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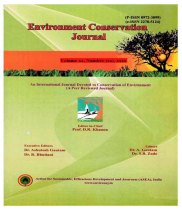

Effect of pre-treatments on nutritional quality of dehydrated spine gourd (*Momordica dioica* Roxb.) powder

Hamsa, R. ✉
College of Horticulture, UHS Bagalkot, India.
Bhuvaneshwari, G.
Department of Post Harvest Technology, College of Horticulture, UHS Bagalkot, India.
Jagadeesh, S. L.
Department of Post Harvest Technology, College of Horticulture, UHS Bagalkot, India.
Jameel, J. M. D.
Department of Post Harvest Technology, College of Horticulture, UHS Bagalkot, India.
Rudresh, D. L.
Department of Microbiology, College of Horticulture, UHS Bagalkot, India.

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ABSTRACT

An exploration was conducted in the year 2017-2018 at College of Horticulture, Bagalkot, Karnataka, India to evaluate nutritional quality of dehydrated spine gourd (*Momordica dioica* Roxb.) slices as influenced by different pre-treatments. Spine gourd is a high value underexploited vegetable which is rich in nutrition, medicinal value and also having potential to cure many diseases and disorders with good cultivation potential. In order to enhance its availability in the offseason along with proper retention of nutritional property dehydration was carried out with different pretreatments as a preservative method. The effect of pretreatments on nutritional attributes was observed in the present study. The treatment T_2 which include blanching of spine gourd slices for 3 min. and steeping in 0.2 per cent KMS and 2 per cent salt solution for 10 min. showed significantly best results with respect to protein (1.93%), ash (8.11%), total phenols (831.20 mg GAE/100g) and *L(78.32), *a**(0.68), except *b** (32.28) values and carbohydrate per cent (p>0.01). The effect of pre-treatments showed non-significant results for moisture, water activity, fat, crude fibre and calorific value (kcal/100g). It was concluded form the study that the pretreatment with KMS (0.2 %) and salt (2%) solution along with blanching for 3 min. was considered best with respect to nutritional quality retention.**

Introduction

Underutilized crops species are ancient crop species which are used at small scale usually not cultivated commercially but used by the traditional people of the respective location, also they can contribute with higher percentage towards nutritional security. The genus *Momordica* contains nearly about 60 species which belongs to cucurbitaceous family. Spine gourd is a native of tropical and subtropical Africa, Asia and Australia. Karnataka (kodagu and malnad region) and Maharashtra are the main states in India cultivating spine gourd. Since it is an underutilized crop, grown by few farmers for their own consumption in homesteads or those which collected wildly are sold in the market. Although demand and price are high, nobody thought of cultivating it commercially. *Momordica* is an underutilized and wild-gathered vegetable which as both food and medicine value (Sakshi *et al.,* 2020) Indira Kakonda by Indira Gandhi Krishi Viswa Vidyalaya (Raipur) and Arka Neelachal Shree by Central Horticultural Research Station (Bhubaneswar, IIHR) are the two varieties released in India and also few farmers in Dakshina Kannada district have cultivated the Assamese teasel gourd for domestic consumption (Motapalukula *et al.,* 2020). Spine gourd is perennial in nature, with the

Corresponding author E-mail: rajrekha043@gmail.com
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chromosome number of 2*n* = 28. It is cultivated up to an altitude of 4,921.26 ft, and is mainly grown in Orissa, Maharashtra, Bihar and West Bengal. In the western ghats of south India it is called by popular names like *Malanada Honnu, Mada Hagala* (Golden Vegetable of the Western Ghats) (Basavaraj *et al.,* 2014). It comes to the market in the Mansoon season (May - August). Indira Kakonda by Indira Gandhi Krishi Viswa Vidyalaya (Raipur), Arka Neelachal Shanti and Arka Neelachal Shree by Central Horticultural Research Station (Bhubaneswar, IIHR) are the two varieties released in India. Fruits weigh around 18-25 g and yield 1.5-2 kg fruits per plant (Motapalukula *et al.,* 2020). Since spine gourd is seasonal and perishable in nature processing techniques are essential to make it available throughout the year and also it reduces postharvest losses. Drying is one of the traditional and commonly used techniques to increase the post-harvest life of the produce. Before drying blanching with hot water or (KMS) helps in retention of colour and texture of the produce by inhibiting enzymatic activity (Prajapati *et al.,* 2009). Blanching was recommended as an effective method for reducing antinutritional compounds (Mosha *et al.,* 1995). The information available on the nutritive value of underexploited crops is less, which may help in combating nutritional insecurity of rural. There are many vegetables available in this part of the country, whose nutritional profile is yet to be documented. More systematic study on these vegetables is required in order to fully utilize them. The nutritional insecurity in many countries, with many children and particularly women suffering from nutritional deficiencies, is a backbone for determining the nutritional composition of traditional crops. In this background, the present study was planned to systematically analyse and document the nutrient content of spine gourd (*Momordica dioca* Roxb.) This exploration can help to address malnourishment from eating a diet in which one or more nutrients are either not enough. It may involve calories, protein, carbohydrates, vitamins or minerals. Standard protocols for biochemical analysis are employed for nutrient analyses.

