RESEARCH PAPER | International Journal of Agricultural Engineering | Volume 11 | Sp. Issue | April, 2018 | 197-206
ISSN–0974–2662 ■ Visit us : *www.researchjournal.co.in* ■ **DOI: 10.15740/HAS/IJAE/11.Sp. Issue/197-206**

Studies on dehydration of *Moringa oleifera* leaves by using different method and its utilization in *Paratha*

■ **S.M. Shinde, K.P. Babar and D.T. Bornare**

Received : 10.04.2018; **Accepted :**13.04.2018

See end of the Paper for authors' affiliation

Correspondence to :

S. M. Shinde
Department of Agricultural Engineering, Maharashtra Insitute of Technology, **Auranganad (M.S.) India**
Email : swapnashinde43@gmail.com

■ **Abstract :** *Moringa oleifera* is a multipurpose and exceptionally nutritious vegetable tree with a variety of potential uses and its leaves are most nutritious and drying of *Moringa leaves* powder not only increases the micronutrients but also it increases the shelf- life of its powder. In this study three types of drying methods are used sun drying, tray drying and shade drying to improve nutritional property of *Paratha*. Proximate composition of three methods of dehydrated leaves were determined and compared. Four sensory attributes of appearance, aroma, texture, taste and overall acceptability using 9-point hedonic scale. Nutritional value of Dehydrated *Moringa* leaves added sample was compared with a control. Result revealed, obtaining a significant increase in ash and carbohydrate content. Further, obtained a significant improvement in beta- carotene content and mineral content of leaves. 95:5, wheat flour: dehydrated *Moringa* leaves incorporated *paratha* was best considering all sensory attributes. Under proximate analysis of control and Dehydrated *Moringa* leaves incorporated biscuits, obtained a significant difference in ash, crude protein, fibre, carbohydrate and mineral content except moisture and fat. Hence, incorporation *Moringa* leaves into *Paratha* can improve nutritional profile and reduce calorie value.

■ **KEY WORDS :** *Moringa oleifera* leaves, Dehydration, *Paratha*

■ **How to cite this paper :** Shinde, S.M., Babar, K.P. and Bornare, D.T. (2018). Studies on dehydration of *Moringa oleifera* leaves by using different method and its utilization in *Paratha*. *Internat. J. Agric. Engg.*,**11**(Sp. Issue): 197-206, **DOI: 10.15740/HAS/IJAE/11 Sp. Issue/197-206.**

Moringa oleifera is a common medicinal herb tree belonging to the family *Moringaceae*. It is also known by the different names in different region such as Mulangay, Benzolive, Drumstick tree, Sijna, Kelor, Saigihan and Marango.

The *Moringaceae* is a single genus family with 13 known species (Khawji *et al*., 2010). These species are originated in India and Aferica, are now grown around the world. Major production include Ghana, Senegal and Malawi, smaller production are in New Zealand and Fiji and more recent production in Nicarague and Bolivia (Singh *et al*., 2013; Kumar and Satheesh Kumar, 2014).

Moringa oleifera is a small native tree of the sub-Himalaya regions of North West India, which is now indegenious to many regions in Africa, Arabia, South America. Traditionally, besides being a daily used vegetable among people of these regions, the *Moringa oleifera* is also widely known and used for its name as the "miracle tree" because it is a multipurpose and exceptionally nutritious vegetable with a variety of potential uses. All parts of the tree are useful, especially due to pharmacological, nutritional, and also as an alley crop in the agro-forestry industry, livestock feed, vegetable dyes, foliar spray, cosmetics and oil production etc.

Fig. A : *Moringa oleifera* leaves

(Adeniyi, 2007).

As compared to other leafy vegetables *Moringa oleifera* leaves is most nutritious and it is available throughout the year. Even a common man can purchase and consume these leaves by cooking fresh leaves or in dry powdered form. *Moringa* leaves are rich source of proteins *i.e.* in the range from 29.1 to 35.3g/100g dry weight and it is used as herbal medicine (Olson *et al*., 2016).

Moringa oleifera is grown in any tropical and subtropical regions of the world with the temperature around 25-350 C. It requires sandy and loamy soil with a slightly acidic to slightly alkaline pHand a net rainfall of 250-3000mm (Adejumo and Abayomi, 2012). The direct seedling method is followed as it has high germination rates. Since *Moringa* seeds are excepted to germinate within 5-12 days after seedling and can be implanted at a depth of 2 cm in the soil. After it grows to about 30 cm, it can be transplanted. The tree can also be cultivated from cutting with 1 m length and 4-5cm in diameter, but these plants may not have a good deep system. Such plants tend to be sensitive to drought and winds. For commercial cultivation, spacing is important as it helps in the plant management harvest. *Moringa oleifera* differs in nutrient composition at different locations (Mustapha *et al*., 2012). The tree grown in India has slightly different nutritional components than a tree grown in Nigeria.

Moringa oleifera provides 7 times more vitamin-C than oranges, 10 times more vitamin-A than carrot, 17 times more calcium than milk, 9 times more protein than yoghurt, 15 times more potassium than banana and25 times more iron than spinach (Wankhede *et al*., 2013). The fact that *Moring*a is easy cultivable makes it sustainable remedy for malnutrition. It is also considered as "mothers best friend" because in phillipines these leaves are cooked and fed to babies (Price, 2000).

