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Effects of some Drying Methods on Nutritional Characteristics of Moringa (*Moringa Oleifera*) Seeds

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Abstract. *Moringa Oleifera* seeds have been found to be highly nutritious and medicinal. Drying preserves and enhances nutritional characteristics of the seeds; hence, moringa seeds were dried using, oven-drying, sun-drying, cabinet tray drying and shadow drying methods to study the effects of drying on nutrient retention so as to determine the suitable drying method that will retain the maximum nutrient expected from the seeds. 200g of the seeds were used for each drying experiment and each drying process was monitored by weighing the samples periodically until bone dry was achieved. The nutrient retained in the dried samples was determined using proximate analysis according to AOAC standard. The nutrients retained after drying using oven, sun, cabinet tray and shadow respectively are protein (31.31, 30.01, 32.13 and 30.79%), crude fat (15.55, 15.92, 16.78 and 15.80%), Carbohydrate (31.29, 27.22, 29.95 and 28.37%) and crude fibre (9.15, 14.72, 9.38 and 13.28%). More nutrients were retained in cabinet-tray drying method (in terms of protein and fat) compared to other drying methods. It was concluded that the cabinet tray drying method was the best method of drying of moringa seeds.

Keywords: proximate analysis, moringa seed, oven drying, sun-drying, cabinet tray drying, shadow drying

1. Introduction

Drying is one of the most relevant and challenging processes of food industry, since a great number of food products are subjected to at least one drying step during its production (Wankhade *et. al.*) [1].

Dehydration or drying of foods is described as any process that involves thermal removal of volatile substances to obtain a dry solid (Xiao *et. al*.) [2], (Zhan Wu *et. al*.) [3]. The main purposes of drying crops are to increase its shelf life, to better its quality, to simplify the handling, storage and transport of the products and also to prepare the product to subsequent processes.

Moringa Oleifera is native to some parts of Africa and Asia and it is the sole genus in the flowering plant family Moringaceae. Moringa is full of nutrients and vitamins and is good for both human and animal consumption (Adejumo and Abayomi) [4]. Moringa helps to clean dirty water (Mustapha *et. al*.) [5]. It is also a useful source of medicines (Busani *et. al.*) [6].

Drying of Agricultural crops is done in most farms by sun-drying (Lasisi *et. al.*) [7]. This results into contamination by insects and dust. Therefore, there is need to introduce the use of mechanical dryers provided that the nutritional characteristics would be retained better than using sun-drying method.

This study will therefore provide adequate information about a suitable drying method that will give the maximum nutrient retention of *Moringa Oleifera* seeds and will also guide Engineers in designing storage facilities for Moringa seeds for various medicinal and nutritional uses.

2. Methodology

2.1. Raw materials collection and preparation

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Moringa pods shown in plate 1 were sourced from subsistence farmers around Ajibode area, a neighbourhood of University of Ibadan, Nigeria. The pods were harvested when the average temperature was between 27-30^{0}C and the relative humidity of the environment was between 70-80%. The pods were carefully shelled to obtain moringa seeds shown in plate 2. The seeds were cleaned and then soaked in water for 20 hours, decanted to remove chaffs and then kept in moisture tight polyethene bags and stored inside refrigerator at about 15^{0}C to allow for a stable and uniform moisture content of the bulk seeds. The stored seeds were left in the laboratory for about 2hours to attain ambient conditions before used for the experiment.

Plate 1: moringa oleifera pods

Plate 2: Moringa Oleifera seeds

2.2. Methods of drying

200g of the stored sample was used for each drying experiment using the method described by Ojediran and Raji [8] and Satwase [9] with little modifications to suit laboratory and experimental conditions and each experiment was repeated thrice. The drying process was monitored by weighing the samples every 30 minutes for cabinet tray drying and oven drying, every 1 hour for sun-drying and every 5 hours for shadow-drying. The time interval was adopted because of the difference in drying rates of each drying method. The weighing was carried out using a Metra precision weighing balance (0.1-5000g) and it continued until there was no difference in the weight of the sample.

2.2.1. Oven-drying

Freshly prepared moringa seeds were oven-dried in Agricultural and Environmental Engineering Department of the University of Ibadan, Nigeria using a Supermatec Oven produced by Hotpackphila, PA, USA. The temperature of the oven was set to as low as 60 ℃.For air circulation, the oven door was propped open two to six inches wide. Circulation was improved by placing a fan outside the oven near the door. Drying trays were narrowed enough to clear the sides of the oven and was 3 to 4 inches shorter than the oven from front to back.

