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Effect of various dehydration methods on proximate composition and retention of antioxidants in different fruit powders

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Abstract

Present study was carried out to assess the effect of various dehydration techniques such as sun drying, solar drying, drying after freezing (Freeze for one hour followed by drying using lab scale air oven), vacuum drying and drying using lab scale air oven on physiochemical and retention of antioxidant in different fruit powder prepared from Bael *(Aegle marmelos)*, Sour Sop *(Annona muricata)* and Palmyra *(Borassus flabellifer)*. Moisture content, Total Ash, Crude fiber %, Fat %, Crude protein %, ascorbic acid and β-Carotene were tested. All fruit powders prepared by using sun drying showed minimum moisture content and the highest level of moisture content was recorded by the samples dehydrated using vacuum drying. Among different drying treatments the highest fat percentage recorded by the solar dried sample and there is no any significant difference (α= 0.05) between sun drying and vacuumed drying. Higher concentration of β-Carotene was recorded in vacuum dried samples both in bael and Palmyra fruit powders and it significantly different (α= 0.05) from other treatments tested. Maximum retention of ascorbic acid content (26.59 Mcg/100g) was recorded by the soursop powder prepared by vacuum drying.

Introduction

Fruits having essential dietary nutrients such as vitamins, minerals, fiber and essential antioxidants and many clinical researches support the fact that consuming fruits are beneficial to age related diseases, cancers, heart diseases (Ames *et al*., 1993; Halliwell,1993). This could be mainly attributed to those antioxidants contained in fruits. Keeping the product fresh is the best way to maintain its nutritional value, but most storage techniques require low temperatures, which are difficult to maintain throughout the distribution chain. However most of the fruits are wasted due to microbial rot during storage and hence there is need for fruit preservation technologies (Nikema *et al*., 2003).

Tropical fruits are excellent source of carotenoids, vitamins and minerals. In recent years increasing attention has been paid to the role of diet in human health and among antioxidant vitamins, vitamin C has many biological activities human body reducing level of C-reactive protein, a marker of inflammation and possibility a predictor of heart diseases (Podsedek, 2007) Bael *(Aegle marmelos)* is a tropical fruit native to south east Asia and its grown throughout India, Sri Lanka, Pakistan, Bangladeshand most of the Southeast countries (Sing and Roy ,1984). The bael fruit pulp contains many functional and bio active compounds such as carotenoids, phenolics, alcoloids, flevonoids and has innumerable traditional medicinal uses (Arseculerantne *et al*., 1981; Karunanayake *et al*., 1984; Singh, 1986; Nagaraju and Rao, 1990). Drying is the suitable alternative for postharvest management specifically in countries like Sri Lanka where exist poorly established low temperature distribution and handling facilities. It is noted that over 20% of the world perishable crops are dried to increase shelf life and promote food security (Gragowski *et al*., 2003). Preservation of fruits through drying dates back many countries and is based on sun and solar drying techniques. The poor quality and product contamination lead to the development of alternate drying techniques (Bezyma *et al.*, 2005). However the high moisture content of fruits, approximately 87%, can cause rapid deterioration after cropping. Thus, the dehydration is used to improve fruits stability by decreasing the water activity and microbial activity to minimize physical and chemical reactions that may occur during storage. Besides aggregating commercial value to the fruits drying reduces wastage of postharvest losses and might allow their commercialization for extended period of time with minor dependence of seasonal conditions (Marques *et al*., 2007).The choice of drying method depend on

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various factors such as type of product, availability of drying machineries, cost of dehydration and final quality of product. Energy consumption and quality of dried products are other critical parameters in the selection of drying process. The aim of this work will be to Determination of the influence of different drying methods in preservation of antioxidants and other physical and chemical properties of selected fruit powders.

Materials and Methods

Sample preparation

Bael *(Aegle marmelos)*, Palmyra *(Borassus flabellifer)* and Sour Sop *(Annona muricata)* were used to prepare powder by different dehydration techniques like sun drying, solar drying, drying after freezing (Freeze for one hour followed by drying using lab scale air oven at 55ºC), vacuum drying at 50ºC and drying using lab scale air oven at 55ºC. The diseased and damaged fruits were sorted out where as remaining were washed and pulp was taken. Fruit powders were prepared by drying followed by grinding it in a mixer grinder and shifted to get fine partials.