Material and Methods

Location of the experimental site and climate: Bagalkot is a city in the state of Karnataka, India, which is also the headquarters of Bagalkot district. UHS, Bagalkot established by the Government of Karnataka at Bagalkot district. Bagalkot is located at 16.18°North 75.7°East. It has an average elevation of 1,748.69 feet. Bagalkot was chosen as headquarters of UHS, as the district is known for its rich horticultural production base of grapes, pomegranate, sapota. The area has a suitable climate for different crops making it an suitable place for establishment of the university.

Procurement and sample preparation: The horticulture matured spine gourd fruits were collected from local market (Sirsi, Karnataka, India) in replicates to avoid qualitative and quantitative losses**.** The fruits were sorted, cleaned and graded in order to remove defect or damaged and to maintain uniform maturity, then fruits were thoroughly washed under tap water, dried under fan to remove surface moisture. Fruits of 500g weighed for each replication (each treatment replicated for five times) and cut into 0.20 inches slice with a sharp knife. Slices were succeeded for further processing methods to know nutritional quality parameters of spine gourd slices.

Pre-treatments and Dehydration

T_1: Spine gourd slices without pre-treatment (Control)

T_2: Spine gourd slices + Blanching (3 min) + Steeping in 0.2 % KMS and 2 % Salt (10 min)

T_3: Spine gourd slices + Roasting (Temp 120 ^{0}C for 5 min.)

T_4: Spine gourd slices + Steeping in vinegar (24 hr.)

The slices of 0.20 inches thickness were subjected to pre-treatments as listed above and drying process was carried out using easy tray drier which is positioned at Department of Postharvest Technology, UHS Bagalkot, Karnataka, India. The slices along with seed were dried at temperature of 60^o C until crack sound when break. The dried spine gourd slices along with seeds were weighed in electronic balance and crushed by food grinder into powder. The powder was packed in high density polyethylene bags, sealed and used for further studies.

Analysis of nutritional quality of spine gourd powder: Spine gourd powder colour was measured with a ColorFlex (Model CFEZ 1919, Hunter Associates Laboratory, Inc., Reston) with a 1.7717 inches (diameter) measuring tube using a white tile

background. *L** *a** and *b** values indicates lightness, red-green and yellow-blue scales. Moisture content of spine gourd powder was measured by moisture meter. Weighed spine gourd powder (2 g) was placed on plate and then it was inserted inside the instrument. The end point was indicated by three beep sound and the instrument gives constant value for moisture and recorded as per cent moisture content. Water activity of dried spine gourd powder was determined by water activity meter (Labswift-a_w, Novasina). Determination of protein content was carried out by micro Kjeldhal method which consists of wet digestion, distillation and titration AOAC (1980). Fat content was determined by using the Socs plus-SCS-6 AS instrument as described by Ojure and Quadri (2012). Total ash content was determined by burning the spinegourd powder in pre-weighed crucible in a muffle furnace at 500^0 C for 6 hours (Rao and Bingren, 2009). Crude fibre estimation was done by using Fibra plus-FES-6 instrument. Carbohydrate % and calorific value were calculated as per AOAC (1980). Total phenol content of spine gourd powder was estimated by using Folin Ciocalteu reagent (FCR) method and expressed as mg Gallic acid equivalent (GAE) per 100 ml. (Sadasivam and Manickam, 2005).

