ijPPHT
e ISSN-2231-6426
Volume 8 | Issue 2 | December, 2017 | 75-82
Visit us: *www.researchjournal.co.in*
International Journal of Processing and Post Harvest Technology

RESEARCH PAPER
DOI: 10.15740/HAS/IJPPHT/8.2/75-82

Effect of pre-treatments and drying methods on nutrient composition and sensory quality of milk yam (*Ipomoea digitata* L.) tuber powder

N. S. SONIA*, P. C. JESSYKUTTY AND G. S. SREEKALA
Department of Plantation Crops and Spices, College of Agriculture (K. A.U.), VELLAYANI (KERALA) INDIA
Email : coa2008soniya@gmail.com; pcjessy@gmail.com;drsreekalags@gmail.com

*Author for Correspondence

Research chronicle : Received : 05.07.2017; **Revised :** 03.11.2017; **Accepted :** 17.11.2017

SUMMARY :

Milk yam (*Ipomoea digitata* L.) (Family-Covolvulaceae) or Ksheervidari is a potential medicinal cum nutraceutical agent. It is a perennial climber having tuberous roots which are medicinal. Dried and powdered tubers are used in several nutraceutical preparations. The present study focussed on different pre-treatments and drying techniques that can be adopted for improving the flour whiteness and quality of milk yam tuber powder. Peeled as well as non-peeled tubers were shredded and washed (three times, two times, single time and no washing), de-watered by keeping in bamboo basket. These tuber shreds were dried under sun and in a hot-air oven (60^0C, 70^0C and 80^0C). The samples were evaluated for micronutrients, non-nutrient but beneficial components as well as sensory quality attributes.Milk yam tuber powder prepared by three times washed peeled tuber shreds dewatered by keeping in bamboo basket and dried in hot-air oven at 60^0C recorded optimum micronutrients, non-nutrient but beneficial components and sensory (overall visual quality – OVQ) quality attributes. Micronutrients composition include, calcium-3.40 mg/100g, iron-2.47 mg/100g, sodium-2.53 mg/100g, high vitamin A (613.33µg/100g) and vitamin C (7.43 mg/100g). Non-nutritional but beneficial components *viz.*, crude fibre-7.13 g/100g and total ash-3.56 g/100g. Mean rank value for the overall visual quality (OVQ) is 288.55.

KEY WORDS : Beneficial components, Ksheervidari, Micronutrients, Nutraceutical, Overall visual quality

How to cite this paper : Sonia, N.S., Jessykutty, P.C. and Sreekala, G.S. (2017). Effect of pre-treatments and drying methods on nutrient composition and sensory quality of milk yam (*Ipomoea digitata* L.) tuber powder. *Internat. J. Proc. & Post Harvest Technol.,* **8** (2) : 75-82. **DOI: 10.15740/HAS/IJPPHT/8.2/75-82.**

Milk yam (*Ipomoea digitata* L.) is an underutilised medicinal plant naturalized in many parts of the world belonging to the family, Convolvulaceae. It grows as a perennial climber and has been noticed near river banks, marshy regions and along other moist areas. As the species name '*Digitata*' suggests it has five to seven lobed leaves and bell shaped gracefully pink coloured flowers. Its tubers are considered to be medicinal that are upto 60 cm long and 30 cm thick, weighing about 5 to 10 kg. The tubers are popularly called as Ksheervidari - a substitute of Vidari (*Peuraria tuberosa*).

In India, Ayurvedic industries and traditional medical practitioners (TMP) use Vidari for preparing galactagogues and immunomodulatory herbal medicines (Rasayan) (Khan *et al*., 2009). Its tubers have been used from ancient Sanskrit times in several Ayurvedic nutraceutical products and also as tonic, alterative, aphrodisiac, demulcent, galactogogic and cholagogic (Sonia *et al*., 2017). Vidari is also an important component of the popular ayurvedic formulation *Chyavanaprasha* (Venkatasubramanian *et al*., 2009). It is recommended for emaciation in children and put into a compound decoction which is nutritive, diuretic, expectorant and useful in fever and bronchitis. Powdered tuber with honey is used for curing high blood pressure and heart disease.

Milk yam tubers exhibit no dormancy so are prone to insect infestation. So, once it is harvested they deteriorate rapidly due to physiological changes and damages during harvesting, transportation and handling. It is better to follow suitable postharvest preservation techniques to enhance the storage stability of milk yam tubers. The cheapest and the easiest may be converting them to dehydrated chips or flours as followed for other edible tubers like sweet potato, tapioca etc.