2.2.2. Sun-drying

The seeds were place in a tray one layer deep on a table. Air was allowed to circulate below as well as above seeds to speed up drying time. The seeds in the tray on the table were placed in direct sun and turned occasionally. These Moringa seeds were placed in direct sun for several hours and the weight of the sample was being measured at intervals of 1hour until the weight became constant.

2.2.3. Cabinet tray drying

Cabinet tray drying was carried out at the Department of Agricultural and Environmental Engineering in the University of Ibadan, Nigeria. The cabinet tray dryer was designed and fabricated at the Department of Agricultural and Environmental Engineering. It consists of a 0.374kW axial flow fan blowing at a velocity of 3.5m/s over the heating elements into a drying chamber with perforated trays. The dryer casing is lagged wit

cushion to give it a compact look. A door was provided to suite the design for loading and unloading the dryer. The prepared moringa seeds were spread on the tray and placed into the cabinet tray drier at 60℃ and the weight was being measured at interval of 30mins until a constant weight was being recorded.

2.2.4. Shadow drying

The seeds were placed in a tray on a single layer in a room well ventilated. Natural current of air was allowed to flow within the room and was used for shadow drying the seeds. The weight of the seeds was being measured at intervals of 5hours and drying continued for 4 days until bone dry was achieved.

2.3. Determination of proximate analysis

The proximate analysis of moringa seeds was carried out using the standard method by AOAC [10].

2.3.1. Determination of moisture content

Food samples intended for moisture analysis was prepared rapidly to prevent loss of water. Sampling errors were reduced by taking large samples, mixing well, and taking smaller sub-sample for analysis. Samples stored in polythene bags, and when they cannot be analysed immediately, they were kept under refrigeration. The percentage of moisture in the samples was calculated using the formula shown in *(1)*

$$\%Moisture = Weight\ of\ moisture/weight\ of\ sample\ X\ 100 \quad (1)$$

2.3.2. Determination of ash content

Ash content of material represents inorganic residue remaining after destruction of organic matter or the mineral content present in the sample. The silica dish was kept in muffle furnace at not more than 525℃ for 4-6 hours. The weight of ash was taken and determined. The % ash by formula is shown in *(2).*

$$\%\ ash\ content = weight\ of\ ash/weight\ of\ sample \times 100 \quad (2)$$

2.3.3. Determination of crude fat

Ether soluble material in the seeds was extracted from dried sample using a Soxhlet extraction apparatus. The ether was evaporated and residue was weighed. Water soluble materials were not extracted since the sample has been thoroughly dried, prior to extraction with petroleum ether. The formula to calculate crude fat is shown in *(3).*

$$\%\ fat\ content = weight\ of\ ether\ soluble\ material/weight\ of\ sample \times 100 \quad (3)$$

2.3.4. Determination of crude fibre

Crude fibre was organic residue which remains after the food sample has been treated under standardized conditions with standard boiled acid and alkali solutions. Fibro-tron was very sophisticated instrument for analysis of crude fibre of sample with standard boiled acid and alkali solutions. The crude fibre was determined by standard method as shown in *(4).*

$$\%\ Crude\ fiber = loss\ in\ weight/weight\ of\ sample \times 100 \quad (4)$$

3. Results and Discussion

3.1. Equilibrium moisture content

It has been observed that the equilibrium moisture content is significantly less than the initial moisture content (Table 1) due to fluctuating relative humidity during drying, the equilibrium moisture content can

also be assumed to be 0 g/g dry solid (Sacilik [11], Doymaz and Ozdemir [12]) . Table 1 shows the initial moisture content and equilibrium moisture content of moringa seeds for the various drying methods studied.

From this table, it was observed that the initial moisture content of moringa oleifera ranges between 69% and 70% while the equilibrium moisture content was found to be between 1.4% to 2.6%.

3.2. Proximate analysis

The result of proximate analyses (Fig. 1) shows that the moisture content in the dried seeds ranges between 8.3-8.6%. Maximum moisture content was in shadow dried sample (8.51%) and the minimum was in cabinet dried sample (8.31%). Carbohydrate content of the dried samples was in the range of 27.22-31.29g per 100g. The carbohydrate content in the oven-dried sample was maximum. The protein content in the four samples was in the range of 30.01-32.13g per 100g. Maximum protein content was in the cabinet tray - dried sample. The fresh moringa seeds contain 6.33% protein. The fat content of dried samples was in the range of 15.55g- 16.78g. The fat content was highest in the cabinet tray dried samples (16.78%) and lowest in the oven-dried sample (15.55%). The fibre content of the sundried sample was highest yield (14.72g). Ash content of dried moringa seeds was in the range of 2.89-4.39g.

