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Moringa Oleifera Leaf as Functional Food Powder: Characterization and Uses

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Abstract

Moringa oleifera commonly known as drumstick, horse radish, shobhanjana, murungai, soanjna, shajna, sainjna is often referred as “mother’s best friend” is a plant found wide applications in food and allied fields due to rich source of diverse range of nutrients and bioactive materials. Moringa is considered as one of the world’s most useful plant per available literature and thus all the plant parts is widely used in curing various ailments like antibiotic, anti-hypertensive, anti-spasmodic, antiulcer, anti-inflammatory, anti-asthmatic, hypocholesterolemic and hypoglycemic. Moreover, leaves of this plant being rich in protein may serve in combating the protein energy malnutrition for the undernourished population of world. Our studies have confirmed some useful importance of Moringa in context of its nutritional as well as its medicinal properties. Addition of small amount of leaf powder was not reflected any significant and disagreeable effects on the taste of a foods but improved the nutritional aspects on its incorporation. Reduction in water activity by decreasing the moisture content through the process of dehydration is followed in order to improve the shelf life and availability of this underutilized plant. Efforts are in way to develop the process and products to make available in the form of more acceptable and at the reach to the consumer at least to the under developed and developing countries for the inherent cited purposes. Under present investigation, we are representing the successful trials provided to the fresh leaves. The characteristics of the blanched leaves have been compared with the product of untreated samples in isothermal dehydration conditions (50 - 80°C, with an equal temperature interval of 10°C). This developed shelf-stable leaf powders were characterized and possible uses on the basis of nutritional aspects in various foods like soup, sauces and other culinary have been cited.

Keywords: Moringa; drumstick; dehydration; powder; characterization.

1. Introduction

Moringa oleifera is a perennial tree, still considered as among underutilized plant and falls under *Moringa*ceae family. The plant is also known as drumstick, sahjan or sohanjana in India. All plant parts are having remarkable range of some functional and nutraceutical properties (Singh et al, 2012) make this plant a diverse biomaterials for food and allied uses. The leaves, flowers and fruits of this plant are used in the preparation of several delicacies in Indian sub continent. Associated with high nutritional value of its edible portions pave a way in making this plant more popular as an important food source in order to combat protein energy malnutrition problem prevailed in most of the under developed and developing countries of the world. Presence of various types of antioxidant compounds make this plant leaves a valuable source of natural antioxidants (Anwar *et al.,* 2007) and a good source of nutraceuticals and functional components as well (Makkar and Becker, 1996).

The effect of environmental variables on quality and storability after harvesting are of more concern to food products especially of high concern with reference to leafy vegetables due to more area to thickness ratio. This leads to quality deterioration in very short duration of storage. This concept has been utilized under present investigation to get accelerated process of moisture reduction during the dehydration process in order to reduce the water activities with ceasing the enzymatic activity. The quality of dehydrated vegetables is affected by responsible physico-chemical constitutes, environmental conditions and pre processing methods applied (Singh et al, 2013). Thus, it is important to determine the properties of different biomaterials for the design and develop the food processing equipment (Sahin and Sumnu, 2006). Considering these aspects, the objective of this investigation was critically planned to assess the characteristics of *Moringa oleifera* leaf powder in order to further use as functional food ingredient in the food and pharmaceutical products of concern also basically to enhance this important less explored readily available in certain parts of the country in a shelf stable easily usable form to the masses for the purpose.

2. Materials and Methods

2.1 Sample Preparation

Fresh *Moringa oleifera* leaves were harvested during early morning from the available plant present in the residential area of Sant Longowal Institute of Engineering and Technology, Longowal, Punjab, India. The harvested leaves were thoroughly washed in running tap water twice to remove the presence of dirt or surface impurities if any.