Moringa oleifera leaves can be successfully dried or powdered for making different types of meal and porridge diets mostly aiming pregnant expectants mother, nursing mothers, infants and young children, as well as adults of all age groups (Alakali *et al*., 2015), mostly due to their nutritional and medicinal properties. Usually the dried leaves can be stored for a long time and can be used regularly without refrigeration, and reported without loss of nutritional value (Fahey, 2005).

Micro-nutrients deficiencies are now recognized as a major contributer of most of the diseases spread throughout the world. According to WHO (2003), 19% of the 10.8 million child deaths globally a year are attributable to iodine, iron, vitamin A, and zinc deficiencies (Fuglie, 2001). Lots of recent studies have proved *Moringa oleifera* is an excellent source of beta carotene and other vitamins as well as minerals and amino acids that can combat the effect of malnutrition (Khawji *et al*., 2010; Moyo *et al*., 2011; Okiki *et al.,* 2015). *Moringa* leaves also contains a-linolenic acid (all cis-9.12, 15-octadecatrienoic acid) (Moyo *et al*., 2011 and Sanchez-Machado *et al.,* 2006), which can be converted for eicosapentaenoic acid (EPA) and docosa hexaenoic acid (DHA) within the human body (University of Maryland Medical Center 2016). *Moringa* is especially promising as a food source in the tropics because the tree is in full leaf at the end of the dry season when other foods are typically scarce (Mishra *et al*., 2012).

Moringa has lot of minerals that are essential for growth and development among which, calcium is considered as one of the important minerals for human growth. While 8 ounces of milk can provide 300-400mg, *Moringa* leaves can provide 1000mg and powder can provide 400mg. *Moringa* powder can be used as substitute for iron tablets, hence as a treatment of anemia while *Moringa* leaf powder has 28mg of iron. It has been reported that *Moringa* contains more iron than spinach (Doymaz and Ozdemir, 2013). A good dietary intake of zinc is essential for proper growth of sperm cells and is also necessary for synthesis of DNA and RNA *M. oleifera* leaves show around 25.5-31.03 mg of zinc/kg, which is the daily requirement of zinc in the diet, about 6 spoonful of leaf powder can meet a women's daily iron and calcium requirements, during pregnancy.

Drumstick leaves are also rich sources of flavonols such as kaempferoland 3'-OMe quarcetin, flavone, acacetin and a glycoflavone 4-OMe vitexin was also

identified. The phenolic acids identified included melilotic acid, p-coumaric acid, and vanillic acid (Nambiar *et al*., 2005). The one of most important component of *Moringa oleifera* leaves is used as inhibitor for the growth of cancer cell in human being.

Leaves rich in biologically active riboflain, niacin, pyrodixine, biotin, carotenoids, tocopherols and vitamin C have health-promoting potential in maintaining a balanced diet and preventing free-radical damage that can initiated many illnesses and also increase iron absorption in the animal body (Anwar *et al*., 2007; Broin, 2006). Vitamin A is necessary for many functions in the ruminants including vision, bone growth, immunity and maintenance of epithelial tissue. It can be also used for releasing the bound iron status and thus, help in reducing anemia as well as prevalence of vitamin A deficiency. Vitamin E is known to help maintain and increase the storage of vitamin A and iron in the body vitamin E with selenium contains antioxidant that work co-dependently in the body to help destroy free radicals (Rock *et al*., 2001; Smolin and Grosvernor, 2007). Succulent leaves are harvested daily for soups, sauces, or salads. Can ate fresh, cooked, or stored as dried powder for many months. Dried or fresh leaves used in foods such as soups and porridges (Lockett *et al*., 2000). Farmers have added the leaves to animal feed to maintain a healthy livestock (Sarwatt *et al*., 2002; Fahey, 2005 and Sancheza-Machado, 2006).

Newer applications includes the use of *Moringa* powder as a fish food in aqua cultural systems (Dongmeza *et al*., 2006) and the *Moringa* leaves as a protein supplement for animals, such as cows. The feeding value of *Moringa* reported to be similar to that of soyabean and rapeseed meal (Soliva *et al.,* 2005). Pregnant women and lactating mothers use the powdered leaves to enhance their child or children's nourishment. Especially, in underdeveloped countries mothers suffering from malnutrition (McBurney *et al*., 2004; Lockett *et al*., 2000 and Kasolo *et al*., 2011), stated that *Moringa oleifera* leaves were safe for human consumption because no serious side effects have been observed by the people using them.

Moringa oleifera have multipal beneficial biological effects that include antioxidant activity, anti- inflammatory action, inhibation of platelet aggregation, antimicrobial activities and antitumour activities (Thurber and Fahey, 2009). Calcium is observed to be higher compared with other plant sources (Nkafamiya *et al.,* 2010). It is required for formulation and maintenance of bones and teeth thus, preventing osteoporosis. It is also needed for normal blood clotting and nervous function. Interestingly, even Fe, which is commonly deficient in many plant based diets, was found in abundance in this plant's leaves. Iron is a necessary component of haemoglobin and myoglobin for oxygen transport and celluar of growth and division (Kozat, 2007). Iron is an essential trace element for normal functioning of the central nervous system and in the oxidation of carbohydrates, proteins and fats (Umar *et al*., 2007).

