Comparative Analysis of the Nutritional Composition of Three Different Drying Methods of Moringa Oleifera Leaves

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Abstracts

The effect of three different drying methods of drying (sun drying, multipurpose drying and air drying) on Moringa Oleifera leaves were investigated. Three hundred gram leaves were harvested, cleaned, grouped into one hundred gram each and dried in the multipurpose dryer (50°C), air drying (room temperature) and sun drying (farmers and villagers practice). They were all subjected to proximate and microbial analysis including the fresh moringa leaves. The Carbohydrate, Protein, Crude fiber, Ash, Fat, Moisture content and pH of fresh Moringa Oleifera leaves was 2.18 ±2.11, 13.13 ±0.29, 10.67±0.27, 4.66±0.14, 1.50±0.32, 75.90±3.12, 6.32±1.01 respectively. There was a significant increase (p<0.05) in the carbohydrate content of multipurpose dryer and sun drying as compared with air drying with a corresponding decrease in the protein and fat content. There was no significant difference (p>0.05) in the crude fiber, ash and pH content of the three methods of drying. The microbiology examination reveal highest incidence of bacteria in sun drying method and least in multipurpose drying method. The fungal incidence is highest in sun drying and least in both air drying and multipurpose drying. There was no P.aerugionosis, E.coli, salmononella present in all samples. It was therefore concluded that multipurpose drying method is the best as it was able to retain its imbedded nutrients and at the same time recorded the least microbial incidence.

Keywords: Microbial load, sun drying, proximate, multipurpose, air drying, fresh.
Introduction

*Moringa oleifera* is one of the best known and most widely distributed and naturalized species of monogeneric family *Moringaceae* [1,2]. It is native of the western and sub-Himalayan tracts, India, Pakistan, Asia Minor, Africa and Arabia [3,4] but is now distributed in the Philippines, Cambodia, Central America, North and South America and the Caribbean Islands [5]. It has so many names like Horseradish tree, Drumstick tree, Never Die tree, West Indian Ben tree, and Radish tree [2]. In Nigeria, *M. oleifera* is locally known as ‘Zogale’ among the Hausa speaking people. It is an important vegetable which has been having enormous attention as the ‘natural nutrition of the tropics’ and is considered as “miracle tree” because all its parts are used, especially for their pharmacological, nutritional and purifying water properties [6,7,8]. Leaves are eaten as vegetables, and when pressed, are used in traditional pharmacology to treat many ailments, such as diabetes, gastric ulcers and so many others. The fruits are mainly used in condiments or cooked as vegetables. Flowers produce nectar and have anti-inflammation properties. *Moringa* seeds are rich in proteins and oil, and, are traditionally used for beauty care. Seeds are also used for water purification. The wood provides a blue dye and is used for live fences. *Moringa* leaves have been reported to be a rich source of β-carotene, protein, vitamin C, calcium and potassium and act as a good source of natural antioxidants; and thus enhance the shelf-life of fat containing foods due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids [9, 10].

Drying has been one of the oldest methods of food preservation used to prevent post harvest loss. Fresh produce do contain up to 95% water and thus is sufficiently moist to support both enzyme activity and growth of microorganisms [11]. Dehydrated foodstuff has a higher shelf life, making it available throughout the year. These dehydrated products can be used in various preparations even in off-season. Sun-drying in direct sunshine and under shade are the common practices used in most parts of Nigeria to preserve vegetables for dry season consumption [11]. However ways of food preparation and preservation may affect significantly the concentration and availability of essential compounds in food. Some reports have documented the losses of nutrients from vegetables during drying [12] and cooking [13, 14] therefore this work is done to ascertain the effect of the different methods of drying that will still retain the nutritional content and will not support microbial growth.

Materials and methods

Collection and preparation of samples: The leaves of *Moringa oleifera* were harvested from our institute’s premises in Kano, Kano State, Nigeria. They were properly washed and drained. The leaves were later divided into three treatments of 100g each; A, B & C.

A was kept inside the multipurpose dryer (a generally accepted enclosed drying device developed by Nigerian Stored Products Research Institute), the Multipurpose dryer was maintained at 50°C and is referred to as multipurpose drying.
B was kept in our chemistry laboratory under air/room drying system and was maintained at ambient temperature and is referred to as air drying.

C was kept outside in the open environment as it is the common practice among villagers and most farmers and is referred to as sun drying.

They were all loaded and allowed to dry to a constant weight, after which they were milled until the leaves became powder. The leaf powder was kept inside a clean bottle at room temperature (30-37°C). The fresh and dried moringa leaves were subjected to proximate and microbial analysis.

Chemical Analysis
The leaves were analyzed for their proximate contents using the AOAC [15] method. The crude protein contents by microKjeldah method (% protein = N x 6.25). The lipid content was determined using petroleum ether (bp. 60-80°C) in a soxhlet extraction apparatus and crude fiber content by dilute acid and alkali hydrolysis. Carbohydrate contents were calculated by difference of total contents from 100.