Flours have a further scope of value addition to bakery products, nutritional supplements, health mix etc. Antioxidant activity of health mixes prepared using milk yam flour was studied by Sonia and Jessykutty (2017) and proved that it is a potential nutraceutical agent not completely explored. Also it is a verry beneficial and priority species facing extinction threats. Hence, in the present study, micronutrients, non-nutrient but beneficial components present in milk yam tuber powder as well as its sensory quality attributes was explored which aids in its value addition.

EXPERIMENTAL METHODS

Milk yam tubers of optimum maturity were collected from the Instructional Farm, College of Agriculture, Vellayani. The tubers were thoroughly cleaned, outer skin are peeled off or kept intactand shredded using a manual shredder for preparing milk yam tuber shreds. The shreds were washed and kept in a bamboo basket for dewatering. The experiment was conducted without washing the shreds also. The pre-treatments adopted are listed below.

T_1 – Peeling + shreds washing in clean water three times + removal of excess water by keeping in bamboo baskets

T_2 – Non-peeling + shreds washing in clean water three times + removal of excess water by keeping in bamboo baskets

T_3 - Peeling + shreds washing in clean water two times + removal of excess water by keeping in bamboo baskets

T_4 – Non-peeling + shreds washing in clean water two times + removal of excess water by keeping in bamboo baskets

T_5 – Peeling + shreds washing in clean water single time + removal of excess water by keeping in bamboo baskets

T_6 – Non-peeling + shreds washing in clean water single time + removal of excess water by keeping in bamboo baskets

T_7 – Peeling + no washing

T_8 – Non-peeling + no washing

The tuber shreds are then subjected to different drying methods *viz.*, sun drying (D_1) or oven dryingat different temperature conditions (D_2- 60^{0}C, D_3- 70^{0}C and D_4- 80^{0}C). Forsun drying pre-treated milk yam tuber shreds were placed under sun light, during that period when mid-day temperature reached around 35^{0}C. Oven drying was carried out in Labline, Laboratory Oven, by placing fresh tuber shreds in oven trays and heated at required temperature conditions.

Milk yam tubers pre-treated in eight different ways were dried by adopting four different drying methods/ conditions. The experiment was conducted in a design CRD with three replications.

No. of pre-treatments the tuber underwent	- 8
No. of drying methods adopted	- 4
Total no. of treatments (8 x 4)	- 32

The pre-treated fresh tuber shreds were dried and then powdered using a mixer grinder, sifted (50 mesh), packed in an air tight container and stored in low temperature conditions and evaluated for its nutritional and sensory quality parameters.

Milk yam tuber powder samples were evaluated for its micronutrients (calcium, iron, sodium, vitamin A and vitamin C) and non-nutrient but beneficial components (crude fibre and ash). The crude fibre and ash content were determined using standard methods of AOAC (2000). Calcium content was estimated using ethylene diamine tetra acetic acid (EDTA) titration method, iron contentusing thiocynate by colorimetric method and sodium contentusing sodium chloride solution as standard by flame photometer method following ICARDA (2013). The mineral composition was expressed as mg/100g. Beta-carotene content of milk yam tuber powder samples were estimated by following (Knuckles *et al*., 1972) and expressed as μg/ 100g samples. Vitamin A content in the samples were calculated using the equation, Vitamin A (μg/100g) = (β-carotene ÷ 0.6). Ascorbic acid content in milk yam tuber powder samples were estimated using 2, 6-dichlorophenol indophenol (DCPIP) dye method as described by Sadasivam and Manickam (1992) and expressed as mg/ 100g.

Sensory evaluation of the prepared milk yam tuber powder samples were done by scoring of the samples for its overall visual quality (OVQ) by a 30 member semi trained panel comprising of research scholars of College of Agriculture, Vellayani. The panel were asked to score for the OVQ of the samples using a designed score card (Yuan *et al*., 2010) according to the order of preference - Excellent- 9, Good- 7, Fair- 5, Poor –3, Bad- 1.

Analysis of variance (ANOVA) was performed in SAS software. Mean rank value for the overall visual quality of products was performed by Kruskell Wallis test. Based on superior nutritional and sensory quality parameters, best quality milk yam tuber powder sample was selected.