Leafy vegetables occupy an important position in the Indian diet. As per National Horticulture Board of India, during 2012-13 India produce 162.19 million metric tons of vegetables with cultivated area of 9.21 million hectares (Kumar and Satheesh Kumar *et al*., 2013). Besides post harvest reduction, improved processing and storage of processed products can play a significant role in availability of these products. Reduction in processing and storage costs can further increase their availability. Drying is most commonly used method for enhancing shelf life of leafy vegetables. The dried green leafy vegetables were mostly used in powder form, which reduced the volume required for storage and easy to handle.

During the drying process there is lot of losses take place like nutritional, physical and chemical composition of leaves. India is one of the largest producer of vegetables in the world. It is estimated that India processes less than 1% of production and about 30-35% production cannot be utilized due to lack of adequate technology for processing, handling, storage and processing infrastructure. To avoid the extensive losses drying is required. Therefore attempts have been made in present investigation to increase the shelf-life of vegetables by converting them into powders. The leaves are highly nutritious being a significant source of beta-carotene, proteins.

Their earlier studies reported the significance of drumstick leaves as a source of vitamin (Nambiar *et al*., 2003 a and b). These leaves could retain 50% of their beta carotene on shade dehydration and the dehydrated leaves could be easily rehydrated and incorporated into traditional Western India recipes without altering their acceptability characteristics.

Present dietary scenario necessitates exploring the

possibility of incorporating novel ingredient in commonly consumed foods rather than developing new food product (Kar *et al*., 2013). Hence in this study we have dehydrated *Moringa oleifera* leaves in the form of powder for the purpose of value addition of existing product *i.e. Paratha* to reduce wheat flour usage and people become more health conscious regarding their food etc. This research study also therefore studied the nutritional or proximate composition of *Moringa paratha* and evaluates its acceptability through sensory evaluation tests.

METHODOLOGY

Moringa oleifera leaves products especially leaves powder are becoming more popular because of its amazing nutritional value. However, limited studies have been investigated on the effects of processing and preservation on the nutritional, physio-chemical and sensory characteristics of these products. The present investigation entitled, "Studies on Dehydration of *Moringa oleifera* leaves by using different methods and its utilization in *Paratha*" was carried out in the Department of Agricultural Engineering, Maharashtra Institute of Technology, Aurangabad. This chapter deals with the experimental material and method adopted for conducting the investigation. The methodologies on preparation of *Moringa oleifera* powder and analysis of powder under the following headlines.

Material :

Raw Material :

Collection of *Moringa oleifera* leaves- The *Moringa* leaves are collected from the local area, Aurangabad. The freshly harvested leaves are washed with tap water to remove any pesticides or foreign matter on leaves and then they are sorted and kept for different drying process.

Methods :

Preparation of *Moringa oleifera* leaves for drying:

Sorting :

The fresh leaves are collected from the local area, Aurangabad. The stems and other unwanted parts are removed from the *Moringa* leaves during sorting.

Washing :

The leaves were washed with slightly warm water to remove dirt and pesticide residue during washing and excess water is drained. Before the actual drying process we have to take care that all water molecules present in leaves should be drained out. After draining all the water molecules the leaves are spread on the musline cloth in thin layered in tray for actual drying process. The three types of drying techniques are used in this study like sun drying, shade drying and tray drying process.

Methods for drying:

Shade drying :

In shade drying process 500 g of *Moring oleifera* leaves are air dried and spread on the filtered paper in well ventilated room for two weeks until constant weight is obtained. Natural current of air was used for shade drying of leaves.

Sun drying :

In sun drying process 500 g of *Moringa* leaves are weight accurately. In this method the fresh leaves are washed and air dried for few minutes then put on filter paper. Filter paper with tray placed at a place where adequate amount of sunlight until the constant weight is obtained. sun drying is carried out for 4-5 at a moisture content 6-8 %.

Tray drying :

In tray drying process, 500 g of fresh *Moringa* leaves are washed with the sufficient amount of lukewarm water till it was free from dirt and insects and then these leaves are spread in thin layered on tray and placed in cabinet tray dryer at different temperature like 400 C, 500 C, 600 C, 700 C, 800 C for different hours until the constant weight is obtained.

Ingredients for making *Moringa paratha :*

Whole wheat flour, *Moringa* leaf powder, salt and water and oil.

Chemicals :

Chemicals required for the analysis are hexane, sodium hydroxide, sulphuric acid, copper sulphate, nitric acid, ammonium sulphate, mercury oxide, etc. are procured from the Department of Agricultural Engineeing, MIT, Aurangabad.

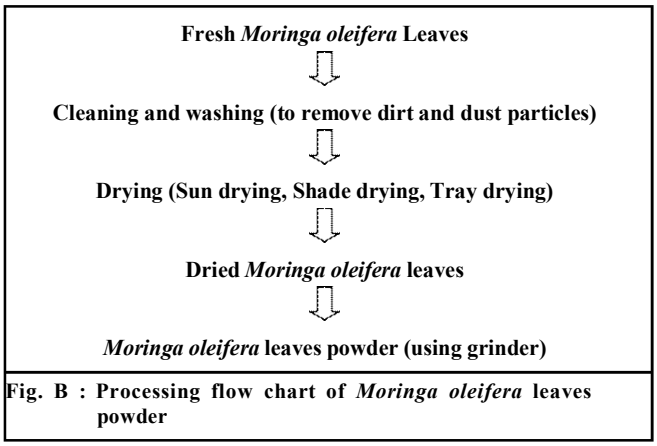

Fig. B : Processing flow chart of *Moringa oleifera* leaves powder

Table A : Addition of *Moringa oleifera* leaves powder

Treatments	*Moringa oleifera* leaves powder (%)
T_0	Control
T_1	5%
T_2	10%
T_3	15%
T_4	20%

Addition of *Moringa oleifera* leaves powder in *paratha* :

Development of paratha by addition Moringa oleifera leaves :

Four paratha samples were prepared by blending Dehydrated *Moringa* leaves with wheat flour at two different proportion according to two factor factorial experimental design as given below:

Sample T_1 = Paratha sample with 95:5 of wheat flour: *Moringa* leaves powder.