The average initial moisture content of the harvested leaves was found to be 79.28 ± 0.83% (wwb) as determined using hot air oven method (AOAC, 2000). Steam blanching as pretreatment was given to the *moringa* leaves for 2 minutes in a developed steam blancher consisted of two chambers, one as steam generation chamber and other as steam generation cum blanching chamber. The combined pressure vessels with control units served effective process of blanching and given the name for this blancher as Precision steam blancher. Similarly, the developed precision dehydration chamber with developed precision control unit was used to study the effect of isothermal dehydration temperatures 50, 60, 70 and 80°C with an average temperature fluctuation of ±1°C on product characteristics. The leaf sample, approximately 100g, was uniformly spread in a square flat perforated non corrosive metal basket in a single layer on attaining the desired drying temperature condition. The dehydrated leaves obtained after the completion of previous process, the product was removed from the dryer and cooled in a controlled environmental chamber and further kept in air tight opaque glass jars and stored at 4±2°C for further use. The dehydrated leaves were crushed to powder using dry mixer grinder. Subsequently, the dehydration characteristics for dehydration ratio, rehydration ratio and coefficient of rehydration were assessed (Ranganna, 1997).

2.2 Characterization

The particle size analysis of separated fractions, over and under size particles of 150 BSS sieve of *Moringa* leaf powder were determined through the developed image analysis technique (Prasad et al, 2012). The procedure for the determination of other physical properties, the gravimetric properties (Bulk density, BD; True density, TD), the frictional properties (Angle of repose, AOR; Coefficient of friction on glass surface, COFG; Coefficient of friction on galvanized iron surface, COFGI; Coefficient of friction on plywood surface, COFP) and optical properties (L; a; b and colour difference, ΔE) was adopted as described elsewhere (Singh and Prasad, 2013). The chemical analysis as moisture content, crude protein, crude fiber, crude fat, carbohydrate and ash was carried out by standard method (Ranganna, 1997). The total antioxidant capacity (TAC) and hydroxyl ion scavenging (HIS) of *Moringa* leaf powder was evaluated by measuring 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity. Total phenol content (TPC) was determined spectrophotometrically at 750 nm by adding Folin-Ciocalteu reagent to the extract and expressing the results in gallic acid equivalents. The Water absorption index (WAI) was evaluated as the weight of sample obtained after removal of the supernatant per unit weight of original dry solids. The Water solubility index (WSI) was determined as the weight of dry solids in the supernatant expressed as a percentage of the original weight of sample.

The statistical analysis for the data of obtained in triplicate were evaluated with mean separation to determine any statistically significant effects prevailed among them (Singh and Prasad, 2013).

3. Results and Discussion

The effect of blanching and dehydration temperature on the drying characteristics of *Moringa oleifera* leaves are shown in Table 1. The quality of dehydrated *Moringa oleifera* leaves was found to be treatment and temperature dependent as per the variations in the colour parameters. The intense and appropriate greenness values was found to be associated with the untreated and dehydrated leaf at 50 and 60^{O}C. Considering the benefits of dehydration rate with the optical parameter the powder prepared out of dehydrated leaves at 60^{O}C was optimum. The dimensional characteristics of mixed, course and fine moringa unblanched and blanched powders as obtained through image analysis with the particle size distribution is presented in Fig. 1. It is evident that the sieving with 150 BSS mesh separates two fractions clearly, as far as particle size is concerned (Fig. 1), having the aspect ratio in the range of 1.36 to 1.62. The bulk density of the leaf powder was found to be directly affected by pretreatment as well as found dependent on particle size distribution (Fig. 2). As the particle size decreased, bulk density of leaf powder was also found to be decreased. This could be justified with the increased inter particle pore space of leaf powder on size reduction. The important parameter of frictional properties, the angle of repose was also found to vary from 54.02 to 58.34 for unblanched and from 50.16 to 57.97 for blanched m*oringa* leaf powder (Fig. 2). Blanched samples were found to have lesser value of angle of repose as compared to the unblanched sample basically due to compact structure with less adhesive frictional force for blanched powder at same dehydration temperature. Among the three different surfaces used, galvanized iron sheet was found to exhibit least coefficient of friction as compared to the plywood and glass surface. The plywood surface responded highest coefficient of friction, it may be due to its rough surface in comparison to other surfaces (Fig. 2).