Table 1: Initial Moisture Content And Equilibrium Moisture Content of Moringa Seeds for Various Methods

Drying Conditions	Initial Moisture Content	Final Moisture Content
Sun-drying	0.694 ±0.13	0.0235 ±0.12
Shadow drying	0.702 ±0.24	0.0256 ±0.16
Oven drying	0.686 ±0.07	0.014 ±0.21
Cabinet drying	0.686 ±0.21	0.0156 ±0.07

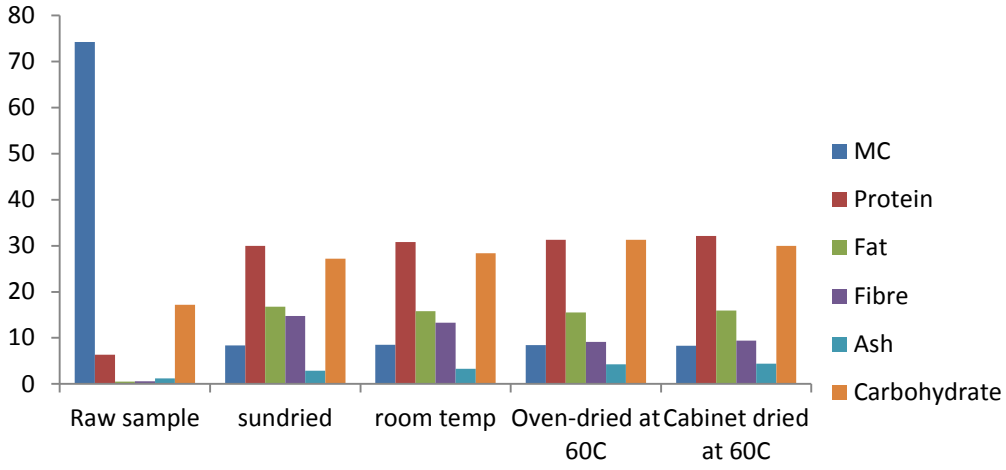

Fig. 1: Representation of nutritional values of moringa seeds for different drying methods

3.3. Drying curves

Generally, oven drying (Fig. 2) and cabinet tray drying method (Fig. 3) leads to a considerable reduction of drying time and reduction in loss of product quality and nutrient compared to sun-drying method (Fig. 4) and shadow drying method (Fig. 5). The various drying methods affects, to varying degrees, the quality attributes and nutrient retention. Such variations in quality attributes may be due to product type and maturity, thickness of seeds, and the drying method. Nutrition characteristics were also affected by moisture content and water activity, temperature change, relative humidity and drying rate. The graphs were plotted between moisture ratio (MR) and drying time (t). The time was in hours and the moisture ratio has no unit. Fig. 2-5 shows the results obtained during the drying processes for the four drying methods.