Sample T_2 = Paratha sample with 90:10 of wheat flour: *Moringa* leaves powder.

Sample T_3 = Paratha sample with 85:15 of wheat flour: *Moringa* leaves powder.

Sample T_4 = Paratha sample with 80:20 of wheat flour: *Moringa* leaves powder.

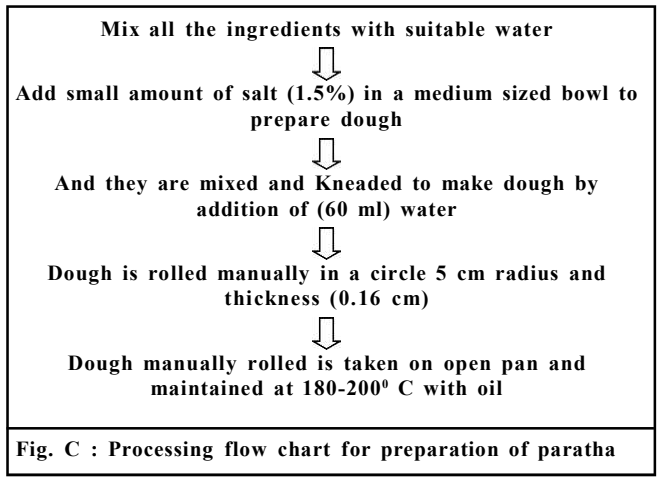

Fig. C : Processing flow chart for preparation of paratha

Sensory evaluation:

The sensory evaluation was performed by evaluating five major sensory attributes such as apperance, aroma, texture, taste, and overall acceptability by using nine point hedonic scale. A semi trained sensory panel with thirty members were used in this study.

Proximate analysis :

Proximate analysis were carried out for three types of dehydrated *Moringa* leaves samples and Two *paratha* samples as *Moringa* leaves incorporated paratha sample that was selected from the sensory analysis along with an ordinary *Paratha* sample of same recipe without adding *Moringa* leaves powder.

All the chemicals and equipment used for the analysis were obtained from the Department of Food Engineeing, University of Bambu, Aurangabad. Moisture content, protein, fat, fibre, and ash are determined by the method of AOAC (2005) while carbohydrate was determined by difference (Ihekoronye and Ngoddy,1985).

■ RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Drying curves :

Sun drying leads to considerable reduction of drying time by upto 50% and a significant improvement in product quality in terms of color, texture, flavor and nutrient retention. For the vegetables, the dehydration process affects to varying degrees, the quality attributes of color, texture and nutrient retention such variations in quality attributes may be due to vegetable type and maturity, type of pretreatment, thickness of the vegetable pieces and the drying method, quality characteristics were also affected by the moisture content and water activity, temperature, relative humidity and rate of rehydration (Esper, 1998).

The Fig. 1 was plotted between moisture content

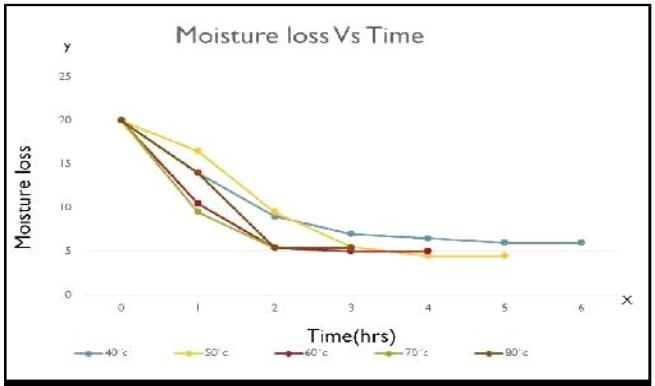

Fig. 1 : Moisture content of tray drying of temperature 40⁰ C, 50⁰ C, 60⁰ C, 70⁰ C, 80⁰ C of *Moringa* leaves

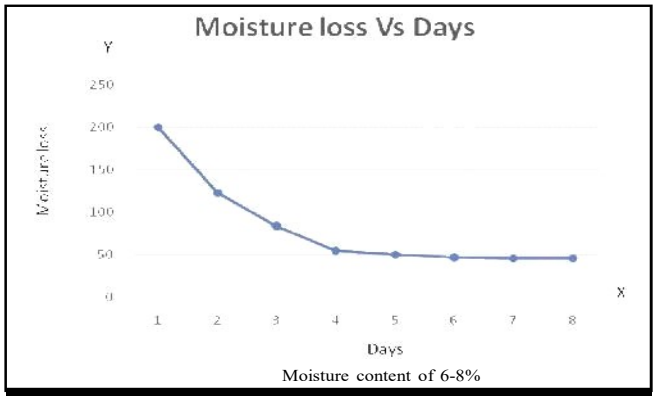

Fig. 2 : For sun drying sample plotted between moisture content Vs time

Table 1 : Proximate analysis of fresh *Moringa* leaves

Parameters (%)	Readings (%)
Moisture	76.10 ±0.2
Protein	6.73±0.1
Ash	1.6±0.01
Fat	1.7±0.1
Carbohydrate	13.8±0.01

* Each value represents the value of three dimension

Vs time. The time was in hour and the moisture content was in percentage.