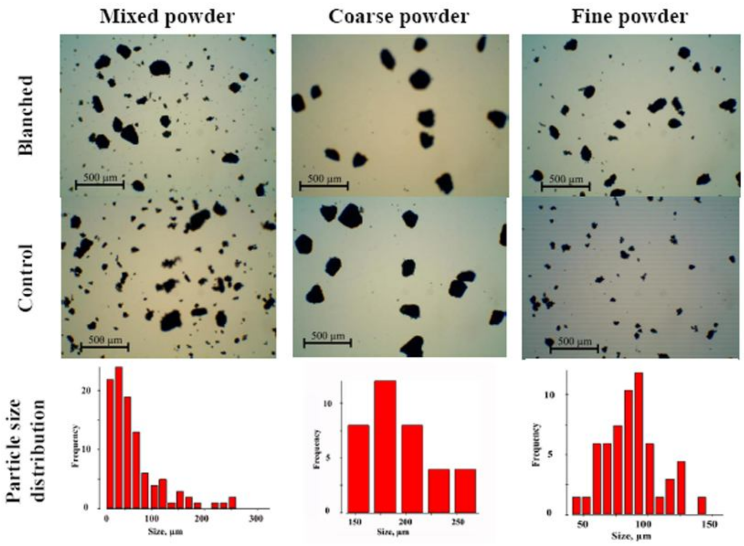

Figure 1: Effect of blanching treatment on particle size distribution of Moringa leaf powder.

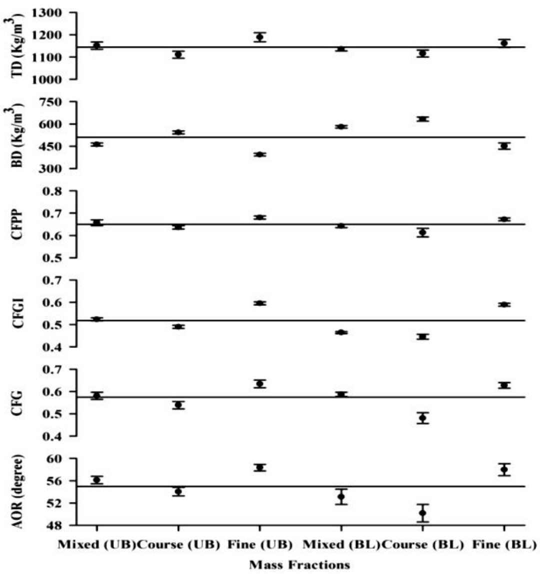

Figure 2: Frictional and gravimetric properties of Moringa oleifera leaf powder dehydrated at 60°C.

Table 1: Temperature dependent dehydration parameters and optical characteristics as affected by pretreatment.

	Unblanched *moringa* leaf				**Blanched *moringa* leaf**			
	50°C	**60°C**	**70°C**	**80°C**	**50°C**	**60°C**	**70°C**	**80°C**
Dehydration Ratio	3.873±0.244	4.111±0.227	4.291±0.265	4.473±0.248	3.921±0.202	4.134±0.265	4.318±0.246	4.488±0.231
Rehydration Ratio	1.447±0.130	1.450±0.123	1.458±0.150	1.460±0.115	1.445±0.113	1.449±0.148	1.455±0.132	1.455±0.101
Coefficient of Rehydration	0.374±0.073	0.353±0.070	0.340±0.075	0.326±0.071	0.369±0.067	0.351±0.074	0.337±0.088	0.324±0.083
L	57.67±1.98	43.87±1.03	35.86±1.45	32.89±1.66	34.74±1.41	36.48±1.34	38.45±1.27	40.08±1.12
a	-16.19±1.07	-15.73±1.42	-8.12±1.07	-7.41±1.23	-10.41±1.12	-11.33±0.58	-13.67±1.21	-14.33±1.11
b	22.5±1.05	21.82±1.08	19.79±1.15	18.85±1.26	14.33±1.21	14.58±1.09	18.33±1.09	19.67±1.06
ΔE	26.09±1.56	13.29±1.24	10.19±1.36	9.88±1.43	6.07±1.28	6.05±1.67	7.32±1.46	9.14±1.43