The data analysis done by Completely randomized design method of analysis. The data was interpreted in accordance with Pause and Sukhatme (1985). The level of significance used in 'F' and 'T' test was p = 0.01. Critical difference values were calculated whenever F test found significant (test was p = 0.01).

Results and Discussion

Colour (*L*, a*, b*) values*:

Colour is key quality attribute. Because at the time of marketing it play a major role with respect to the appearance which is the prime thing in sales with respect to quality. The *L** value was significantly influenced by the pre-treatments on spine gourd powder and it was ranged from 75.49 to 78.32 (Table 1 and Figure 1). Among the different pre-treatments, the highest value was recorded in T_2 (78.32) and it was statistically significant from other treatments. The minimum *L** value was recorded in T_4 (75.52). The present finding is concordant with the results of Muley *et al.* (1994) who observed that the enzymatic browning in KMS pre-treated samples was lowest in cabbage which confirmed the inhibitory effect of SO_2. The *a** value of pre-treated spine gourd powder ranged from 0.68 to 2.88 (Table 1). The lowest *a** value was recorded in T_2 (0.68) and it was statistically different from all other treatments. This is because blanching retains colour by destruction or inactivation of enzymes. KMS (SO_2) reduces colour deterioration by preventing oxygen solubility. Sodium Chloride (NaCl) reduces oxidative browning due to its osmotic property and also NaCl prevents bleaching by using it with other mixtures Jackson and Mohamed (1971). Hence T_2 showed less colour degradation compared to other treatments. The *b** value of pre-treated spine gourd powder ranged from 30.73 to 33.13 (Table 1). No significant difference was found in-between the treatments.

Water activity (a_w):

Higher concentration of a_w reduces the safety of the food. Statistically no significant difference was found in pre-treated samples. Higher water activity was found in the treatment T_1 (0.42 a_w) (Table 1) and the lower water activity was found in the treatment T_4 (0.34 a_w). The pre-treated samples showed more water removal when compared with the control samples due to the acidic pH activates cell wall loosening proteins (EXPANSINs, EXTENSINs ARABINOGALACTAN), enzymes and breakdown of polysaccharides which helps in maintaining structure of cell wall which in turn leads to loosening of cell wall structure by acetic acid in the vinegar treated samples (Micheli, 2001) and also Lerici *et al.* (1983) observed minimum a_w in the osmotic agent treated samples.

Moisture (%):

Moisture per cent in food influences on weight, taste, texture, appearance and shelf life. Increase in moisture per-cent increases the microbial growth resulting in spoilage. The mean moisture content of spine gourd powder subjected to pre-treatment ranged from 9.78 to 11.10 per cent (Table 1). No significant difference observed in the moisture content in-between the pre-treated samples. The lowest moisture per cent was recorded in T_4 (9.78%) and highest moisture per cent was observed in untreated sample that is T_1 (11.10%). In treatment T_2 sodium chloride (NaCl) helps in

Table 1: Effect of pre-treatments on colour values, moisture, water activity and protein content of spine gourd powder.

Treatments	Colour values			Moisture (%)	Water activity	Protein (%)
	*L**	a*	*b**			
T_1	76.53	0.76	33.13	11.10	0.42	1.66
T_2	78.32	0.68	32.28	10.18	0.36	1.93
T_3	75.49	0.87	32.98	10.72	0.38	1.56
T_4	75.52	2.88	30.73	9.78	0.34	1.36
Mean	76.46	1.28	32.28	10.45	0.37	1.63
SEm ±	0.44	0.23	0.84	0.48	0.02	0.08
CD at 1%	1.83	0.97	NS	NS	NS	0.33
C.V.	1.29	40.79	5.81	10.36	13.17	10.92

T1: Spine gourd slices without pre-treatment (Control)
T2: SGS + Blanching (3 min) + Steeping in 0.2% KMS + 2 % Salt (10 min)
T3: SGS + Roasting at 120 oC (5 min)
T4: SGS + Steeping in vinegar (24 hrs.)
SGS: Spine gourd powder
L* Lightness, a* (+) redness/(-) greenness, b* (+) yellowness/ (-) blueness