EXPERIMENTAL FINDINGS AND ANALYSIS

Drying can be applied as a cost effective processing method, and the dried product can be value added by further means (Chua and Chou, 2003). Also, quality of dried product is a measure of excellence of the methods adopted for its preparation (Fabbri and Crosby, 2016) hence, pre-treatments are suggested (Grabowski *et al*., 2008). Consumer acceptability and quality is usually evaluated using nutritional and sensory analysis of any food product (Lawless, 1995). So, milk yam tuber powder samples were evaluated for nutritional and sensory quality attributes and the best quality milk yam tuber powder was selected.

Effect of pre-treatments and drying methods on nutritional quality of milk yam yuber powder :

Micronutrient composition of milk yam tuber powder:

Micronutrients include minerals *viz.*, calcium, sodium, iron, potassium, magnesium etc. and vitamins *viz.*, vitamin A, vitamin C etc. (NIN, 1971). All the micro nutrients are required by human body in very small amounts but are extremely important for the normal functioning of the body (Mahan and Escott-Stump, 2004).

In the present study, pre-treatments applied to the milk yam tuber shreds, drying methods adopted or their interactions didn't influence the mineral content of milk yam tuber powder (Table 1). Calcium, sodium and iron content of milk yam tuber are, 112.00 to 138.67 mg/100g, 23.33 to 28.00 mg/100g and 45.47 to 52.93 mg/100g, respectively. This denoted washing the tuber shreds even upto three times would not cause any mineral loss. Furthermore, drying under sun or in hot air oven even at high temperature (80^0C) would not affect the mineral composition. This result agrees with the findings of Lymio *et al*. (2010) that dry heat treatment in oven at 60^0C and sun drying had no significant effect on calcium and iron content of sweet potato flour. Also, peeling or washing didn't affect the calcium content of Anchote (*Coccinia abyssinica* Lam. (Cong.) – Cucurbitaceae) tuber powder as reported by Fekadu *et al*. (2013). Sodium is water soluble nevertheless, three times washing of tuber shreds was not enough to cause a significant loss of this mineral. Besides, the low sodium contentrenders it safe for consumption by people suffering from cardio-vascular risk parameters.

Both the vitamins studied in milk yam tuber powder *viz.*, Vitamin A and Vitamin C had influenced by the pre-treatments applied, drying methods adopted as well as their interactions (Table 1). Vitamin A content of milk yam tuber powder was maximum (476.67 μg/100g) for non-peeled and non-washed tuber shreds (T_8) and the minimum value (416.67 μg/100g) was recorded by peeled tuber shreds washed for three times (T_1). Vitamin C content was also maximum for T_8 (5.18 mg/100g) and minimum for T_1 (3.87 mg/100g) itself. The same finding was recorded on dehydrated sweet potato slices by Pinherio – Santana *et al*. (1998) that peeling and washing resulted a low beta-carotene content (852.04 ± 67.45 μg/g) compared to peeled slices dehydrated without washing (1062.87 ± 204.07 μg/g). Vitamin C retention usually get affected negatively by pre-treatments like peeling, cutting,

Table 1 : Micronutrient composition of 100 g dried and powdered milk yam tubers

	Calcium (mg/100g)					Iron (mg/100g)					Sodium (mg/100g)				
	D_1	D_2	D_3	D_4	Mean	D_1	D_2	D_3	D_4	Mean	D_1	D_2	D_3	D_4	Mean
T_1	128.00	136.00	128.00	122.67	128.67	48.00	49.47	47.47	46.93	47.97	27.00	25.33	24.67	25.33	25.58
T_2	125.33	122.67	128.00	130.67	126.67	48.00	51.07	49.20	49.07	49.34	24.67	28.00	26.00	24.00	25.67
T_3	136.00	130.67	130.67	130.67	132.00	48.33	50.27	48.93	49.73	49.32	27.33	24.67	28.00	24.00	26.00
T_4	128.00	136.00	120.00	117.33	125.33	52.13	48.93	49.33	50.27	50.17	23.33	27.33	24.00	24.00	24.67
T_5	125.33	138.67	120.00	136.00	130.00	52.47	50.93	50.27	54.67	52.09	26.67	26.00	25.33	26.67	26.17
T_6	133.33	112.00	133.33	120.00	124.67	51.07	51.07	45.47	51.47	49.77	26.00	26.67	28.00	26.67	26.84
T_7	122.67	136.00	130.67	122.67	128.00	51.47	48.53	47.80	49.86	49.42	26.00	26.67	26.67	27.33	26.67
T_8	136.00	125.33	120.00	133.33	128.67	51.47	52.93	45.73	52.13	50.57	28.00	27.33	27.33	26.67	27.33
Mean	129.33	129.67	126.33	126.67		50.37	50.40	48.03	50.52		26.13	26.50	26.25	25.58	
Treatments	S.E.±		C.D. (P=0.05)			S.E.±		C.D. (P=0.05)			S.E.±		C.D. (P=0.05)		
Pre-treatment	3.13		NS			1.17		NS			0.93		NS		
Drying	2.21		NS			0.83		NS			0.65		NS		
Pre-treatment x drying	6.25		NS			2.33		NS			1.85		NS		

