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Effect of different drying techniques and quality evaluation of moringa leaf powder

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Abstract
Moringa oleifera Lam (*M. oleifera*) is the most extensively cultivated tree species of the genus Moringa that belongs to the family Moringaceae. *M. oleifera* is a highly valued plant, distributed in different parts of tropics and sub-tropics around the world. Moringa leaves has been used as medicine for various health benefits in several countries. In the present investigation, the efforts have been made to prepare the powder of Moringa Leaves by applying different drying techniques viz. Tray drying and Infrared drying. The drying was done at different temperatures 50°C, 60°C and 70°C. Also, Nutritional and Mineral content were analyzed for the powders obtained. At a temperature, the Tray dryer took maximum time for complete drying of Moringa leaves followed by Infrared dryer. Maximum moisture content was removed from fresh Moringa leaves using Infrared dryer, whereas for Tray dryer it varied with temperature. As temperature increased from 50°C to 70°C, the drying rate increased and hence the removal of moisture. The studies indicated that Infrared drying was faster and effective in the removal of moisture. Whereas, method of Tray drying at 60°C is suitable to obtain a Fiber rich product of 12.5%. To obtain a mineral rich product, Infrared drier at 60°C showed little high content of Calcium (2.93%) and Magnesium (26%). As the temperature increased from 50°C to 70°C, the Protein content decreased by ~0.83%, Fibre reduced by ~0.33% and iron content reduced by ~0.35%.

Keywords: moringa leaves, drying, infrared dryer, tray dryer, nutritional composition, mineral content

Introduction

Moringa oleifera Lam (*M. oleifera*) is the most extensively cultivated tree species of the genus Moringa that belongs to the family Moringaceae. *M. oleifera* is a highly valued plant, distributed in different parts of tropics and sub-tropics around the world (Anwar *et al*., 2007). Each part of this tree is edible and could be consumed by humans. The M. oleifera tree has numerous vernacular names such as Horseradish tree Marango, Kelor, Drumstick tree, Horseradish tree, Mlonge (Fahey, 2005). *M. oleifera* is considered as one of the most beneficial tree in the world, it has several traditional medicines, industrial and nutritional uses (Fuglie, 1999; Anwar *et al*., 2007; Wadhwa, 2013). This tree is a perennial softwood tree with timber of low quality, as an important crop in some countries in the world such as India, Ethiopia, and Sudan. Moringa tree has also been grown in African countries, Latin America, tropical Asia, and in Pacific (Meena *et al*., 2010). Various parts of *M. oleifera* are highly nutritious and contain important minerals, proteins, vitamins, antioxidant, β-carotene amino acids and various phenolic (Anwar *et al*., 2007). The leaves of *M. oleifera* are a good source of a natural antioxidant due to the presence of various compounds such as ascorbic acid, flavonoids, phenolic and carotenoids (Makkar and Becker, 1997). Moringa leaves (*Moringa olifera*) contains high amount of β-carotene, vitamin c, vitamin E and iron.

Moringa leaves contain more vitamin A than Carrot, more potassium than Bananas, more iron than Spinach. Moringa preparations have antibiotic, antitrypanosomal, hypotensive, antispasmodic, antiulcer, anti-inflammatory, hypocholesterolemic, and hypoglycemic activities as well as have considerable efficacy in water purification by flocculation, sedimentation, antibiosis and even reduction of Schistosome cercariae titer. Cooked moringa leaves provide more bio-available iron. (Ray-Yu Yang *et al*. 2006).

Moringa products are used in traditional medicine for diabetes and cardiovascular diseases. There are scientific indications that Moringa holds therapeutic potential for chronic hyperglycemia and hyperlipidemia, as symptoms of diabetes and cardiovascular diseases. Its therapeutic potential is often explained by the relatively high antioxidant activity of its leaves, flowers and seeds. Reactive oxygen species (ROS) and free radicals are the main contributors to oxidative stress in cells, if these compounds are not reduced by certain pathways and oxidative stress is a major contributing factor to cardiovascular diseases and diabetes. In Moringa, mainly flavonoids seem to be responsible for the antioxidant activity of the plant (Mbikay, 2012). The plant also seems to have anti-inflammatory properties. What is more, Moringa contains phytosterols – such as beta-sitosterol – which could reduce the dietary intake of cholesterol (Mbikay, 2012). Moringa contains pterygospermin, which has antibiotic effects and acts as a fungicide (Heuzé *et al*., 2014). The flowers are sometimes used in a concoction as a remedy for the common cold (Orwa *et al*., 2009).