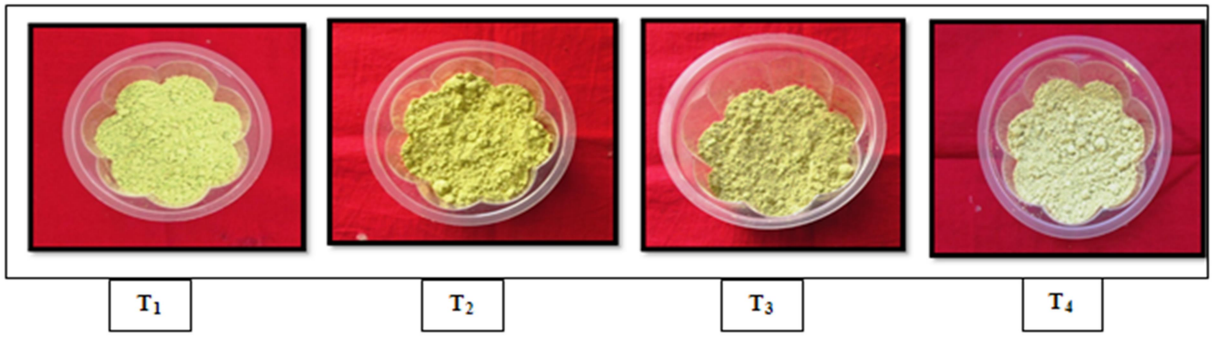

Figure 1: Spine gourd powder of different pre-treatments.

moisture removal by acting as a osmotic agent (Jackson and Mohamed, 1971). Mohseni and Ghavidel (2011) reported that sodium chloride treated tomato slices showed increase in moisture removal. Sample pretreated with brine solution took higher drying time to achieve the final moisture content. The KMS treated slices were achieved higher value of drying rate and brine treated slices were achieved lowest drying rate (Vaishali *et al.,* 2020).

Protein (%):

Significantly highest protein content was observed in T_2 (1.93%) (Table1). The highest protein content in T_2 could be due to prevention of enzymatic browning through blanching and pre-treatment with KMS + citric acid (Take *et al.,* 2012) where non enzymatic browning causes condensation of reducing sugars with amino groups (Utomo *et al.,* 2008) which leads to loss of protein. The results found are in agreement with Mozumder *et al.* (2012) where the protein content of the KMS + $CaCl_2$ pre-treated tomato samples showed higher protein content than untreated samples. The lower protein content in T_4 could be due to leaching of amino acids in the vinegar medium and also thermal degradation reduces the protein content.

Fat (%):

The highest fat content recorded in T_2 (3.12%) and there was no statistical difference among the treatments (Table 2). The lowest fat content was recorded in T_4 (2.64%). This may be due to solubility of fat content with acetic acid which leads to decrease in fat content. The higher fat content in T_2 could be due to decrease in dry matter content by leaching of soluble compounds like minerals, sugar and vitamins into water by blanching (Chapagain *et al.,* 2018), as the fat is insoluble in water the percentage of fat will increase in the remaining dry matter (Nilnakara *et al.,* 2009). The findings of present study are

Table 2: Effect of pre-treatments on fat, ash, crude fibre, carbohydrate, calorific value and total phenol content of spine gourd powder

Treatments	Fat (%)	Ash (%)	Crude fibre (%)	Carbohydrate (%)	Calorific value (Kcal/100g)	Total phenols (mg GAE/100g)
T_1	2.68	5.23	12.29	67.14	298.93	698.00
T_2	3.12	8.11	14.78	61.91	283.34	831.20
T_3	2.89	5.17	12.91	66.59	299.05	620.00
T_4	2.64	3.53	14.24	68.45	302.99	758.00
Mean	2.83	5.51	13.55	66.02	296.08	726.50
S Em +	0.41	0.54	0.68	1.22	5.22	25.93
CD at 1%	NS	2.23	NS	5.06	NS	107.10
C.V.	32.05	21.88	11.16	3.17	3.66	-

supported by Mozumder *et al.* (2012) where fat content of $CaCl_2$ + KMS pre-treated tomato powder showed higher because of lower moisture content.