	Vitamin A (µg/100g)					Vitamin C (mg/100g)				
	D_1	D_2	D_3	D_4	Mean	D_1	D_2	D_3	D_4	Mean
T_1	280.00	613.33	433.33	340.00	416.67	3.30	7.43	3.93	3.53	3.87
T_2	333.33	533.33	460.00	353.33	420.00	3.43	7.33	4.10	3.83	4.67
T_3	313.33	613.33	440.00	360.00	431.67	3.57	7.33	4.20	4.16	4.82
T_4	343.33	540.00	480.00	366.67	432.50	3.63	7.20	4.30	4.23	4.84
T_5	333.33	620.00	453.33	363.33	442.50	3.70	7.23	4.27	4.37	4.89
T_6	353.33	566.67	493.33	413.33	456.67	3.87	7.13	4.70	4.47	5.04
T_7	341.67	626.67	473.33	386.67	457.09	4.00	7.17	4.73	4.50	5.10
T_8	366.67	593.33	506.67	440.00	476.67	4.20	7.00	4.93	4.60	5.18
Mean	333.12	588.33	467.50	377.92		3.71	7.23	4.40	4.21	
Treatments	S.E.±		C.D. (P=0.05)			S.E.±		C.D. (P=0.05)		
Pre-treatment	10.34		29.345			0.08		0.249		
Drying	7.32		20.651			0.06		0.175		
Pre-treatment x drying	20.66		58.583			0.18		0.498		

NS= Non-significant

washing etc. in several agricultural produces (Santos and Silva, 2008) since, it is water-soluble. This is in accordance with the findings of Ikanone and Oyekan (2014) who reported that heating and boiling resulted vitamin C loss occurred in sweet potato (72.37 %) and Irish potato (63.90 %).

Among the different drying methods tried, milk yam tuber powder prepared by drying the tuber shreds in hot-air oven at 60^0C (D_2) recorded maximum vitamin A (588.33 μg/100g) and vitamin C (7.23 mg/100g). The minimum value for both vitamin A and C were recorded by sun dried tuber powder (D_1), 333.12 μg/100g and 3.71 mg/100g, respectively. Sun drying caused high oxygen and light exposure which accelerated oxidative degradation processes of vitamins (von Elbe and Schwartz, 1996). Ruttarattanamongkol *et al*. (2013) reported a similar reduction in beta carotene content of orange fleshed sweet potato all along oven drying at 50^0C (8.3 times) and a severe reduction at 80^0C (22.7 times).

Among the milk yam tuber powder samples prepared using different pre-treatments and drying methods, all the peeled tubers shreds irrespective of the washing methods adopted, dried in hot air oven at 60^0C (D_2) recorded high vitamin A (613.33-626.67 μg/100g). Vitamin C content was maximum (7.00-7.43 mg/100g) in all the pre-treated samples dried in hot-air oven at 60^0C (D_2). The lowest vitamin A (280.00 μg/100g) and vitamin C (3.30 mg/100g) content was recorded by three times washed peeled tuber shreds dried under sun (T_1D_1) which might be due to the high moisture content that caused prolonged heat and light exposure and ultimately resulted in oxidation and isomerization loss of vitamins (Ruttarattanamongkol *et al*., 2013).

Although mineral composition of milk yam tuber powder are non-significant, both the vitamin contents were significantly high for all the tuber powder samples dried in hot –air oven at 60^0C. Among them, milk yam tuber powder prepared using three times washed peeled tuber shreds (T_1D_2) is considered to be superior since it was having optimum macronutrients too. Moreover, it is sufficiently enough to meet the recommended dietary allowance (RDA) of vitamin A (900 μg/day) and vitamin C (90 mg/day) for an average healthy male of 44 years old (USDA, 2017) when using as a dietary supplement.