Microbiological analysis
One millilitre (1 ml) aliquot of each samples for zero (0 h) and ambient stored samples were transferred into 9 ml of 0.1% (w/v). Sterile peptone water was used as diluent. Ten-fold serial dilution was carried out and appropriate dilution was aseptically plated using pour plate technique for total viable aerobic bacteria count on nutrient agar (Biotech) and total fungi count on potade dextrose agar (Biotech). The media used were prepared and incubated according to the manufacturer’s instructions. The numbers of viable microorganisms were counted, calculated and expressed as colonies forming units per millilitre (cfu/ml).

Statistical analysis
All experimental data were subjected to statistical analysis of mean, standard deviation and analysis of variance (ANOVA) [16]. Values were considered significant at p < 0.05.

Result
The nutritional composition of the fresh and different methods of drying moringa leaves are shown in Table 1. It was observed that all the nutritional parameters increased drastically except the moisture content which decreased as a result of drying. The carbohydrate content is highest in sun-drying (39.9±1.12) and least in air drying (29.08±0.32). The protein content is high in room shading (35.60) and low in sun-drying (26.20). There was no significant difference (p>0.05) in the crude fiber, ash and pH content of the three methods of drying. Air drying recorded the highest fat content of (6.00±1.57) while multipurpose drying has the highest moisture content.
Table 1: Nutritional composition of fresh and dried *moringa* leaves.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Carboy (%)</th>
<th>Protein (%)</th>
<th>Crude fiber (%)</th>
<th>Ash (%)</th>
<th>Fat (%)</th>
<th>Moisture (%)</th>
<th>pH (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.S</td>
<td>2.18±2.11</td>
<td>13.13±0.29</td>
<td>10.67±0.27</td>
<td>4.66±0.14</td>
<td>1.50±0.32</td>
<td>75.90±3.12</td>
<td>6.32±1.01</td>
</tr>
<tr>
<td>M.D</td>
<td>39.9±1.12*</td>
<td>27.26±0.36*</td>
<td>10.12±1.01*</td>
<td>7.33±1.23*</td>
<td>3.25±0.17*</td>
<td>5.5±0.20°</td>
<td>6.6±0.11*</td>
</tr>
<tr>
<td>S.D</td>
<td>41.03±0.99*</td>
<td>26.20±1.40*</td>
<td>9.80±0.65*</td>
<td>8.0±0.99*</td>
<td>3.25±0.45*</td>
<td>4.7±0.49°</td>
<td>6.52±0.20°</td>
</tr>
<tr>
<td>A.D</td>
<td>29.08±0.32*</td>
<td>35.60±2.20*</td>
<td>10.30±0.28*</td>
<td>7.83±0.12*</td>
<td>6.00±1.57*</td>
<td>5.1±0.64°</td>
<td>6.09±0.85°</td>
</tr>
</tbody>
</table>


Table 2-5 shows the microbial parameter of fresh and dried *moringa* leaves, the total plate count was highest in sun drying and least in multipurpose drying, the yeast was high in fresh sample and least in both air drying and multipurpose drying. There was no *P.aeruginos*, *E.coli*, salmonella present in all samples.

**Table 2:** Microbial parameter of Fresh/ wet *moringa* leaves.

<table>
<thead>
<tr>
<th>Quality parameters</th>
<th>Result</th>
<th>NIS value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total plate count</td>
<td>(cfu/ml)</td>
<td>50</td>
</tr>
<tr>
<td><em>P.aeruginos</em></td>
<td>(cfu/ml)</td>
<td>Absent</td>
</tr>
<tr>
<td><em>E.coli</em></td>
<td>(cfu/ml)</td>
<td>Absent</td>
</tr>
<tr>
<td>Yeast</td>
<td>(cfu/ml)</td>
<td>70</td>
</tr>
<tr>
<td>Salmonella</td>
<td>(cfu/ml)</td>
<td>Absent</td>
</tr>
</tbody>
</table>

**Table 3:** Microbial parameter of *moringa* leaves dried in multipurpose dryer.

<table>
<thead>
<tr>
<th>Quality parameters</th>
<th>Result</th>
<th>NIS value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total plate count</td>
<td>(cfu/ml)</td>
<td>5</td>
</tr>
<tr>
<td><em>P.aeruginos</em></td>
<td>(cfu/ml)</td>
<td>Absent</td>
</tr>
<tr>
<td><em>E.coli</em></td>
<td>(cfu/ml)</td>
<td>Absent</td>
</tr>
<tr>
<td>Yeast</td>
<td>(cfu/ml)</td>
<td>10</td>
</tr>
<tr>
<td>Salmonella</td>
<td>(cfu/ml)</td>
<td>Absent</td>
</tr>
</tbody>
</table>
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Table 4: Microbial parameter of *moringa* leaves dried by air drying method.

