, grain cereal or oilseed
flours, potatoes and other additives are added as thickeners to
improve the soup body; depending on the desired end
product. Although, soup is a choice delicacy virtually
everywhere; the recipe varies from place to place; depending
on regional/traditional food habits, taste and local
availability of specific ingredients [17]. Generally, the
process of preparing a delicious soup is time consuming,
laborious and painstaking; hence, semi-processed soup
mix/powders have gained worldwide recognition in fast
cookery. Being a liquid-food (usually served warm), a
good soup powder should be re-hydratable and cookable
within minimum time, retaining nutrients and palatability
almost similar to the freshly cooked product [18].

New trends in food science now makes soup available
in pre-processed form; as canned or dehydrated products
permitting the inclusion of medicinal herbs, spices and
adjustment of nutrients to meet specific dietary needs
[17, 19]. Soup mixes have been developed for a number of
food products including: dika kernels; fish, moringa
leaves; vegetables and mushroom [7, 16, 18, 20, 21, 22, 23].
In addition, groundnut, soybean, cowpea and crayfish
soup powder are popularly eaten in Nigeria and other
countries in the sub-Saharan region. In Asia and Middle
East, cashew, almonds and pitachio are popularly used as
food garnish, but hitherto there is no such information
regarding moringa seeds. Given the growing awareness
about the nutritional benefits of moringa seeds, this work
investigates the microstructural and some quality
characteristics of soup enriched with debittered *Moringa
oleifera* seeds flour.

### 2. Materials and Methods

#### 2.1. Sample Preparation

Dry *Moringa oleifera* seeds, Onion, carrot, ginger,
garlic, green chilly, coriander leaves, pepper powder,
seasoning and sodium chloride (Merck Co., Mumbai India)
were purchased from Mysore market, Karnataka, India.
The soup recipe was in accordance with a traditional
method of curry preparation in Mysore, Karnataka, India.
*Moringa oleifera* seeds were defatted, debittered, dried
and powdered according to the method of Ogunsina and
Radha [11] to obtain debittered moringa seed flour
(DBMS). The ingredients: carrot, 14 g; onion, 24 g; green
chilly, 2 g; coriander leaves, 6 g; powder pepper, 1 g;
ginger, 1 g and garlic, 1.6 g were washed and chopped
into small pieces and allowed to season for 2-3 mins.
Debittered moringa seeds flour varied at 0, 0.5 and 1.0% w/w
levels was added as pre-gelatinized solution and
boiling continued for 5-7 mins until the desired
consistency was reached. The soup samples were
garnished with additional chopped coriander leaves and
about 5 ml of vinegar was added to the preparation and it
was stirred properly. The soup samples were dried at 50-
55°C for 2 days in a cabinet drier; and afterwards,
powdered by dry-milling in a kitchen blender to obtain
instant soup mix [24]. Each soup mix sample was
reconstituted in boiling water (1:100 w/v) and allowed to
simmer for about 2 mins. The entire procedure may be
summarized as shown in Figure 1.

#### 2.2. Protein Estimation

Percent nitrogen was estimated by micro-Kjeldhal
method using an automated nitrogen distiller and protein
content was calculated by multiplying the nitrogen value
with 6.25. Determinations were carried out in Triplicates.

#### 2.3. Sensory Evaluation

The soup samples were subjected to sensory evaluation
by a taste panel of 20 people. The panelists have no
prejudice against any specific food product. At the time
of evaluation, soup samples were served in glazed china
plates labeled with three-digit random codes and panelists
were provided with distilled water to clean their mouth
between samples. The order of serving of the soup
samples was randomized so that bias due to the sequence
of presentation was minimized. Twelve volunteers were
screened and chosen as panelists based on their ability to
identify the six basic tastes: sour, bitter, salty, pepper,
onion, garlic and bitter. The panelists gave remarks about
each sample; especially, considering colour, appearance,
body and overall acceptability. A balanced 10-point

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**Figure 1.** Procedure for preparing soup enriched with debittered moringa seeds flour.
hedonic rating was employed for all the attributes with 9–
10 denoting “like very much”, 7–8 “like”, 5–6 “neutral”, 3–
4 “dislike”, and 1–2 indicated “dislike very much.” The
booth area was under white fluorescent lighting at a
temperature and relative humidity of 22±2°C and 50±5%
respectively. The typical attributes for the soup samples
were earlier identified in a preliminary session to profiling.

2.4. Scanning Electron Microscopy

The microstructural characteristics of the soup mix
samples were studied by scanning electron microscopy.
Scanning electron micrographs were taken using a
scanning electron microscope (LEO 435 VP, Cambridge,
UK). Dried and powdered soup samples were coated with
gold using polaron coating system E5000 within 2–3 min.

The coating thickness was calculated as 200–300 nm,
using the formula: 

\[ T = 7.5I t \]

where \( I \) = current (mA), \( t \) = time (min), \( T \) = thickness (Å). The coated samples were
transferred to the microscope where it was viewed at 15
kV and 9.75×10⁻⁵torr using secondary electron image. A
35 mm Ricoh Camera (LEO 435 VP, Operator Manual
Version V2.04) was used to capture the image.

2.5. Viscosity

Viscosity was determined using a viscometer (Model
R1:3:M-3, Rheology International Ltd., Shannon, Ireland).
About 80 mL of soup sample was filled into the 100 mL
sample adaptor and the ASTM spindle size number 3
attached to the viscometer was immersed into the soup to
the marked portion. Viscosity was measured at 100 rpm
rotor speed under ambient temperature conditions
(26±2 °C) and expressed as m.Pa.S.