Non-nutrient but beneficial components of milk yam tuber powder :

Non-nutrient but beneficial components in food materials include crude fibre and ash (NIN, 1971). Crude fibre include non-starch polysaccharides (hemicelluloses and celluloses), non-carbohydrate polyphenols like cutin, suberin, waxes and also gums and pectin. Fibres are less digestible but fibre rich foods can modulate the digestive processes and thereby improves adsorption to human body (McCleary, 1999). Ash content represents the total mineral content in that food material. Ash value equal to

Table 2 : Non- nutrient but beneficial components in 100 g dried and powdered milk yam tubers

	Crude fibre (g/100g)					Ash (g/100g)				
	D_1	D_2	D_3	D_4	Mean	D_1	D_2	D_3	D_4	Mean
T_1	7.27	7.13	7.00	6.93	7.08	3.49	3.56	4.13	3.82	3.75
T_2	6.93	6.93	6.73	6.67	6.82	3.80	3.91	4.05	4.32	4.02
T_3	5.87	5.93	6.13	6.00	5.98	3.99	4.25	4.36	5.21	4.45
T_4	6.27	6.13	6.20	6.27	6.22	4.75	4.70	5.06	5.29	4.95
T_5	4.60	5.13	4.80	5.07	4.90	4.11	5.44	5.14	5.16	4.96
T_6	5.07	5.07	4.80	5.13	5.02	5.13	5.56	5.05	5.29	5.26
T_7	4.73	4.80	4.60	4.40	4.63	5.13	4.96	5.31	5.42	5.21
T_8	5.07	4.73	4.60	4.67	4.77	5.02	5.03	5.18	4.99	5.06
Mean	5.74	5.73	5.61	5.64		4.43	4.68	4.78	4.94	

Treatments	S.E.±	C.D. (P=0.05)	S.E.±	C.D. (P=0.05)
Pre-treatment	0.13	0.369	0.20	0.558
Drying	0.09	NS	0.14	NS
Pre-treatment x drying	0.26	NS	0.40	NS

NS= Non-significant

or more than 0.5 per cent is a good portrayal of mineral content (Adeleke and Odedeji, 2010).

Pre-treatments applied to milk yam tuber shreds had influenced both the crude fibre and ash content of tuber powder. But drying methods adopted as well as its interaction with pre-treatments never influenced the crude fibre and ash content of tuber powder (Table 2). Peeled and three times washed milk yam tuber shreds (T_1) recorded maximum crude fibre, 7.08 g/100g and the minimum value was recorded by non-washed peeled (T_7) as well as non-peeled (T_8) tuber shreds, 4.63 and 4.77 g/100g, respectively. Increased crude fibre content of milk yam powder was due to more number of washings and vice versa. This might be due to the leaching of soluble components while washing and resulted in the concentration of crude fibre. An analogues increase in crude fibre content was recorded by Fekadu *et al*. (2013) for peeled and boiled Anchote tubers.

Maximum value for ash content (5.26 g/100g) was recorded by non-peeled tubers washed for single time (T_6). It was observed that washing more than two times cause a significant loss in ash content but moderate level of ash are present in those samples too. Among all the pre-treated samples non-peeled samples recorded more ash content than the peeled ones indicating the presence of more minerals in peels than the flesh which is in agreement with the findings of Salawu *et al*. (2015) in sweet potato.

Crude fibre (4.40-7.27 g/100g) and ash content (3.49-5.56 g/100g) of milk yam tuber powder are higher than that of other roots and tubers listed by NIN (1971). For sweet potatoes the crude fibre (Alam *et al*., 2016) and ash content (Salawu *et al*., 2015) ranges from 2.28-11.7 per cent and 1.47-5.40 per cent, respectively. This characteristic might be due to its genetics, climatic conditions, cultivation differences, stage of maturity etc. (Alam *et al*., 2016).

Effect of pre-treatments and drying methods on sensory quality of milk yam tuber powder :

Sensory evaluation is defined as a scientific method used to evoke, measure, analyse and interpret those responses to products perceived through senses of sight, smell touch, taste and hearing (Stone and Sidel, 1993). Sensory evaluation plays a major role in food quality assessment. Moreover, in several cases products that win quantitative physico-chemical as well as nutritional tests might got rejected for its poor sensory attributes (Jonnalagadda *et al*., 2001). While performing sensory evaluation it is always not practical for tasting and judging

