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Effect of various drying methods on the quality of moringa leaf powder (*Moringa oliefera* Lam.)

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ABSTRACT : The present study effect of various drying methods on the quality of moringa leaf powder (*Moringa oleifera* Lam.) was carried out during (Feb.–Dec.) 2016-17 in the post harvest technology lab. Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar. The experiment was laid out in Completely Randomized Block Design with four treatments and five replications. The moringa leaves were dried into powder under four different drying methods *viz.*, T_1 (outdoor drying), T_2 (indoor drying), T_3 (oven drying) and T_4 (microwave drying). Among the different treatments T_3 (oven drying) recorded high powder yield and also recorded highest value for iron and zinc content. The treatment T_2 (indoor drying) recorded high powder yield, besides the same treatment also recorded highest value for beta-carotene and ascorbic acid.

KEY WORDS : Powder, Leaf quality, Vitamins, Minerals, Indoor drying, Outdoor drying

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The leaves are the most nutritious part of the moringa plant, being a significant source of B vitamins, vitamin C, provitamin A as beta-carotene, vitamin K, manganese, and protein, among other essential nutrients (Rajkumar *et al.*, 1973). Moringa trees have been used to combat malnutrition especially among infants and nursing mothers. Since moringa thrives in arid and semiarid environments, it may provide a versatile, nutritious food source throughout the year. One rounded tablespoon (8g) of leaf powder will satisfy about 14 per cent of the protein, 40 per cent of the calcium and 23 per cent of the iron and nearly all the vitamin A needs for a child aged 1-3. Six rounded tablespoonful of leaf powder will satisfy nearly all of a women's daily iron and calcium needs during pregnancy and breast feeding. Moringa leaves have been proposed as an iron-rich food source to combat iron deficiency. Some of the calcium in moringa leaves is bound as crystals of calcium oxalate though at levels 1/25th to 1/45th of that found in spinach, which is a negligible amount. Moringa, an indigenous plant, is now valued for providing the fruits for vegetable with nutraceutical traits. Leaf, flower, bark, root and even wood are also used. Thus, is considered as one of the world's wonder crop, packed with nutrients in all its plant parts (Babu, 2000). Traditionally, moringa was used by people to prevent and protect various physiological disorders, since it contains 7 times more vitamin-C than orange, 4 times more calcium than milk, 4 times more vitamin A than carrot, 2 times more protein than milk and 3 times more potassium than banana, besides, its richness in iron. Leaves in dried and powdered forms are more nutritious then fresh leaves (Fahey, 2005). Drying is a simple process of moisture removal from a product in order to reach the desired moisture content and is an energy intensive operation. The prime objective of drying apart from extended storage life can also be quality enhancement, ease of handling, further processing and sanitation and is probably the oldest method of food preservation practiced by humankind (Mujumdar, 2007).

RESEARCH METHODS

The present investigation on the effect of various drying methods of moringa leaves on the quality of Moringa leaf powder (*Moringa oleifera* Lam.) was carried out at the postharvest lab, Department of Horticulture, Faculty of Agriculture, Annamalai University during 2015 -16. The treatments consisted of T_1 (outdoor drying), T_2 (Indoor drying), T_3 (oven drying) and T_4 (Micro-wave drying). In outdoor drying, the sample (400g) was spread on a newspaper and dried in open sun light for 6 days. The peak temperature during drying was 35°C. In indoor drying, the sample (400g) was spread on a newspaper and dried in shade for 9 days. The peak temperature during drying was 28°C. In oven drying, the sample (400g) was dried in a hot air oven at 60°C for 6 hours. In micro-wave drying, 100 g of fresh leaves were kept in a ceramic container and dried in microwave oven at 700 watt for 11.5 minutes.

The dried material from each drying method was powdered in a mixie and then sieved through 0.2 mm sieve. The dry powder yield was calculated in percentage as detailed below:

$$\text{Dry power yield} = \frac{\text{Powder weight}}{\text{Dry weight}} \text{x100}$$

β-carotene was estimated following approved methods as described below. Eight gram powder was taken in 150ml glass stopped Erlenmeyer flask and 40ml water saturated butanol (WSB) was added. The contents of the flask was vigorously mixed for 1 minute and kept overnight (16-18) hours at room temperature under dark for complete extraction of β-carotene. Next day contents were shaken again and filtered completely through whatman no.1 filter paper into 100ml volumetric flask. The optical density of clear filtrate was measured at 440 nm using HITACHI U-3210 spectrophotometer. Pure WSB was used as blank. The β-carotene content was calculated from calibration curve from known amount of β-carotene and expressed as parts per million (ppm). Standard solution of β-carotene (sigma) was prepared in water standard butanol (WSB) at the concentration of 5μg/ml.WSB was prepared by mixing n-butanol with distilled water in 8:2 ratio. Calibration curve is made from known amount of β-carotene from 0.25μg/ml which are prepared after suitable dilutions of original stocks with WSB in calibrated 10 ml volumetric flask (0.5ml to 3ml of standard solutions in10 ml). Absorbance of each dilution was measured and a calibration curve is established, β-carotene content of unknown samples was calculated from standard curve and expressed in mg/ 100g.