Moisture content

Moisture content was estimated using the method described in AOAC (2005). 10 g sample was dried in hot air oven at 130ºC ±1ºC in pre-weight dishes till constant weight. The dried sample was transferred to desiccators alone with dishes and cooled to room temperature. The dish weight was and moisture content in per cent was calculated from loss of weight.

Ash

A known quantity of ground sample was taken in a pre-weighed a silica crucible and charred over the heater to make it smoke free. The crucible with the sample was ignited at 600ºC for 3 hours in a muffle furnace. When muffle furnace was slightly cooled, the crucible with ash was taken out, kept in desiccators to cool down, constant weight was taken. The difference between the weight of the silica crucible as empty and the ash was the amount of total ash. The percent ash was calculated (AOAC, 2005).

Crude fat

Five gram of dried sample was extracted with petroleum ether in Soxhlet extraction apparatus for 6hrs.The ether extract was filtered in pre-weighed beakers, petroleum ether was evaporated completely from the beaker and the increase in weight of beaker represented the fat content (AOAC, 2005).

Crude fiber

Two gram fat free dried sample was transferred to 600 ml beaker and 200 ml of 1.25% H_2SO_4 was added. Beaker was placed on digestion apparatus with readjusted hot plate and boiled for 30 min. and filter the contents through a filter paper. Wash the residue free of acid using hot distilled water and then transferred to a same beaker to which added 200 ml of 1.25% sodium hydroxide. Digest the contents for half an hour, filter and wash free of alkali using hot distilled water. The residue was transferred to crucibles, weighed, dried in oven overnight at 105ºC, and then placed in a muffle-furnace at 600ºC for 3 hrs. The loss in weight after ignition represents the crude fiber in the sample (AOAC, 2005).

Crude protein

Crude protein was estimated by using micro-kjeldal method, (AOAC, 2005) using the factor 6.25 for converting nitrogen content into crude protein.

β -Carotene

β -Carotene content was determined using High Performance Liquid Chromatography (C-R6A, Shimadzu, Japan). Five grams of fruit sample was saponified with 20 ml of 95% ethanol and 5ml of 100% KOH and refluxed for 30 min at 85ºC. The mixture was extracted with hexane until the sample become colorless. The extracted sample was then filtered through a 0.45µm. nylon membrane filter and analyzed using revised-phase high performance liquid chromatography .The test solution was injected under isocratic conditions into the µBondpack C18 column (300 nm x 3.9 mm, 125A, 10 µm) with a ternary mixture of acetonitrile-methanol-ethyl acetate (88:10:2 v/v) as mobile phase with the flow rate of 1.0 ml/minute. Detection was performed at 436 nm. The results expressed as µg/100g in dry weight (Tee and Lim, 1991).

Standard preparation of β -carotene

Standard of β -Carotene solutions were prepared by taking 10 mg in 100 ml n-Hexane. The standard solutions were prepared as 20, 40, 60, 80 ppm dilutions of 5 ml of each n-Hexane solutions.

Ascorbic acid

Ascorbic acid content was determined using High Performance Liquid Chromatography, (C-R6A, Shimadzu, Japan) following a modified method by Wimalasiri *et al.* (1983). Five grams of fruit samples was extracted with 200 ml of 3%w/v citric acid. The mixture was then centrifuge at 10000 rpm for 5 min. at 25ºC using Centrifuge (Remi, R4A; India)

machine. The supernatant was then filtered using C18 Cep-pack-cartridge and 0.45 µm membrane filter, prior to HPLC injection. The mobile phase used in isoctratic elution was acetonitrile-methanol (80:20 v/v) at a flow rate of 1ml/min. A revised phase column was used, µBondpack C_{18} column (300 nm x 3.9 mm, 125A, 10 µm). Detection was performed at 234 nm. Results obtained were expressed as Mcg/100g dry weight).

Statistical analysis

Data obtained were in triplicate (n=3) and the results were assessed by completely randomized design using ANOVA by SAS statistical package. Mean separation was done by using Least Significant Difference (LSD) at α= 0.05.