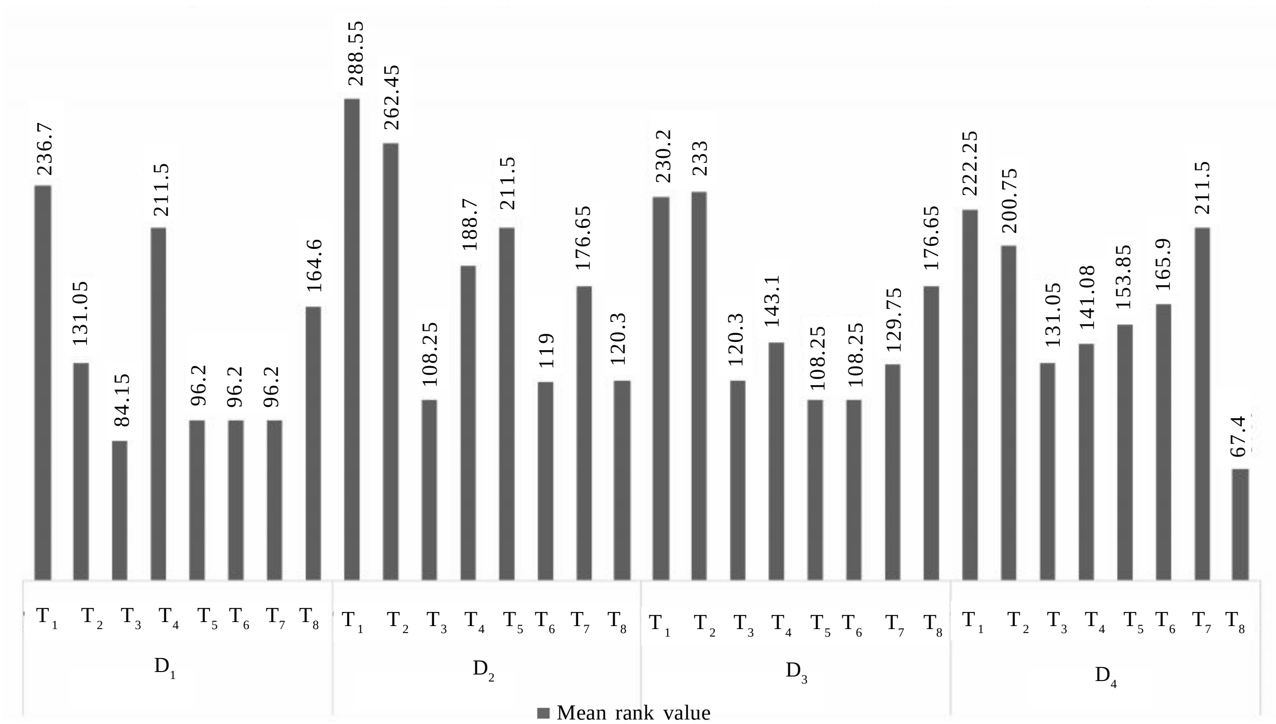

Fig. 1: Overall visual quality (OVQ) of milk yam tuber powder prepared using different pre-treatments and drying methods

the product quality (Manay and Shadaksharaswamy, 2008). In this exigency it is appropriate to assess the overall visual quality (OVQ) of the product, the main tool of consumers in judging the product (Gomez-Lopez, 2012).

In the present study, milk yam tuber powder prepared using three times washed peeled tuber shreds dried in hot-air oven at 60^0C (T_1D_2) recorded maximum mean rank value for OVQ (288.55) (Fig. 1). Non-peeled and non-washed tuber shreds dried in hot-air oven at 80^0C (T_8D_4) recorded the lowest mean rank value for OVQ (67.40) of the tuber powder. Irrespective of the drying methods used three times washed peeled tuber shreds (T_1) recorded higher OVQ than those non-peeled and non-washed tuber shreds (T_8). Moreover, it was observed that milk yam tuber powder prepared by sun drying had poor sensory quality. It was seen that samples that recorded lower OVQ values were darker in colour that might be due to enzymatic browning or presence of poly phenolic compounds (Ihekoronye and Ngoddy, 1985) or due to the caramelisation of soluble solids (Pinherio-Santana *et al*.,1998). This is in agreement with the findings of Seidu *et al*. (2012) who reported darker appearance of sweet potato chips and flakes due to mould growth before proper drying which impaired its quality. Washing the peeled tuber shreds for three times and drying those shreds in hot air oven at low temperature (60^0C) (T_1D_2) averted all un-favourable effects on sensory quality attributes thus, scored high mean rank value for OVQ.