Ash (%):

The ash content gives presence of mineral composition present in the food. Significantly higher ash content was recorded in T_2 (8.11%) (Table 2) while the lowest ash content was associated with T_4 (3.53%). The higher ash content in T_2 could be due to addition of some sulphites and sodium ions into the vegetables. The similar results were observed by Oboh, (2005) where the ash content of *Cnidoscolus acontifolus* subjected to abration of salt showed higher salt content by abrasion of sodium ions into the vegetable. The lower ash content in T_4 might be due to leaching out of some inorganic salt during pre-treatment (Chapagain *et al.,* 2018). Pre-treatments influence the ash contents of sweet potato flour by leaching of minerals in the citric acid solution during soaking (Vanhal, 2000).

Crude fibre (%):

Crude fibre helps in roughage improvement and bulk, also helps in maintaining intestinal issues (Potter and Hotchkiss, 2004). The maximum mean crude fibre content was recorded in T_2 (14.78%) might be due to the leaching of soluble solids during blanching which in turn result in decrease of total dry matter. Therefore, an increase in proportion of the crude fibre per unit dry matter has been observed in blanched samples (Nilnakara *et al.,* 2009).

Carbohydrate (%):

Carbohydrates provide heat and energy for all forms of body activity. They are a major food source and a key form of energy for most organisms. Significantly higher carbohydrate content was obtained in T_4 (68.45%) (Table 2) and minimum carbohydrate content was obtained in (61.91%) might be due to leaching of soluble components like minerals, sugar and vitamins in water during blanching resulting in decrease in total solids. The energy accumulated in food as protein, fat and carbohydrates.

Calorific value (Kcal/100g):

The highest calorific value in T_4 (302.99 Kcal 100 g^{-1}) and lowest calorific value in T_2 (283.34 Kcal 100 g^{-1}) (Table 2). was due to decrease in carbohydrate content and higher amount ash and crude fibre as per the present study which does not add any calories. Aberoumand (2010) studied on nutritional aspects of spine gourd fruits where he stated that spine gourd powder provides energy of 288.25 Kcal 100 g^{-1} on dry weight basis.

Total phenols (mg GAE/100g):

Total phenol content of spine gourd *Khakra* varied significantly. The maximum phenol content of (831.20 mg GAE 100 g^{-1}) was recorded in T_2 (Table 2) and minimum total phenol content was recorded in T3 (620 mg GAE 100 g^{-1}). The results are supported by Shrinivas *et al.* (2009) where *Momordica dioica Roxb.* contains total phenolic content of about 9.25 mg GAE per gram of dry sample. Maximum phenol content in T_2 might be due to activity of potassium metabisulfate and sodium chloride which causes irreversible changes in the quality of dried produce there by it reduces tissues damages by oxidative reactions (Mwende *et al.* 2017). Bamidele *et al.* (2017) reported that increase in total phenol content of selected green leafy vegetables after blanching for 5 minutes with reduction of enzyme mediated polyphenol

degradation (complete inactivation of native polyphenol oxidase) and also increase in total phenolic content could also be due to the release of bound phenolic acids from the breakdown of cellular constituents of the plant cell walls in the leafy vegetable while blanching. Also supported by the study conducted by Chapagain *et al.,* 2018, chemical pre-treatment done before drying showed significant effect on physiochemical properties of solar dried tomato slices. Solar and sun-dried tomato pre-treated with potassium metabisulfite had significantly high carotenoids, lycopene and beta carotene compared with the other pre-treated samples and controls (Owureku-Asare *et al.,* 2018)

Conclusion

Spine gourd powder prepared by employing pre-treatments was evaluated for the nutritional parameters and *L*, a* and b** colour values. Results indicated significant differences among the treatments. The appearance of the spine gourd powder was retained in T_2 which is foremost for consumer acceptance and also it retained higher per cent of protein, fat, ash, crude fiber and total phenol content. Therefore results of this study indicated that treatment T_2 [Spine gourd slices + Blanching (3 min) + Steeping in 0.2% KMS and 2% Salt (10 min)] was found to best for the production of spine gourd powder in terms of nutritional and colour values which can be incorporated to many products for value addition and to enhance therapeutic value.

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Conflict of interest

The authors declare that they have no conflict of interest.

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