Results and Discussion

The changes observed in the proximate composition of different fresh fruits and its dehydrated powder in Table 1 and 2 respectively. The results of moisture content that were produced using different dehydration techniques are shown in Table 1, in their percentage. All fruit powders prepared by using sun drying showed minimum moisture content and the highest level of moisture content was recorded by the samples dehydrated using vacuum drying. It was found that the moisture content of powders varied from 16.49% to 11.13% (dry weight basis) with the highest level in vacuum dried sample.

There was significant difference between ($p<0.05$) both treatments. Palmyra and bael recorded the higher protein content when dried using solar drying technique whereas lowest protein content was recorded in sample freeze prior to drying. Among the fruit powders tested only palmyra powder recorded the presence of fat ranged from 3.64±0.02 to 3.95±0.01. Among different drying treatments the highest fat percentage recorded by the solar dried sample and there is no any significant difference (α= 0.05) between sun drying and vacuumed drying. The lowest fat percentage was recorded by sample freeze before drying. Among five different drying methods tested oven dried samples recorded heights level of ash % in bael. This correlated with the results of various drying methods used, significantly increased the ash, fiber and mineral content of the leaves of Gynandropsis gynandra (Hassan *et al.*, 2004).

Ash is the inorganic residue remaining after the water and organic matter have been removed by food. The ash content is measure of the total amount of mineral present within a food; whereas the mineral content is a measure of amount of specific inorganic

Table 1. proximate composition of 100 g of edible portion

Fruit	parameter	% composition
Bael	Moisture (%)	61.60±0.02
	Fat (%)	0.27±0.01
	Protein (%)	1.12±0.01
	Total ash (%)	0.80±0.01
	Fiber	3.27±0.01
Palmyra	Moisture (%)	80.10±0.02
	Fat (%)	0.16±0.01
	Protein (%)	0.79±0.01
	Total ash (%)	0.62±0.01
	Fiber	6.31±0.02
Soursop	Moisture (%)	79.72±0.01
	Fat (%)	0.27±0.01
	Protein (%)	0.94±0.01
	Total ash (%)	0.67±0.01
	Fiber	4.12±0.01

Standard deviation for three replicate (n=3) determinations

compounds present in the food. The increase in the ash and fiber contents observed in this study could be as a result of the removal of moisture which tends to increase the concentration of nutrients (Morris *et al.*, 2004).

The fruits were analyzed for β-Carotene in each treatment was shown in Table 3.The peaks for β-Carotene were recorded at 4 to 5 min. as the peaks obtained at 4.6 min in standard. The standard β -Carotene peak was achieved at 4.6 minutes (Rt=4.7). The results conformation with (Ahamad *et al*., 2007) standard beta carotene peak was achieved at the retention time of 4.7 min. Among the treatment tested such as; vacuum drying, drying using lab scale air oven, Drying after freezing (Freeze for one hour followed by drying using lab scale air oven), solar drying, sun drying showed the concentration of β -Carotene ranged from 818.62 µg/100g to 2111.59 µg/100g and 617.55 µg/100g to 2647.19 µg/100g in bael and palmyra respectively. Among different treatments tested the higher concentration of β -Carotene was recorded in vacuum dried samples both in bael and palmyra fruit powders may be the reason due to low temperature applied during drying process. The results obtained was supported reported that fruits vegetables and their products in the dried form are good source of energy, mineral and vitamins. However during the process of dehydration, there are changes in nutritional quality (Singh *et al*., 2006). A more number of vitamins such as A, C and thiamin are heat sensitive and sensitive to oxidative degradation

Table 2. Proximate composition of freshly prepared fruit powder by different drying techniques