Proximate analysis of *Moringa* leaves powder by using Tray drying per 100g :

This is the graphical presentation of tray drying method. Where, T_1- 40⁰ C , T_2 - 50⁰ C, T_3 - 60⁰ C, T_4 - 70⁰C, T_5 - 80⁰C.

Proximate analysis of *Moringa oleifera* leaves per 100g :

The moisture content in the three samples of the

Table 2: Proximate analysis of *Moringa* leaves powder by using tray drying

Parameters	T_1	T_2	T_3	T_4	T_5
Moisture (%)	5.5±0.1	5±1	4.5±0.1	4±1	3.5±0.1
Protein (%)	31.63±0.01	30.62±0.01	30.61±0.02	30.30±0.05	30.20±0.01
Ash (%)	4.6±0.1	4.83±0.01	4.85±0.01	4.87±0.01	3.2±0.02
Fat (%)	3.60±0.1	3.45±0.01	3.35±0.05	3.30±0.05	3.25±0.02
Fibre (%)	13±1	12.5±0.1	12±1	11.5±0.1	11±1
Carbohydrate (%)	41.67±0.01	43.6±0.1	44.69±0.01	45.8±0.1	47.21±0.01

* Each value represents the value of three dimension

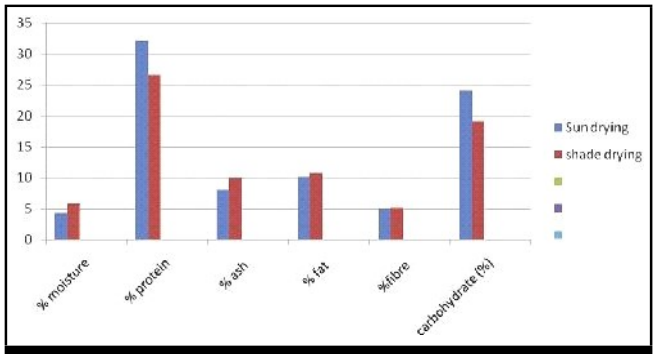

Fig. 3 : Nutritional parameter of *Moringa* leaves powder by using tray drying method

dehydrated leaves was in the of 5.89 - 3.5%. Maximum moisture was in the shade dried sample 5.89 and minimum was in the cabinet tray dried sample 3.5%. This result was consistent with the findings of (Greve *et al.*, 1994 and Waldron *et al.*, 2003). The carbohydrate content in the dehydrated powder of cabinet tray dried sample was maximum (47.21 %). The protein content in the three sample of the dehydrated leaves was in the range of 32.14-26.57 per 100g.maximum moisture content was in the tray dried sample. The fresh *Moringa oleifera* leaves contain 6.73% protein. The difference in protein

Table 3 : The proximate analysis of sun dried and shade dried sample

Parameters (%)	Sun drying	Shade drying
Moisture	4.25 ± 0.05	5.89 ±0.005
Protein	32.14 ± 0.005	26.57 ± 0.01
Ash	8.05 ± 0.01	9.90 ± 0.05
Fibre	10.15 ± 0.01	10.75 ± 0.02
Fat	5.02 ± 0.01	5.18 ± 0.1
Carbohydrates	24.09 ± 0.01	19.07 ± 0.01

*Each value represents the value of three dimension

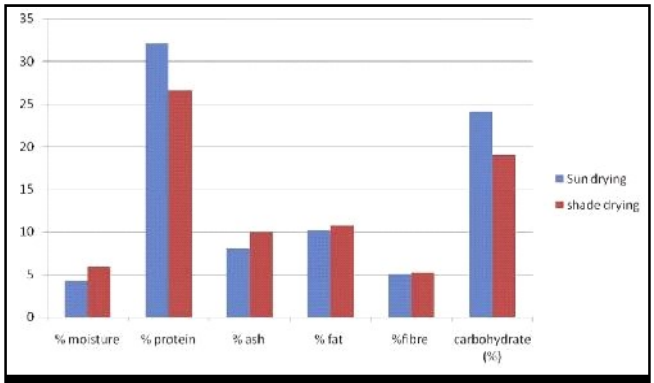

Fig. 4 : Graphical presentation of sun dried and shade dried sample

content of the three sample of the leaves to the fresh leaves was statistically significant. The fat content of three dried sample was in the range of 5.18-3.25 %. The fat content was highest (5.18%) in the shade dried sample and lowest in tray dried sample of temperature 800 C is 3.25 %. Dehydrated leaves have highest amount of fat content as compared to the fresh leaves (Lakshmi and Vimla, 2000) from Table 4 and 5.

The fibre content of tray dried sample was highest yield (13 g) as compared to sun dried and shade dried sample. the leaf sample was a rich source of fibre. The content of fibre found in processed *Moringa* leaves was indicative that they were substantial and will provide bulk for peristaltic action, which will enhance movement of food through the alimentary canal with the potential to prevent colon cancer (Bemiller and Whistler, 1999).