Table 2: Chemical composition of Moringa oleifera leaf powder dried at 60°C.

	Unblanched			Blanched		
	Mixed	**Coarse**	**Fine**	**Mixed**	**Coarse**	**Fine**
Moisture, %	5.57±0.18	5.46±0.22	5.63±0.38	5.45±0.28	5.35±0.14	5.52±0.28
Crude Protein, %	20.06±0.17	18.66±0.54	20.28±0.07	19.77±0.55	18.36±0.25	20.02±0.85
Crude Fibre, %	28.01±0.16	28.4±0.25	26.32±0.55	28.76±0.27	29.22±0.18	27.07±0.66
Crude Fat, %	3.12±0.22	3.03±0.55	3.26±0.81	2.68±0.15	2.62±0.51	2.71±0.28
Carbohydrate, %	31.59±0.81	30.96±0.52	31.93±0.12	29.20±0.10	28.64±0.52	29.54±0.14
Ash, %	8.96±0.04	9.78±0.15	8.25±0.56	9.84±0.21	9.95±0.18	9.65±0.24
[*]TAC, mg/g	321.54±0.12	295.99±0.57	329.26±0.28	144.09±0.50	138.48±0.94	146.99±0.11
[#]TPC, mg/100g	150.55±0.21	144.83±0.18	155.15±0.14	24.50±0.14	23.57±0.12	25.37±0.51
[†]HIS, %	71.68±0.18	67.85±0.65	75.72±0.28	46.37±0.47	43.02±0.22	48.61±0.68
[‡]WSI	3.71±0.02	3.67±0.03	3.91±0.01	3.51±0.01	3.37±0.01	3.85±0.04
[!]WAI	37.69±0.74	34.04±0.61	38.73±0.86	36.91±0.63	33.15±0.58	37.31±0.46

[*]Total antioxidant capacity (Trolox equivalent mg/g), [#]Total phenol content (mg gallic acid equivalent /100g), [†]Hydroxyl ion scavenging (%), [‡]Water Solubility Index, [!]Water Absoption Index

The obtained values for chemical characteristics of differently treated *Moringa* leaf powder are summarized in Table 2. The analyzed chemical attributes were moisture, crude protein, crude fiber, crude fat, carbohydrate, ash, total antioxidant capacity, hydroxyl ion scavenging, total phenol content, water absorption index and water solubility index. The maximum value of crude protein content (20.28%) was observed for fine unblanched *Moringa* leaf powder at the moisture content of 5.63 ± 0.38%. The treatment of *Moringa* leaf exhibited minor variation in the amount of crude fiber and crude fat. However, the presence of appreciable contents of protein, fiber and fat leads the potential of this biomaterial to have dietary purposes with associated nutritional aspects. Water solubility index and water absorption index of *Moringa* leaf powder ranges from 3.37 to 3.91 and 33.15 to 38.73, respectively. Appreciable amount of total antioxidant capacity with hydroxyl ion scavenging properties further makes this important biomaterial as anti cancer and other therapeutic purposes to make the food a functional food.

4. Conclusion

Moringa oleifera leaf powder as obtained at a dehydration temperature of 60°C without any treatment further improves on fractionation and the fine fraction could be considered as an important functional and optimal biomaterial to be used to make the food rich with therapeutic values. Thus, this underutilized plant could further be justified as mother's best friend plant to combat the associated problems of under developed and developing countries.

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