For centuries and in many cultures around the world, the medicinal usage of the Moringa has been used to treat problems such as skin infections, anaemia, anxiety, asthma, blackheads, blood impurities, bronchitis, catarrh, chest congestion, cholera and many other illnesses (Khawaja *et al.*, 2010; Hamza, 2010; Singh *et al.*, 2012). *Moringa oleifera* also consists of anti-inflammatory, anti- spasmodic, anti-hypertensive, anti-tumour, anti-oxidant, anti-pyretic, anti-ulcer, anti-epileptic, diuretic, cholesterol lowering, renal, anti-diabetic, (Paliwal *et al.*, 2011; Sharma *et al.*, 2012) and hepatoprotective activities (Lai *et al.*, 2010; Huang *et al.*, 2012). It has also long been labelled for its

great cosmetic value in which in recent years, the Moringa has commonly been found to be used in various health care products including body and hair moisturisers and conditioners. It was also discovered that Moringa oil was used in skin ointments ever since the Egyptian times. The Moringa was claimed to be 'the most nutrient-rich plant yet discovered' by Khawaja *et al.* (2010). General nutrition contents of the Moringa up to several specific remedial properties including its anti-fibrotic, anti-inflammatory, anti-microbial, anti- hyperglycemic, antioxidant, anti-tumour and anti-cancer properties.

The objective is to study the nutritional composition of Moringa leaves powder obtained from the different dyers (Tray dryer and Infrared dryer) at different temperatures (50˚C, 60˚C & 70˚C).

Materials and Methods

In accordance with the objectives of the study, experiments on drying of Moringa leaves were conducted using different drying techniques. Using the data, the drying behavior of Moringa leaves viz. temperature and time taken were studied.

Materials

Raw Material

The Moringa leaves were collected from the nearby household to the Osmania University, Hyderabad. The freshly collected Moringa leaves were sorted, washed then kept for drying processes**.**

Equipment

Electronic balance, Tray dryer and Infrared dryer.

Methods

Preparation of Moringa leaves for drying

a. **Sorting:** The fresh Moringa leaves were collected from the nearby household to the Osmania University Campus, Hyderabad. The stems and other unwanted parts were removed from Moringa leaves.
b. **Washing:** The leaves were washed with slightly warm water to remove the dirt particles and the excess water was drained out from leaves. The Moringa leaves were then cleaned by a dry cloth to remove the water particles. After the complete removal of water particles, the leaves were then kept in thin layers in the trays for actual drying process.

Methods for Drying

In this study Moringa leaves were subjected to two different drying techniques (*Tray drying and infrared drying*) at three different temperatures (*50°C, 60°C, 70°C*) to obtain the best possible quality dried product. Initial Moringa leaves samples of 50g were weighed accurately for Tray and 20g were weighed accurately for Infrared drying process. The driers were pre-heated to corresponding temperature before the drying process.

a. Tray drying: The dryer was pre-heated to required temperature and then the Moringa leaves of 50g were spread in thin layers on the trays. Once the drying process started, the weights of the sample were collected at every 20 min until a constant weight was reached. The process was done by taking three samples of 50g each at three different temperatures 50°C, 60°C & 70°C.

b. Infrared drying: The infrared dryer was pre-heated to required temperature and then Moringa leaves of 20g were spread in thin layers on the tray. Once the drying process started, the weights of the sample were collected at every 10 min until a constant weight was reached. The process was done by taking three samples of 20g each at three different temperatures 50°C, 60°C & 70°C.

Method of Packaging

The powders obtained from different drying methods are packed and stored in HDPE pouches with double protection.

Determination of Proximate Analysis

The proximate analysis of Moringa leaves was carried out by standard method.