The result showed that ash content in the shade dried leaves was significantly higher than the leaves dried in sun and tray dried leaves. Ash content of dehydrated leaves was in the range of 9.90 - 4.85g.

Nutritional composition of *Moringa paratha* :

Values are the means of triplicate determinations on fresh weight basis; means within rows with different superscripts differ significantly.

Results of proximate composition of *paratha* produced from *Moringa* and wheat flour are given in the Table 4. There were significant differences in the proximate composition of the various blends of *Moringa paratha* in this study when compared to the control. An increase of protein content was observed with increase in the level of *Moringa* addition. This is expected as *Moringa* is noted for its high quality and quantaty of protein. Cereal grains are limiting in two essential amino acids, lysine and tryptophan. Wheat is not an exception in this; therefore addition of *Moringa* will be good and complement therefore producing a better nutritional quality *Paratha.* This agrees with previous reports on *Moringa* and paratha (Olushola, 2006). The higher fibre and ash contents of the Moringa paratha are a justification of the nutritional importance of *Moringa oleifera*. The utilization of fibre rich plant food is to help in the traffic movement through the intestinal tract (laxative) and in the lowering of cholestrol in blood (American Academy of Pediatrics, 2012) thus help in the control of some prevalent chronic diseases. Also an increase in the intake of dietary fibre supplies greater amounts of Vitamins and minerals (American Academy of Pediatrics, 2012). The high ash contents observed are and indication that *Moringa* is rich in minerals. *Moringa oleifera* has about 25 times more iron than spinach alone and it enhances recall during tests and exams (Castlerock Farms LLC, 2012). The results of this study also show Significant

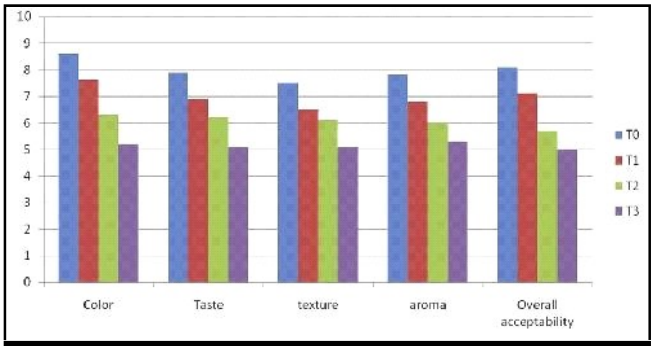

Fig. 5 : Graphical presentation on sensory evaluation of *Moringa paratha*

Table 4 : Nutritional composition of *Moringa paratha*

Sample	Moisture content (%)	Protein (%)	Fat (%)	Fibre (%)	Ash (%)	Carbohydrate (%)
T_0 (0%)	31.59±0.01	31.21±0.049	9.1±0.1	11.95±0.01	1.50±0.01	16.85±0.01
T_1 (5 %)	25.46±0.01	32.95±0.01	9.44±0.01	12.0±0.1	3.50±0.01	16.45±0.01
T_2 (10%)	25.55±0.025	33.1±0.1	9.43±0.01	12.1±0.1	4.70±0.01	15.12±0.01
T_3 (15%)	24.55±0.01	33.2±0.1	9.42±0.01	12.2±0.1	5.75±0.01	15.08±0.01

*Each value represents the value of three dimension

Table 5 : Sensory evaluation of *Moringa paratha*

Samples	Colour	Taste	Texture	Aroma	Overall acceptability
(0%)	8.6±0.1	7.9±0.43	7.5±0.1	7.8±0.1	8.1±0.1
T_1 (5%)	7.6±0.1	6.9±0.43	6.5±0.05	6.8±0.1	7.1±0.1
T_2 (10%)	6.3±0.20	6.2±0.20	6.1±0.1	6.0±0.1	5.7±0.02
T_3 (15%)	5.2±0.1	5.1±0.1	5.1±0.1	5.3±0.05	5.0±0.1

*Each value represents the value of three dimension

decline in carbohydrate and fat contents. Foods of low fat are likely to keep longer as they are less prone to rancidity (Balogun and Oyeyiola, 2011).

Sensory evaluation of *Moringa paratha :*

The *Moringa paratha* from different levels of *Moringa* leaves *paratha* and control sample were subjected to sensory evaluation for color, taste, texture, aroma and overall acceptability. The results of sensory evaluation (Table 5) indicated that all the *paratha* samples were generally acceptable and the values were compared with *paratha* from the fine wheat flour (control sample). The result showed that T1 (5% *Moringa* leaves powder substitution) improved the color, taste, texture, crispiness and overall acceptability of *Moringa paratha* by 9 point Hedonic scale. While T2 and T3 (with 10% and 15% level of *Moringa* powder, respectively). The *Moringa paratha* from (5%) *Moringa* addition was most preferred.

Conclusion :

Moringa oleifera leaves are mostly nutritious and in the present research study, the *Moringa* leaves are dried by using three different drying methods. The *Moringa oleifera* leaves powder not only increases the micronutrients but also increases the shelf life of powder. A good quality and nutritious *paratha* is produced from the wheat and *Moringa* blend. However, at a higher level of *Moringa* addition, the green leafy green taste colour were highly evident and were not highly rated by the panalist through they had higher protein, ash and fibre.

At 5% *Moringa* addition, an excellent *paratha* was obtained which was acceptable.