Conclusion:

Drying is an easiest and cheapest way of food preservation.For exploring the medicinal and nutraceutical potential of milk yam drying can be an essential tool. Adopting appropriate pre-treatments and drying methods could improve the flour whiteness and quality of milk yam flour. In the present study, milk yam tubers peeled and shredded, washed for three times, dewatered by keeping in bamboo basket and dried in hot-air oven at 60^0C, powdered to produce good quality power. This has got superior nutritional and sensory quality attributes. The produced flour can be a raw material for several food and drug industries for the preparation of bakery products, nutraceuticals, dietary supplements etc. since milk yam is having both medicinal and functional potential.

Acknowledgment:

The authors are grateful to Moulana Azad National Foundation for funding the project and Athmic Biotech Pvt. Solutions, Kalliyoor, Thiruvananthapuram for providing analytical services.

LITERATURE CITED

Adeleke, R. O. and Odedeji, J. O. (2010). Functional properties of wheat and sweet potato flour blends. *Pakistan J. Nutr.,* **9** (6) : 535.

Alam, M. K., Rana, Z. H. and Islam, S. N. (2016). Comparison of the proximate composition, total carotenoids and total polyphenol content of nine orange fleshed sweet potato varieties grown in Bangladesh. *Foods,* **5**(3) : 64. Retrieved from *http://www.mdpi.com/2304-8158/5/3/64/htm.*

AOAC [Association of the Official Agricultural Chemists]. (2000). *Official method of analysis* (17th Ed.). Association of the Official Agricultural Chemists, Washington, D.C.

Chua, K. J. and Chou, S. K. (2003). Low-cost drying methods for developing countries. *Trends Food Sci. Technol.,* **14** : 519-528.

Fabbri, A. D. T. and Crosby,G. A. (2016). A review of the impact of preparation and cooking on the nutritional quality of vegetables and legumes. *Internat. J. Gastronomy &Food Sci.,* **3** : 2-11.

Fekadu, H., Beyene, F. and Desse, G. (2013). Effect of traditional processing methods on nutritional composition and anti-nutritional factors of Anchote (*Coccinia abyssinica* Lam. (Cogn.) tubers grown in western Ethiopia. *J. Food Proc. & Technol.,* **4** : 249.

Gomez-Lopez Vincente. M. (2012). *Decontamination of fresh and minimally processed produce.* Wiley-Blackwell: Oxford, U. K.

Grabowski, J.A., Truong, V. D. and Daubert, C.R. (2008). Nutritional and rheological characterisation of spray dried sweet potato powder. *LWT – Food Science & Technology. e – J.,* **41** : 206 – 216. *Retrieved fromhttps://pubag. nal. usda.gov/pubag/downloadPDF.xhtml?id=17240 &content=PDF.*

ICARDA [International Center for Agricultural Research in the Dry Areas]. (2013). *Methods of soil, plant and water analysis*: A Manual for the West Asia and North Africa Region [on-line]. Retrieved from *https://www.google.co. in/search?q=Methods of Soil, Plant and Water Analysis_ A manual for the West Asia and North_Africa region.pdf.*

Ihekoronye, A. I. and Ngoddy, P. O. (1985). *Integrated food science and technology for the tropics*. Macmilian

Publishers, NEW YORK, U.S.A.

Ikanone, C. E. O. and Oyekan, P. O. (2014). Effect of boiling and frying on the total carbohydrate, vitamin C and mineral contents of Irish (*Solanum tuberosum*) and sweet potato (*Ipomoea batatas*) tubers. *Nigerian Food J.*,**32**(2):33-39.

Jonnalagadda, P. R., Bhatt, R. V., Sudershan, R.V. and Naidu, A. N. (2001). Suitability of chemical parameters in setting qualitystandard for fried snacks. *Food Quality & Preference,* **12** : 223-228.

Khan, M.S., Nema, N., Kharya, M. D. and Khanam, S. (2009). Chromatographic estimation of maturity based phytochemical profiling of *Ipomoea mauritiana. Internat. J. Phytomedicine,* **1** : 22-30.

Knuckles, B. E., Bickoff, E. M. and Kohler, G. O. (1972). Pro-xan process: Methods of increasing protein recovery from Alfalfa. *J. Agric. & Food Chem.,* **20** : 1055 - 1057.

Lawless (1995). *Sensory evaluation of food.* Springer link Publishers, USA.