<table>
<thead>
<tr>
<th>Quality parameters</th>
<th>Result (cfu/ml)</th>
<th>NIS value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total plate count</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td><em>P. aeruginosa</em></td>
<td>Absent</td>
<td>Nil</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>Absent</td>
<td>Nil</td>
</tr>
<tr>
<td>Yeast</td>
<td>10</td>
<td>Nil</td>
</tr>
<tr>
<td><em>Salmonella</em></td>
<td>Absent</td>
<td>Nil</td>
</tr>
</tbody>
</table>

Table 5: Microbial parameter of *moringa* leaves dried by sun drying method.

<table>
<thead>
<tr>
<th>Quality parameters</th>
<th>Result (cfu/ml)</th>
<th>NIS value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total plate count</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td><em>P. aeruginosa</em></td>
<td>Absent</td>
<td>Nil</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>Absent</td>
<td>Nil</td>
</tr>
<tr>
<td>Yeast</td>
<td>15</td>
<td>Nil</td>
</tr>
<tr>
<td><em>Salmonella</em></td>
<td>Absent</td>
<td>Nil</td>
</tr>
</tbody>
</table>

Discussion

The results (Table 1) obtained from proximate analysis of fresh *moringa* leaves establishes that they can be ranked as protein rich leaves due to their relatively high protein content when compared with the other components of the leaves. However, the dried leaves further establish that it can also be classified as carbohydrate leaves. Generally, the nutritional composition increased as the leaves were subjected to drying, this could be as a result of the concentration of internal composition of the nutrients which occurs as moisture is reduced. *M. Oleifera* leaves contain high amount of water (75.90%) and a reasonable amount of protein (13.13%) as in Table 1, this agrees with the work of Church World [17] who reported that *M. Oleifera* leaves contain 75.00% moisture and 10.10% protein and Elkaliha et al. [18] who also reported that *M. Oleifera* leaves contain 74.40% moisture and protein 16.70%. There was a significant increase (p<0.05) in the protein content of *moringa* leaves dried using air drying method as compared with the two other methods as indicated in Table 1. The difference observed in the protein content of the three methods of drying especially the low content in sun drying and multipurpose drying may be that heat might have denatured most of necessary amino acids, further confirming that heat has effect on protein content of foods. It was observed that the leaves dried under air drying retained most of its nutritional qualities that can be destroyed by heat. This
supports the work of Beth and Lindsay [19], who suggested that the leaves should be
dried under shade and away from direct light. The low moisture content of the dried
leaves would hinder the growth of micro-organisms and the storage life would be high
without the development of moulds [20]. There was no significant difference (p>0.05)
between the carbohydrate content of multipurpose drying and sun drying with a
corresponding decrease in air drying.

The dried *M. Oleifera* leaves were reported by Church World [17] to contain a
high amount of fibre, 19.20%, in this study it was found to range from 9.80% in sun-
drying to 10.30% in room shading. This may be due to the difference in the
environment where *M. Oleifera* tree was grown. The oil content of the fresh leaves
was found to be 1.5% which is similar to that reported by Church World [17]. The ash
content of dried leaves was found to be between 8% in sun-drying to 7.83% in air-
drying which also supports the work of Elkhalifa et al, [18], which indicate a high
content of minerals elements. These further confirm that heat or method of processing
does not affect the mineral content of vegetables

Statistically, there was a significant increase in fat content of leaves sun dried as
compared to the other two methods. A diet providing 1 – 2 % of its caloric energy as
fat is said to be sufficient to human beings, as excess fat consumption is implicated in
certain cardiovascular disorders such as artherosclerosis, cancer and aging [21]. There
was no significant difference (p>0.05) in the crude fiber content, pH and ash of the
three methods of drying and this makes it a more favourable vegetable since high
fibre content of foods help in digestion and prevention of colon cancer[22, 23]. Non-
starchy vegetables are the richest sources of dietary fibre [24] and are according to
Saldanha [22] employed in the treatment of diseases such as obesity, diabetes and
gastrointestinal disorders. The pH of 6 makes it safe for consumption as it is slightly
acidic and will be good for people suffering from ulcer.

The high total plate count observed in sun drying method as shown in Table 2-5
was not unexpected due to presence of high microbes in the open air which might
have contaminated the leaves. In multipurpose drying method which recorded the
least incidence, may be because the dryer is properly enclosed which will not allow
entrance of microbes. Fresh sample has the highest yeast while air drying and
multipurpose has least, this does not agree with the work of Mozart and Godfred, [25]
who reported high yeast growth in leaves of *moringa* leaves dried using air drying.
The absence of *P.aerugionosis, E.coli*, and salmonella indicates that the dried *moringa*
leaves may be safe for consumption since they are still within safe limit.

**Conclusion**

It was observed that in terms of nutrient retention, air drying can be said to be the best
method of drying but microbiological examination revealed that the use of
multipurpose dryer is the best method as it has the least microbial presence therefore
we are concluding that the multipurpose dryer may be the best method of drying as it
was able to retain most of the nutrients though not as much as air drying method.
Reference


Comparative Analysis of the Nutritional Composition


[19] Beth Doerr and Lindsay Cameron 2005 Moringa Leaf Powder. Echo technical paper