Authors' affiliations:
K.P. Babar and D.T. Bornare, Department of Agricultural Engineering, Maharashtra Insitute of Technology, **Auranganad (M.S.) India**

REFERENCES

Adejumo, B.A. and Abayomi, D.A. (2012). Effect of moisture on some physical properties of *Moringa oleifera* seed. *J. Agric. & Vet. Sci.*, **1**:12-21.

Adeniyi, S. (2007). Nigeria Tribune *moringa*: "Miracle plant" with healing powers, **3**:1-3.

Alakali, J.S., Kucha, C.T. and Rabiu, I.A. (2015). Effect of drying temperature on the nutritional quality of *Moringa oleifera* leaves. *African J. Food Sci.,* **9**(7) : 395-399.

American Academy of Pediatrics (2012). Statement of endorsement. Dietary reference intakes for calcium and vitamin D. *Pediatrics*. **130**(5). Available at: www.pediatrics.org/cgi/content/full/130/5/e1424

Anwar, F., Sajid, L., Muhammad, A. and Anwarul, H.G. (2007). *Moringa oleifera*: A food plant with multiple Medicinal uses. *Phytother. Res.*, **21**:17-2.

Association of Official Analytical Chemists (AOAC). "Official Methods of Analysis," 17th Edition, Association of Official Analytical Chemists, Arlington, 2005.

Broin, M. (2006). The nutrient value of *Moringa oleifera* Lam. Leaves: what can we learn from Figure*? Moringa* news work..pdf. accessed 18/05/2010.

BeMiller, J.N. and Whistler, R.L. (1999). Carbohydrates. In: Fennem Balogun MA and Oyeyiola GP(2011). Microbiological and Chemical changes During the Production of Okepehe from Prosopis africaca Seeds. *J. Asian Scientific Res.*, **1**(8):390-398.

Castler Farms, L.L.C. (2012). Moringa RXBenefits. Retrieved on 02/09/2012.

Dongmeza, E., Siddhuraju, P., Francis, G. and Becker, K. (2006). Effect of Dehydrated methanol extracted *Moringa* (*Moringa oleifera* Lam.) leaves and three of its fractions on growth Performance and feed nutrient assimilation in Nile tilapia (*Oreochromisniloticus* (L)). *Aquaculture*, **261**(1):407-422.

Doymaz, I. and Ozdemir, O. (2013). Effect of air temperature, slice thickness and pre-treatment on drying and rehydration of tomato. *Internat. J. Food Sci. & Technol.*, **49**(2): 558-564.

Esper, A. and Muhlbauer, W. (1998). Solar drying-an effective means of food preservation. *Renew Energ,* **15**: 95-100.

Fahey, J.W.(2005). *M. oleifera:* A Review of the Medical Evidence for its Nutritional, Therapeutic and Prophylitic properties Part-1 .*Trees for Life J.*, **1** : 5.

Fuglie, L.G. (ed.) (2001). The Miracle Tree. The Multiple Attributes of *Moringa.* CTA, Wageningen, The Netherlands.

Fuglie, L.J. (2005). *The Moringa Tree*: A local Solution to malnutrition church world service in Senegal.

Greve, L.C., Shackel, K.A., Ahmadi, H., McArdle, R.N. and Gohlke, J.R. (1994). Impact of heating on carrot firmness: Contribution of cellular turgor. *J. Agric. Food Chem.*, **42** : 2896-2899.

Ihekoronye, A.I. and Ngoddy, P.O. (1985). Integrated Food Science and Technology for the Tropics. Macmillan Publisher LTD, London.

Kar, S., Mukherjee, A., Ghosh, M. and Bhattacharyya, D.K. (2013). Utilization of *Moringa* Leaves as valuable food ingredient in piscuit preparation. *Internat. J. Appl. Sci. & Engg.*, **1**(1):29-37.

Kasolo, J.N., Bimenya, G.S., Okwi, A.L., Othieno, E.M. and Ogwal-Okeng, J.W. (2011). Acut toxicity evaluation of *Moringa oleifera* leaves extracts of ethanol and water in mice. *Aferican J. Animal & Biomedical Sci.,* **6**(1): 40-44.

Khawji, T.M., Tahira, M. and Ikram U.H. (2010). *Moringa oleifera*: A natural gift-A review. *J. Pharmic. Sci. & Res.,***2** : 775-8.

Kozat, S. (2007). Serum T3 and T4 concetrations in lambs with nutritional myodegeneration. *J. Vet. Intern. Med.*, **21**: 1135-1137.

Kumar, A.C.K. and Satheesh Kumar, D.(2013). A review on south Indian edible leafy vegetables. *J. Global Trends Pharmaceu. Sci.*, **4**(4):1248-1256.

Lakshmi, B. and Vimala, V. (2000). Nutritive value of dehydrated green leafy vegetable powders. *J. Food Sci. & Technol.*, **37**:465-471.

Lockett, C.T., Calvert, C.C. and Grivetti, L.E. (2000). Energy and micronutrient composition of Dietary and medicinal wild plants consumed during drought. Study of rural Fulani Northeastern Nigeria. *Internat. J. Food Sci. & Nature,* **51**:195-208.

McBurney, R.P.H., Griffin, C., Paul, A.A. and Greenberg,

D.C. (2004). The nutritional composition of African wild Food plants from compilation to utilization. *J. Food Composition & Analysis*, **17**:277-289.