The ascorbic acid content of leaves was estimated by using the A.O.A.C. (1990) method and expressed in mg/100g of leaf sample. Mineral composition was determined by acid digestion. Ash obtained after incineration at 600°C were dissolved in 5ml of 5M HCL solution and transferred into a 50ml volumetric flask. The resulting solution was made upto the mark with distilled water.The mineral contents (zinc and iron) were then measured using the atomic absorption apectrophotometer (AAS) and expressed in mg 100 g^{-1} (A.O.A.C, 1990). The statistical analysis of data was done by adopting the standard statistical procedures given by Panse and Sukhatme (1985). The critical difference was worked out for 5 per cent level of significance. The IRRISTAT software was used for the statistical analysis of data.

RESEARCH FINDINGS AND DISCUSSION

In the Table 1, among the four different methods of drying, the highest dry powder yield (100%) was observed in oven and microwave drying (T_3 and T_4).

The data on the effect of drying methods on β-

Table 1: Effect of various drying methods on dry powder yield in moringa cv. PKM-1

Treatment details	Powder yield (%)	β carotene (mg 100g^{-1})	Ascorbic acid (mg 100g^{-1})	Iron (mg 100g^{-1})	Zinc (mg 100g^{-1})
T_1 - Outdoor drying	98.54	8.65	120.35	10.56	5.85
T_2 - Indoor drying	84.54	13.76	137.04	12.80	6.92
T_3 - Oven drying	100.00	11.03	130.20	17.75	10.27
T_4 - Micro-wave drying	100.00	9.67	126.07	15.31	8.64
Grand mean	95.77	10.77	128.41	14.10	7.92
S.E.±	0.21	0.29	0.59	0.13	0.19
C.D. (P=0.05)	0.42	0.58	1.18	0.26	0.39

carotene are presented in Table 1. Regarding the β-carotene content, T_2 (indoor drying) excelled all other treatments (13.76 mg/100g). It was followed by T_3 (oven drying) 11.03 mg/100g. The highest ascorbic acid content was recorded by the treatment T_2 (indoor drying) 137.04 mg/100g. This was followed by T_3 ovendrying (130.20 mg/100g). Regarding the iron and zinc content of moringa leaf powder, the treatment T_3 (oven drying) recorded higher value of 17.75 mg/100g of iron and 10.27 mg/100g of zinc.

Food quality is a totality of features and characteristics of a product that bear on its ability to satisfy stated or implied needs for drying, the added heat and exposure times at elevated temperatures affect a number of quality degradations of the food products (Jimoh *et al.*, 2008). The quality of the dried foods is greatly influenced by the drying operation and is judged by the amount of physical, chemical and biochemical changes occurring during the drying process (Jokic *et al.*, 2009). In present investigation result shows that drying reduced moisture content markedly with microwave dried samples having the lowest moisture content of (7.54%). This was followed by oven drying. Shade dried leaves had a moisture content of 18.70 per cent. This observation could be as a consequence of the high and constant temperature in the microwave dryer (60^0C) than that of the shade (peak temperature-28^0C).

In the present investigation it was found that moringa leaves have very high levels of β-carotene with values ranging from 8.65 mg $100g^{-1}$ to 13.76 mg $100g^{-1}$. β-carotene content was significantly different among the four drying methods, which suggested that the drying methods used had significant effect on β-carotene. It was particularly higher in indoor dried leaves with 13.76 mg $100g^{-1}$. Outdoor dried leaves had the lowest β-carotene (8.65 mg $100g^{-1}$). The β-carotene is light sensitive and thus, significant losses can occur if leaves are exposed to sunlight during the drying process. The results are in agreement with the finding of Simpson *et al.* (1988) in mint and coriander.

Among the different treatments, indoor dried leaves had higher ascorbic acid (137.04 mg $100g^{-1}$) than those of microwave, oven and outdoor dried samples. All drying methods significantly cause loss of vitamin C (Kiremire *et al*., 2010) and this could be attributed to the fact that vitamin C is highly prone to oxidative destruction in the presence of heat, light, oxygen, enzymes, moisture and metal ions (Russell and Macdowell, 1989). Thus, outdoor drying causes marked losses in vitamin A and C due to exposure of the drying materials to greater solar radiations particularly ultra violet [UV] rays, which catalyses and carotene oxidation leading to loss of vitamin activity as reported by Ndawula (2002); Tannenbaum *et al*. (1985) and Russell and Macdowell (1989).

In the present investigation, oven dried leaves recorded highest iron content than outdoor, indoor and microwave dried leaves.Oven dried leaves had the highest iron content of 17.75 mg $100g^{-1}$. Vegetables dried in oven exhibited the highest value of iron and superior retention of minerals and vitamins (Bhosale and Arya, 2010) in fenugreek also corroborated the results of the present study. Similarly the oven dried leaves recorded highest zinc content of 10.27 mg per 100g compared to outdoor drying 5.85 mg per 100g, indoor drying 6.92 mg per 100g and micro-wave drying 8.64 mg per 100g. The results are in confirmity with the reports of (Mepba *et al.*,2007).

Based on the results of the present investigation, among the various drying methods, oven drying recorded better retension of zinc and iron whereas indoor drying (shade drying) was found to be superior for the retension of vitamin A and C.

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