2.6. Colour

Colour measurement of flour samples was carried out
using a Labscan XE colour meter (Hunter Associates Lab.
Inc., Reston, VA). Approximately 100 ml of each soup
sample was served in a small glass bowl each with flat
glass cover to provide uniform flat surface. The colour
parameters measured were lightness (L), redness (+a),
greenness (a), yellowness (+b) and blueness (-b). A white
tile of known L, a, and b values were used as standard.
Total colour difference (\( \Delta E \)) was estimated using the
following equation

\[ \Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2} \]

where \( \Delta L \), \( \Delta a \) and \( \Delta b \) were the respective differences between
the standard plate.

3. Results and Discussion

The results show that the protein content of DBMS
flour was about 45.22 g/100 g and that of the soup
increased from 0.3 g/100 g, for the control; to 4 g/100 g, for
soup sample S2 which was enriched with 0.5% DBMS.
In India, the consumption of vegetable proteins in
different food systems is very crucial because the
population is largely vegetarian. Hitherto, soups and
curries enriched with vegetable proteins are widely
accepted as delicacies in different parts of the world and
have been a proven way of enriching the diet of a teeming
population of malnourished people. Instant soup mixes are
popular among busy wives, restaurants and eateries
around the world especially because it largely reduces
problems associated with bulk handling during processing
and the product has longer shelf life than liquid soup
preparations. The utilization of a high protein seed such as
moringa as a soup ingredient is a way of boosting the
nutritional status of the low income group in Asia, Africa,
Latin America where moringa has found favourable
conditions for growth. The rapidly changing food habits in
the tropics and emerging trends in the consumption of
underutilized protein seeds complements the global drive
towards ensuring that the world’s poorest people are no
longer malnourished.

The scanning electron micrographs of the soup samples
are shown in Figure 2. Soup sample enriched with 0.5% DBMS
shows a dense continuous agglomerated protein
matrices of irregular sizes and shapes, whereas the control
shows particles separated by large air vacuoles. Ogunsina
and Radha [11] earlier submitted that the hydrothermal
process involved in debittering may be associated with the
increase in inter-protein bonding between the particles;
because processing of proteins by moist heat can cause
aggregation of particles. The relationship between
structure and function in foods has long been studied by
scanning electron microscopy. It is known that the
microstructural characteristics of a particular food material
are often linked with its texture, rheology, flavor,
appearance and stability.
resist flow. The relationship between viscosity and shear rate is used for classifying foods as newtonian, non-newtonian, pseudoplastic or thixotropic. This finds relevance in food processing, quality control and sensory studies (26, 27); although organoleptical properties are largely a matter of personal perception and cannot be properly determined with analytical instruments.

4. Conclusions

Incorporating DBMS affects the quality and microstructural characteristics of moringa soup. The best overall acceptability was obtained at 0.5% optimal level of incorporation. Soup enriched with DBMS flour soup is richer in protein. Preparation of a DBMS enriched soup mix with acceptable sensory attributes is a means of promoting the consumption of moringa seeds as a valuable but underutilized protein resource.

Acknowledgements

Dr B.S. Ogunsina acknowledges the Fellowship of United Nations University from which interest to work on Moringa oleifera seeds emanated and the entire Management and Staff of Central Food Technological Research Institute (CFTRI), Mysore, India where the work was carried out.

References


Figure 3. Sensory profile of soup samples

The three soup samples show an almost equal score for sourness and saltiness; although the score for S2 was lower and differs significantly (p<0.05) from that of S1 and S3. It was further observed that the soup samples became less peppery as the incorporation of DBMS increased, showing soup sample S3 as the least peppery. Overall acceptability scores were 9, 9.2 and 9.6 for S1, S2 and S3 respectively; showing soup sample S2 as the most acceptable.

The hunter colour values of the soup samples were significantly different (p<0.05) (Table 1). The total colour values (ΔE) of the samples were observed to increase as the incorporation of DBMS increased; showing significant differences (p<0.05). The lightness (L value) of soup S1 differs significantly (52.74) from that of S2 (45.73) and S3 (42.58). Higher “L” value observed for S1 indicates that it is lighter than the other two samples. This was also reflected in the sensory score which indicated a lighter shade of buff color for S1 than the other two samples. The value “a” which indicates redness was indicated for S2 and S3, whereas S1 showed a trace of greenness (-a). The value “b” which indicates yellowness was however found to be more for S2 and S3 compared to S1.

Table 1. Effect of incorporation of DBMS on the colour of moringa soup

<table>
<thead>
<tr>
<th>Sample</th>
<th>L</th>
<th>a</th>
<th>b</th>
<th>ΔE</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>52.74</td>
<td>0.32</td>
<td>12.31</td>
<td>45.78</td>
</tr>
<tr>
<td>S2</td>
<td>45.73</td>
<td>3.69</td>
<td>18.12</td>
<td>53.06</td>
</tr>
<tr>
<td>S3</td>
<td>42.58</td>
<td>1.98</td>
<td>15.78</td>
<td>55.59</td>
</tr>
</tbody>
</table>

S1-Control; S2-0.5% of DBMS added; S3-1% of DBMS added

Values on the same column followed by different superscript letters are significantly different (p<0.05). The colour parameters measured were lightness (L), redness (+a), greenness (a), yellowness (+b) and blueness (-b). A white tile of known L, a, and b values was used as standard. Total colour difference was estimated as: ΔE = (∆L$^2$ + ∆a$^2$ + ∆b$^2$)$^{1/2}$ where ∆L, ∆a and ∆b were the respective differences between the standard plates.