Mishra, S.P., Singh, P. and Singh, S. (2012). Processing of *Moringa oleifera* leaves for human consumption. *Bull. Environ., Pharmacol. & Life Sci.*, **2** (1) : 28- 31.

Moyo, B., Masika, P.J., Hugo, A. and Muchenje, V. (2011).

Nutritional characterization of *Moringa (Moringa oleifera*

Lam.) leaves. *Aferican J. Biotechnol.,* **10**(60) : 12925-1293.

Nambiar, V.S., Bhadalkar, K. and Daxini, M. (2003a).

Drumstick leaves as a source of vitamin A in ICDS-SFP. *Indian*

J. Pediatrics, **70** : 383-387.

Nambiar, V.S., Daxini, M. and Bhadalkar, K. (2003b). Nutritional and sensory evaluation of shade dried Beta-carotene rich drumstick leaf *(Moringa oleifera*) recipes. *Indian Food Packer,* **57**:156-161.

Nambiar, V.S., Mehta, R. and Daniel, M. (2005). Polyphenol content of Three Indian green leafy vegetable. *J. Food Sci. & Technol.,* **42**:312-315.

Nkafamiya 11, Osemeahon, S.A., Modibbo, U.U. and Aminu,

A. (2010). Nutritional status of non-con Ventiona leafy vegetables, Ficusasperifolia and Ficussycomorus. *Aferican J. Food Sci.*, **4**(3):104-108.

Okiki, P.A., Osibote, I.A., Balogun, O., Oyinloye, B.E., Idris, O., Olufunke, A., Asoso, S.O. and Olagbemide, P.T. (2015). Evaluation of proximate, mineral, vitamins and phyto Chemical composition of *Moringaoleifera Lam*. Cultivated in Ado Ekiti, *Nigeria Adv. Biological Res.,* **9**(6): 436-443.

Olushola, A.T.E.(2006). The Miracle Tree,Moringa oleifera (Drumstick). In Achieve Vibrant Health with Nature, Keep Hope Alive Series1, Unijos Consultancy Limited Press, jos, Nigeria.1:120-136.

Olson, M.E., Sankaran, R.P., Fahey, J.W., Grusak, M.A., Odee, D. and Nouman, W. (2016). Leaf Protein and Minerals Concentrations across the "Miracle Tree" Genus.*PloS one*, **11**(7):0159782.

Price, L.L. (2000). The *Moringa* Tree.www.echonet.org. Acessed on 12/08/2012.

Paliwal, R., Sharma, V. and Pracheta, Sadhna S. (2011). Elucidation of free radical scavenging and Antioxidant activity of aqueous and hydroethanolic extract of *Moringa oleifera* pods. *Res. J. Pharmacy Technol.*, **4**:566-571.

Rock, M.J., Kincaid, R.L. and Carstens, G.E. (2001). Effect of prenatal source and level of dietary Selenium on passive immunity and thermometabolism of newborn lambs. *Small Small Ruminant Res*., **40**:129-138.

Soliva, C.R., Kreuzer, M., Foidl, N., Foidl, G., Machmuller, A. and Hess, H.D (2005). Feeding value of whole and extracted moringaoleifera leaves for ruminants their effect on ruminal Fermentation in vitro. *Anim. Feed Sci. Technol*., **118**:47-62.

Sanchez-Machado, D. I., Lopez-Cervantes.J. Rios Vasquez,

N.J. (2006). High performance liquid chromatography method to measure alpha and gamatocopherol in leaves, flowers and fresh beans from *M. Oleifera*. *J. Chromatography*. A, 1105, **1**(2):111-114.

Sarwatt, S.V., Kapange, S.S. and Kakengi, A.M.V. (2002). Substituting sunflower seed-cake with *Moringa oleifera* leaves as a supplemental goat feed in Tanzania agroforestry system, **56**(3):241-247.

Smolin, L.A. and Grosvenor, M.B. (2007). Nutrition: Science &Application.

Singh, R.S.G., Negi, P.S. and Radha, C. (2013). Phenolic composition, antioxident and antimicrobial activities of free and bound phenolic extracts of *Moringaoleifera* seed flour. *Journal of Functional Foods*.

Mustapha H.B., Jonan, C.A. and Suleyman, A.M. (2012). Kinetics of water disinfection with *Moringa* seed extract. *J. Enironmental & Earth Science.*

Thurber, M.D. and Fahey, J.W. (2009). Adoption of *Moringa oleifera* to combat under-Nutrition Viewed Through the Lens of the "Diffusion of Innovations.*Theory. Ecol Food Nutr*., **48** (3) : 212-225.

Umar, K.J., Hassan, L.G., Dangoggo, I.M. and Almustapha,

M.N. (2007). Nutritional content of *Melochia corchoolia* (Linn) leaves. *Internat. J. Biological Chem*., **1**:250-225.

University of Maryland Medical Center (2016). Alpha-linolenic acid [Online] Available at : http://umm.edu/health/medical/altmed/supplement/phalinolenic-acid [Accessed 11 November, 2016].

Waldron, K.W., Parker, M.L. and Smith, A.C. (2003). Plant cell wall and Food quality Comprehensive Reviews in Food Science and Food safety.

WHO (2003). Manual for the Laboratory identification and antimicrobial susceptibility testing of bacterial pathogens of public health importance in the developing world. pp. 103-162.