Lyimo, M. E., Gimbi, D. M. and Kihinga, T. (2010). Effect of processing methods on nutrient content of sweet potato varieties grown in lake zone of Tanzania. *Tanzania J. Agric. Sci.*,**10** (1) : 55-61.

Mahan Kathleen, L. and Escott-Stump Sylvia (2004). *Krause's Food, nutrition and diet therapy*. The Curtis Center, U. S. A.

Manay, N. Shakuntala and Shadaksharaswamy, M. (2008). *Food facts and principles* (Indian Reprint, 2016). New Age International (P) Ltd. Publishers, NEW DELHI, INDIA.

McCleary, B. V. (1999). Enzyme purity and activity in fibre determinations. *Cereal Food World,* **44** : 590-596.

NIN (Nutrition Institute of India) (1971). Nutritive value of Indian Foods (Indian Reprint, 2009). National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India.

Pinheiro-Santana, H. M., Stringheta, P. C., Brandao, S.C. C., Paez, H. H. and de Queiroz, V. M. V. (1998). Evaluation of total carotenoids, β – and β – carotene in carrots (*Daucus carota* L.) during home processing. *Food Sci. & Technol.,* (Campinas), **18** (1) : 1-15.

Ruttarattanamongkol, K., Chittrakorn, S., Veerawatanakorn, M. and Dangpium, N. (2016). Effects of drying methods on physico-chemical characteristics, anthocyanin, beta-carotene and antioxidant activity retentions of purple and orange fleshed sweet potato flours. *J. Food Sci. & Technol.,* **53**(4) : 1811-1822.

Sadasivam, S. and Manickam, A. (1992). *Biochemical method for agricultural sciences.* Wiley Eastern Limited and Tamil Nadu Agricultural University, Coimbatore (T.N.) INDIA.

Salawu, S. O., Udi, E., Akindahunsi, A.A., Boligon, A.A. and Athayde, M. L. (2015). Antioxidant potential, phenolic profile, nutrient composition of flesh and peels from Nigerian white and purple skinned sweet potato (*Ipomoea batatas* L.). *Asian J. Plant Sci. & Res.,* **5**(5) : 14-23.

Santos, P. H. S. and Silva, M. A. (2008). Retention of vitamin C in drying processes of fruits and vegetables – A review. *Drying Technol.,* **26** (12) : 1421-1437.

Seidu, J. M., Bobobee, E. Y. H., Kwenin, W. J. K., Tevor, W. J., Mahama, A. A. and Agbeven, J. (2012). Drying of sweet potato (*Ipomoea batatas*) (chipped and grated) for quality flour using locally constructed solar dryers. *ARPN J. Agric. & Biological Sci.,* **7** (6) : 466-473.

Sonia, N.S. and Jessykutty, P. C. (2017). Antioxidant potential of health mix powder prepared using milk yam (*Ipomoea digitata* L.) [abstract]. In: Research in Present Scenerio (RESCON 2017) – Multidisciplinary National Conference; 27, January, 2017, Nesamony Memorial Christian College, Marthandam, Kanyakumari, p.65. Abstract No. BO 04.

Sonia, N.S., Vidya, K.M. and Jessykutty, P.C. (2017). Ksheervidari (*Ipomoea digitata* L.) an underutilised medicinal plant – an update. *Internat. J. Medicine & Pharmaceutical Sci.,* **7** (1) : 47-60.

Stone Herbert and Sidel, L. Joel (1993). *Sensory evaluation practices* (2nd Ed.). Food and Science Technology Series, Academic Press, California.

USDA [United States Department of Agriculture]. (2017). USDA Food composition databases [on line]. Retrieved from *https://ndb.nal.usda.gov/ndb/nutrients/index.*

Venkatasubramanian, P., Kumar, S. K. and Venugopal, S. N. (2009). Use of 'Kshiravidari' as a substitute for 'Vidari' as per Ayurvedic descriptions. *Indian J.Tradit. Knowledge,* **8** : 310-318.

Von Elbe, J. H. and Schwartz, Steven J. (1996). Colorants. In: Fennema, O. R. (Ed.), Food Chemistry. Marcel Dekker, NEW YORK, U.S.A.

Yuan, G., Sun, B., Yuan, J. and Wang, Q. (2010). Effect of 1-methylcylcopropene on shelf-life, visual quality, antioxidant enzymes and health promoting compounds in Broccoli florets. *Food Chem.,* **118** : 774 – 781.

8th Year
★★★★★ of Excellence ★★★★★