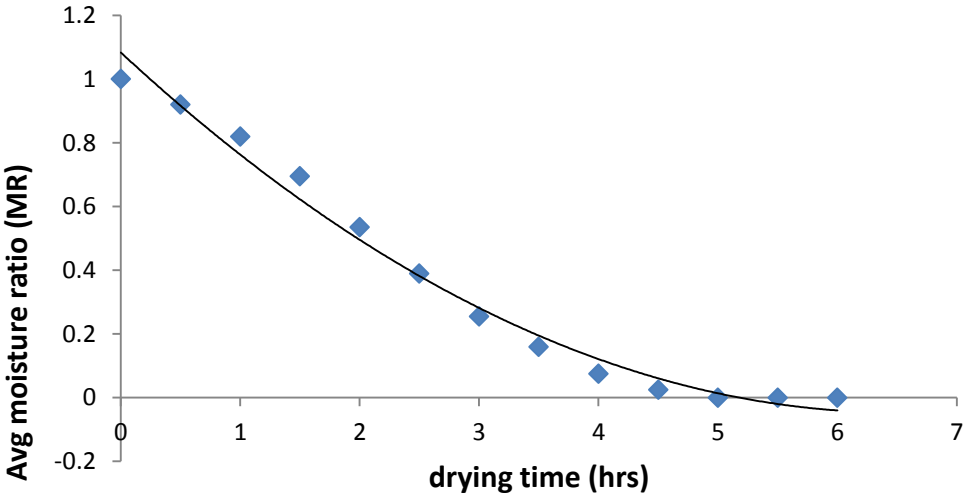

Fig. 2: Result obtained during drying of moringa seeds using oven drying method

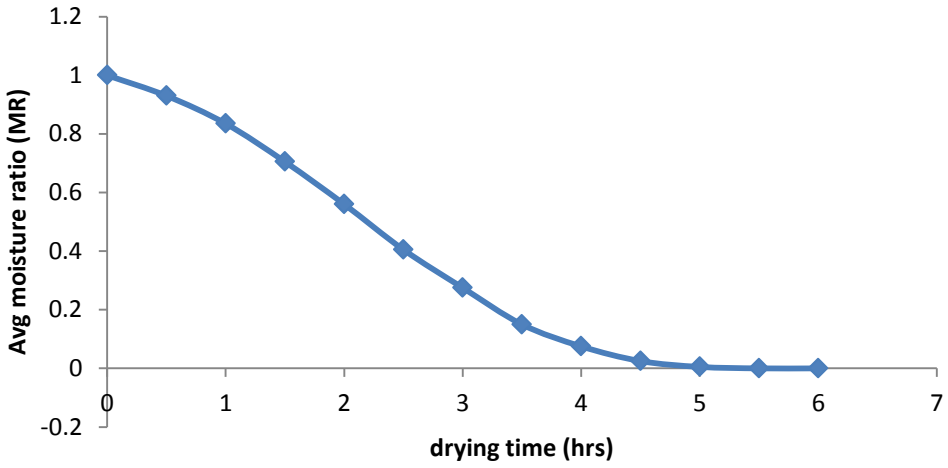

Fig. 3: Result obtained during drying of moringa seeds using cabinet tray drying method

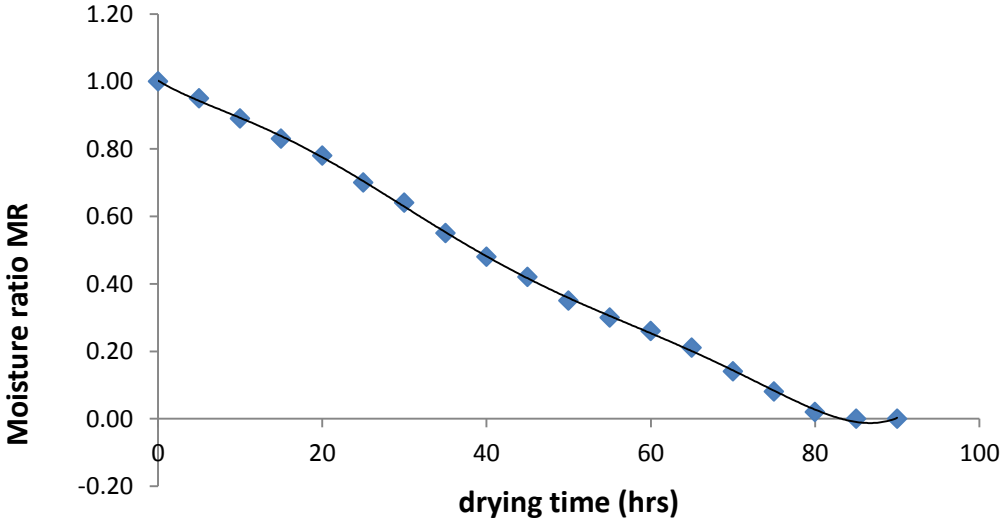

Fig. 4: Result obtained during drying of moringa seeds using sun-drying method

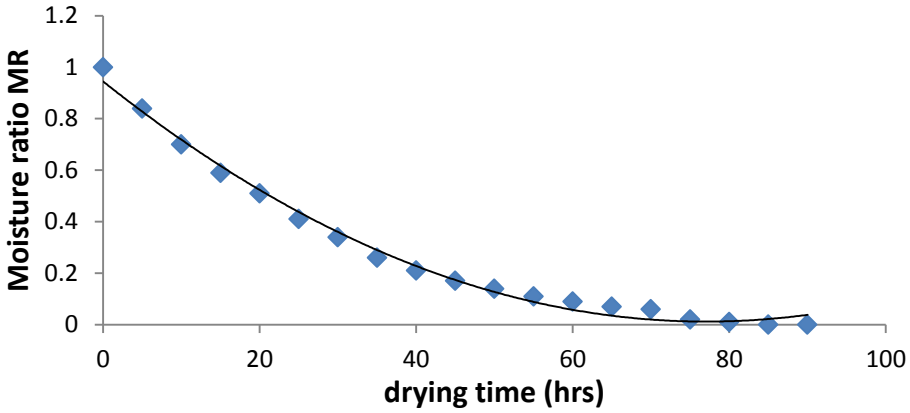

Fig. 5: Result obtained during drying of moringa seeds using shadow drying method

4. Conclusion

From the drying studies and the result of proximate analysis, it can be concluded that the cabinet tray drying method was the best method for drying moringa seeds. There was better retention of nutrients like protein and crude fat and nutritional characteristics as compared to the oven, shadow drying and sun drying methods. Also, it takes a shorter period to dry using oven and cabinet tray dryer which resulted in accumulation of nutrients.

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