Fruit	parameter	Solar drying	Oven drying	Freeze prior to drying	Sun drying	Vacuum drying
Bael	Moisture (%)	9.42±0.02	8.36±0.04	8.60±0.01	7.19±0.02	9.62±0.02
	Fat (%)	-	-	-	-	-
	Protein (%)	2.35±0.02	2.34±0.02	1.75±0.01	2.29±0.08	2.34±0.02
	Total ash (%)	3.97a±0.10	4.03a±0.05	4.10a±0.10	3.90a±0.10	3.18±0.21
	Fiber	2.43±0.06	2.47±0.06	2.13±0.01	2.11±0.01	2.30±0.03
	Total phenol(mg GA/g)	11.65	12.85±0.27	12.62±0.12	10.42±0.16	16.67±0.11
Palmyra	Moisture (%)	8.53±0.03	7.35±0.05	6.66±0.01	6.34±0.02	9.32±0.05
	Fat (%)	3.95±0.01	3.69±0.01	3.64±0.02	3.75±0.01	3.70±0.02
	Protein (%)	4.09±0.01	3.96±0.10	3.50±0.00	3.86±0.20	4.07±0.02
	Total ash (%)	3.92±0.07	3.60±0.00	4.20±0.01	3.90±0.10	3.20±0.01
	Fiber	3.96±0.04	3.70±0.02	3.66±0.05	3.75±0.04	3.80±0.01
	phenol(mg GA/g)	5.57±0.06	5.87±0.07	6.21±0.08	5.41±0.07	7.32±0.06
Sour sop	Moisture (%)	8.95±0.04	8.58±0.11	8.87±0.01	8.52±0.04	9.42±0.01
	Fat (%)	-	-	-	-	-
	Protein (%)	2.34±0.01	1.95±0.63	2.32±0.02	2.31±0.02	2.32±0.02
	Total ash (%)	2.90±0.10	2.90±0.10	2.77±0.06	2.80±0.00	2.77±0.06
	Fiber	27.31±0.01	28.21±0.01	26.62±0.02	29.21±0.02	28.49±0.08
	phenol(mg GA/g)					

Standard deviation for three replicate (n=3) determinations.

Table 3. β -Carotene content (µg/100g) of dehydrated bael and palmyra

Fruit	Solar drying	Oven drying	Freeze prior to drying	Sun drying	Vacuum drying
	β Carotene (µg /100g)				
Bael	1964.74±0.64^{e}	1134.88±0.02^{b}	1291.08±0.05^{c}	818.62±0.04^{a}	2111.59±0.42^{b}
Palmyra	1333.66±0.05^{e}	2201.80±0.04^{c}	2571.51±0.23^{b}	617.55±0.01^{a}	2647.19±1.03^{d}

Standard deviation for three replicate (n=3) determinations. Means with the same letters on the same raw are not significantly different at α= 0.05

Ascorbic acid retention in dehydrated sour soup powder in table 4 indicated that the higher retention was recorded in vacuum dried sample followed by solar drying. The lower retention in ascorbic acid content may be due to drying under high temperature 55°C affect for degradation of ascorbic acid content in dehydrated soursop. Vitamin C losses during fruit drying depend on raw material type and drying method, as well as additional factors, e.g. blanching or sulfitation. Its losses may vary from 10% at careful selection of technological parameters to almost total destruction in the case of drastic hydrothermal treatment and long drying with intensive airflow (Hulme, 1971). In general, quick drying retains larger quantity of ascorbic acid than slow drying. Therefore the vitamin C content of vegetable issue is greatly reduced during the sun and hot air drying (Jayaraman and Das Gupta, 1995). Mishra (2010) reported that the lowest ascorbic acid content after solar during due to increase the rate of oxidation in sundried Amla powder.

Table 4. Ascorbic acid content (mcg/100 g) of dehydrated sour sop

Fruit	Ascorbic acid (Mcg/100g) Solar drying	Oven drying	Freeze prior to drying	Sun drying	Vacuum drying
Sour sop	21.59±0.02	2.14±0.06	12.64±0.01	20.34±0.02	23.22±0.02

*Fresh fruit pulp 28.4mg/100g (f/w), 150.84 mg/100g (d/w)
Standard deviation for three replicate (n=3) determinations.

Conclusions

Higher concentration of β -Carotene was recorded in vacuum dried samples both in bael and Palmyra fruit powders and it significantly different (α= 0.05) from other treatments. Maximum retention of ascorbic acid content (26.59 Mcg/100g) was recorded by the soursop powder prepared by vacuum drying. Therefore vacuum drying can be recommended as the most effective drying method to protect chemical characteristics of fruit powders than other drying treatment tested.