Ash

Ash content of material represents inorganic residue remaining after destruction of organic matter or the mineral content present in the sample. Keep the silica dish in muffle furnace at not more than 525°C for 4-6 hours. Take the weight of ash and determine the % ash by formula, as given in standard method.

$$\%\ Ash\ (dry\ basis) = \frac{Weight\ after\ Ashing}{Weight\ before\ Ashing} \times 100$$

Crude Fat

Ether soluble material in a food 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 ash content was found more in cabinet drying method as compare other drying methods.

$$\%\ Fat\ Content = \frac{Weight\ of\ ether\ soluble\ material}{Weight\ of\ the\ sample} \times 100$$

Crude Fiber

Crude fiber 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 fiber of sample with standard boiled acid and alkali solutions. The crude fiber was determined by standard method.

$$\%\ Crude\ Fiber = \frac{Loss\ in\ Weight\ [(W2 - W1) - (W3 - W1)]}{Weight\ of\ the\ sample\ [W]} \times 100$$

Protein

Crude protein present in the sample is digested with sulfuric acid in the presence of a catalyst, at 380. The nitrogen released from the protein s and non-protein constituents of the sample is converted to ammonium sulfate. The ammonia nitrogen reacts with sali-cylate nitroprusside reagent in the presence of NaOH, to form a green colored complex, whose absorbance is measured at 685nm. The crude protein concentration is calculated by multiplying concentration of nitrogen (Kjeldhal nitrogen-N) obtained with a factor of 6.25**.**

$$Crude\ Protein = N \times 6.25$$

Moisture
The sample is heated at temperature $105^0 \pm 2^0$C for 6 hours in oven that gives gravimetric determination of the mass losses.

$$\%\ Moisture\ Content = \frac{Initial\ weight\ of\ sample\ -\ Final\ Weight\ of\ sample}{Initial\ weight\ of\ the\ sample} \times 100$$

Determination of Mineral contents
Calcium: Calcium is precipitated as Calcium Oxalate. The precipitate is dissolved in hot dilute H_2SO_4 and titrated with standard Potassium Permanganate.

$$Calcium\ (\frac{mg}{100g}) = \frac{Titer \times 0.2 \times total\ volume\ of\ ash\ solution \times 100}{Volume\ taken\ for\ estimation \times Wt\ of\ sample\ taken\ for\ ashing}$$

Iron
The iron in food is determined by converting the iron into ferric form using oxidizing agents like potassium per sulfate or hydrogen peroxide and treating thereafter with potassium thioxepnate to form the red ferric thiocyanate which is measured calorimetrically at 540nm.

$$Concentration\ of\ sample = \frac{OD\ of\ unknown\ sample}{OD\ of\ known\ sample} \times concentration\ of\ known\ sample$$

Results and Discussions
The effect of drying at various temperatures using different dryers (Tray and Infrared dryer) is presented below.

Drying of Moringa leaves using Tray dryer
The drying of moringa leaves was done at Tray dryer using different temperatures i.e., 50˚C, 60˚C and 70˚C. The nutritional analysis of products obtained from different temperatures are presented below.

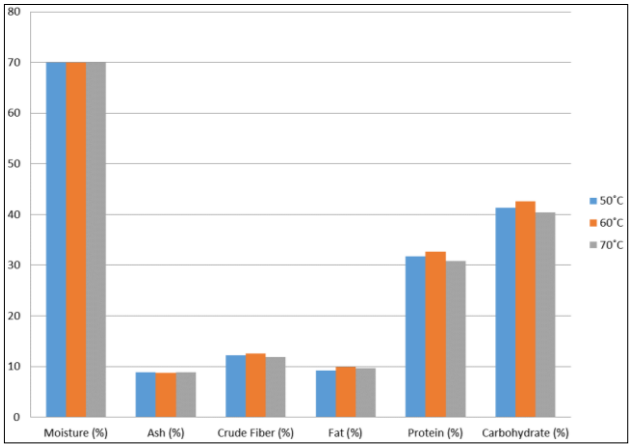

Fig 1: Nutritional composition of Moringa leaves powder at Tray dryer using different temperatures

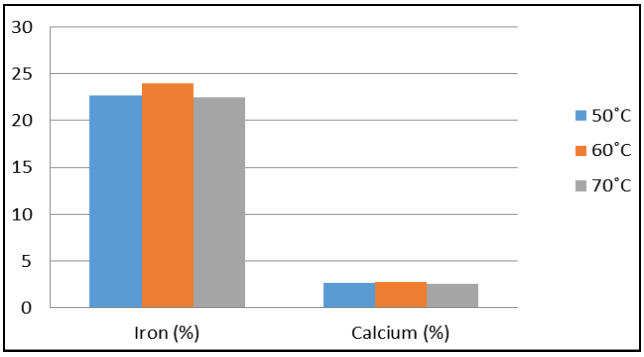

Fig 2: Mineral composition of Moringa leaves powder at Tray dryer using different temperatures

The product product obtained from Tray dryer has the Moisture content 70%. Tray dryer at 60˚C has the highest amount of Crude fiber (12.5%) and Fat (9.85%), whereas, Tray dryer at 70˚C has the highest amount of Ash (8.89%) and has the least amount of Carbohydrate (40.4%) and protein (30.76%) compared to other temperatures. Tray dryer at 60˚C is suitable for highest percentage of Iron (24%) and Calcium (2.8%).

Drying of Moringa leaves using Infrared dryer
The drying of moringa leaves was done at Infrared dryer using different temperatures i.e., 50˚C, 60˚C and 70˚C. The nutritional analysis of products obtained from different temperatures are presented below.

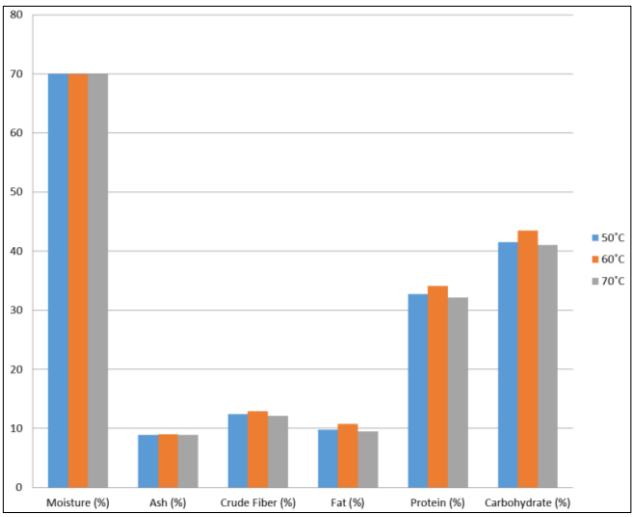

Fig 3: Nutritional composition of Moringa leaves powder at Infrared dryer using different temperatures

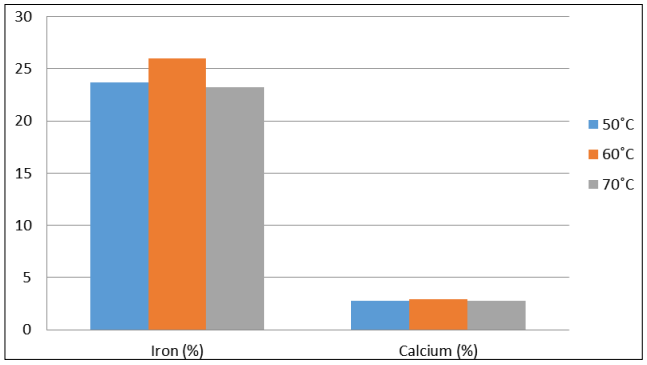

Fig 4: Mineral composition of Moringa leaves powder at Infrared dryer using different temperatures

The product obtained from Infrared dryer has the Moisture content 70%. Infrared dryer at 60˚C has the highest amount of Ash (8.97%), Protein (34.12%) and Carbohydrate (43.5%), whereas, at 70˚C Infrared drying has the least amount of Crude fiber (12.09%) and Fat (9.51%) compared to other temperatures. Infrared dryer at 50˚C has slightly more percentage of Iron (23.7%) compared to Infrared 70˚C Iron content (23.2%). Meanwhile, Infrared dryer at 70˚C has slightly higher amount of Calcium (2.77%) compared to Infrared 50˚C Calcium percentage (2.75%).

Conclusion
It can be concluded that the Infrared drying method was the best method of dehydration of Moringa leaves for the removal of Moisture Content. Whereas, the method of Tray drying at 60°C is suitable to obtain a Fiber rich product of 12.5%. To obtain a Mineral rich product, Infrared drier at 60°C showed little high

content of Calcium (2.93%) and Magnesium (26%) compared to other temperatures. As the temperature increased from 50°C to 70°C, the Protein content decreased by ~0.83%, Fibre reduced by ~0.33% and iron content reduced by ~0.35%.

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