References

Ahamad, M.N., Saleemullah, M. and Shah, H.U. 2007. Determination of beta carotene content in fresh vegetables using high performance liquid chromatography. Sarhad Journal of Agriculture 23(3):767-770.

Ames, B.N., Shigenaga, M.K. and Hagwn, T.M. 1993. Procedures National Academy of Sciences, U.S.A. 90(17): 7915-7922.

AOAC. 2005. Official methods of analysis, 18th edn. Association of Official; Analytical Chemists, Washington DC.

Arseculeratne, S.N., Gunathilake, A.A.L. and Panabokke, R.G. 1981. Studies on medicinal plants of Sri Lanka; Ocarance of pirolizidine alcoloids and hepatotoxic properties in some traditional medicinal plants. Journal of Ethnopharmacology 4(2): 159-177.

Bezyma, L.A. and Kotovoy, V.A. 2005. Vacuum drying and hybrid technologies. Stewart Postharvest Review 4: 6-13.

Gragowski, S., Marcotte, M. and Ramaswamy, H.S. 2003. Drying of fruits, vegetables and spices. In: Handbookof postharvest Technology: Cereals,fruits, vegetables, Tea and spices., Chakraverty,A., Mujumdar, A.S., Raghavan, G.S.V., Ramaswamy, H.S. (Eds). Marcel Dekker,New York,Ch 23, p 653-695.

Halliwell, B. 1993. Free radicals and antioxidants. Trends Pharmacological Science 32: 3-6 .

Hassan, S.W., Umar, R.A., Maishanu, H.M., Matazu, I.K., Faruk, U.Z. and Sani, A.A. 2007. The effect of drying methods on the nutrients and non nutrients composition of leaves of Gynandropsis gynandra . Asian Journal of Biochemistry 2: 349-353.

Hulme, A.C. 1971. The Biochemistry of Fruit and their Products, Academic Press, London and New York,Vol. 2, p. 788.

Jyaraman, K.S. and Das Gupta, D.K. 1992. Dehydration of fruits and vegetables- recent developments in principals and techniques. Drying Technology 10: 1-50.

Karunanayake, E.H., Welihinda, J., Sirimanna, S.R. and Sinnadorai, G. 1984. Oral hypoglycaemic activity of some medicinal plants of Sri Lanka. Journal of Ethnopharmacology 11: 223-231.

Mishra, P. 2010. Physicichemical properties of Chakya variety of Amla *(Embelica officinalis)* and effect of different dehydration methods on quality of powder. African Journal of Food Science 3(10): 303-306.

Morris, A., Barnett, A. and Burrows, O. 2004. Effect of processing on nutrient content of foods. Cajarticles 37(3): 160-164.

Nagaraju, N. and Rao, K.N. 1990. A survey of plant crude drugs of Rayalaseema, Andra Pradesh. Journal of Ethnopharmacology 29: 137-158.

Nikiema, A. and Maesen, J.G. 2003. Identifying candidate wild food plant for a sustainable agroforastry through market survey. International symposium for sustainable dry land agricultural systems.2-5 December 2003 ICRISAT Niamey-Niger pp. 251-256.

Podsedek, A. 2007. Natural antioxidants and antioxidant capacity of *Brassica* vegetables : A review. LWT-Food Science and Technology 40: 1-11.

Singh, R.N. and Roy, S.K. 1984. The bael: Cultivation and processing. New Delhi: ICAR bulleting

Singh, Y.N. 1986. Traditional medicine in Fiji Indians. Journal of Ethnopharmacology 15: 57-88.

Singh, U., Sagar, V.R., Behera, T.K. and Kumar, P.S. 2006. Effect of drying conditions on the quality of dehydrated selected vegetables. Journal of Food Science and Technology 43: 579-582.

Tee, E.S. and Lim, C.L. 1991. Carotenoid composition and content of Malaysian vegetables and fruits by the AOAC and HPLC methods. Food Chemistry 41: 309-339.

Wimalasiri, P. and Wills, R.B.H. 1983. Simultaneous analysis of ascorbic acaid and dihidroascorbic acid in fruit and vegetables by HPLC. Journal of Chromatography 15: 418-421.