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Retention of physicochemical and antioxidant properties of dehydrated bael (*Aegle marmelos*) and palmyra (*Borassus flabellifer*) fruit powders

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Abstract

Present study was carried out to evaluate the effect of various dehydration techniques such as sun drying, solar drying, drying after freezing (Freeze for one hour followed by mechanical drying at 55°C), vacuum drying and drying using lab scale air oven on proximate composition and retention of antioxidants in different fruit powder prepared from Bael (*Aegle marmelos)* and Palmyra (*Borassus flabellifer)*. Moisture content, Total Ash, Crude fiber %, Fat %, Crude protein %, total phenolic content,β –Carotene and antioxidant activity were tested. The antioxidant activity was measured based on the ability of fruit extract to scavenge 1, 1-diphenyl-2-picrylhydrazyl (DPPH). Among different drying treatments the highest fat percentage recorded by the solar dried palmyra fruit powder and there is no significant difference (α= 0.05) between sun drying and vacuumed drying. Higher concentration of β -Carotene and total phenolic content were recorded in vacuum dried samples both in bael and Palmyra fruit powders and it significantly different (α= 0.05) from other treatments. The scavenging activity of bael fruit powder in vacuum drying was ranged from 65.36% to 81.33% of the concentration 200 µg/ml to1000 µg/ml and the palmyra fruit powder was recorded 57.32% to 83.25% of the concentration 200 µg/ml to1000 µg/ml. Vacuum dried fruit powders of palmyra and bael were given highest radical scavenging activity and the scavenging activity of palmyra fruit powder is higher than the bael. Therefore vacuum drying can be recommended as the most effective drying method to protect chemical characteristics and retention of antioxidant properties of fruit powders.

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1. Introduction

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 antioxidants, vitamin C has many biological activities on human body reducing level of C-reactive protein, a marker of inflammation and possibility a predictor of heart diseases. Bael (*Aegle marmelos)* is a tropical fruit native to south east Asia and its grown throughout India, Sri Lanka, Pakistan, Bangladesh and most of the Southeast countries. The bael fruit pulp contains many functional and bio active compounds such as carotenoids, phenolics, alcoloids, flevonoids and has innumerable traditional medicinal uses. 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[2]. 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. 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 .The choice of drying method depend on 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 was to Determination of the influence of different drying methods in preservation of antioxidants and other chemical compounds of selected fruit powders.

2. Materials and methods

2.1 Sample preparation

Bael (*Aegle marmelos)* and Palmyra (*Borassus flabellifer)* were produce from the local market and diseased and damaged fruits were sorted out where as remaining were washed and pulp was taken for preparation of fruit powder. Bael powder was prepared by scooping out the pulp and heat for 1 min. at 80 ºC then passed through the sieve for pulp separation. Palmyra fruits were burn to remove the latex and add water in 1:1 ratio followed by heating for 1 min. at 80 ºC. Pulp was separated by pressing it by hand. Separated pulp (1kg per each) was dried using different dehydration techniques such as sun drying (directly under sun), solar drying (by using direct type sola drier at 55°C), drying after freezing (Freeze for one hour followed by drying at 55ºC), and vacuum drying (JT SELECTA, Spain) at 50 º C and drying using lab scale air oven (ULE-500, Memmert, Germaney) at 55 º C for 24 hrs. Fruit powders were prepared by drying followed by grinding in a mixture grinder and sieved to get fine partials (150 µm).

2.2 Determination of the chemical properties of fresh pulp and dehydrated fruit powders

Moisture, crude protein, crude fat, crude fibre, Total ash were determined in triplicate [1]. β -Carotene content was determined using High Performance Liquid Chromatography (C-R6A, Shimadzu, Japan)[7] with some modifications. Total phenolic content (TPC) of dehydrated food samples were measured by the Folin-Ciocalteu phenol regent and the results were expresses as mg gallic acid equivalents per g of sample as gallic acid as the standard.

2.3. Determination of the antioxidant activity:

2.3.1. Solvent extraction process

1 g of the powdered plant samples Bael (*Aegle marmelos)* and Palmyra (*Borassus flabellifer)* were dissolved in 100 ml of methanol and kept at room temperature for 48 h. The extracts were filtered through a Whatmann filter paper and concentrated using a rotary evaporator at 40 °C.

2.3.2. Antioxidant screening

The DPPH assay (1, 1-diphenyl-2-picryl hydrazyl)/ free radical scavenging assay was followed [4]. The solvent extracts of the sample were taken in the following concentration range i. e., 200, 400, 600, 800, 1000 µL in each test tube and the volume was made up to 1 mL with the solvent and 3 mL of 0.1 mM DPPH is added to all the tubes. The mixture was shaken well and incubated at room temperature for 30 minutes and absorbance was measured at 517 nm using a UV- spectrophotometer. All the experiments were performed in triplicate and the mean taken. Scavenging activity was calculated from control sample OD using the following equation.

Radical Scavenging Activity % = {(Ac –At) / Ac} x 100

Where, Ac-Absorbance of control;

At- Absorbance of test solution /sample

2.4. 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.

3. Results and discussion:

The results of proximate composition in fresh fruit pulp and dehydrated powders were evaluated and the results were given in Table 1 and 2 respectively.

It was found that the initial moisture content of beal and Palmyra was 61.60% and 80.10% respectively and it was reduced up to 7.19% in beal in sun drying and 6.34% (dry weight basis) in Palmyra and the highest was recorded by vacuum dried powder. Palmyra and bael recorded the higher protein content when using solar drying technique whereas lowest protein content was recorded in samples which freeze prior to drying. Analysis of variance showed that there was no any significant difference ($p<0.05$) between vacuum drying and solar drying but there was a difference between other drying methods used.

Among five different drying methods tested, oven dried samples recorded heights level of ash % in bael. Ash is the inorganic residue remaining after the water and organic matter have been removed by food. The increase in the ash and fibre contents observed in this study could be as a result of the removal of moisture which tends to increase the concentration of nutrients [5.] The highest fat content was recorded by Palmyra fruit powder under solar drying and it was not given significant level of fat content in dehydrated beal. The initial fat content was 0.27% and 0.61% in beal and Palmyra respectively. The results confirmation with other findings and it was given the bael pulp contain 0.3% fat, 1.8% protein, 2.9% fibre[3] .

Bael and palmyra fruits were analyzed for β -Carotene in each treatment was shown in Table 2. The initial β -Carotene content of beal and Palmyra was 3456.32 µg/100g and 3512.46 µg/100g (Table1). 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. The initial total phenolic content of fruit powders of beal and Palmyra was 75.34 mgGA /100g and 86.72 mgGA /100g respectively and the higher retention was recorded by vacuum dried fruit powders. Among different treatments tested the higher concentration of β -Carotene and total phenols (Table 2) were recorded in vacuum dried samples both in bael and palmyra fruit powders may be the reason due to low temperature applied during drying process.

Table 1 proximate composition of fresh fruit pulp

Parameter	Beal	Palmyrah
	$\bar{x}$±SD	$\bar{x}$±SD

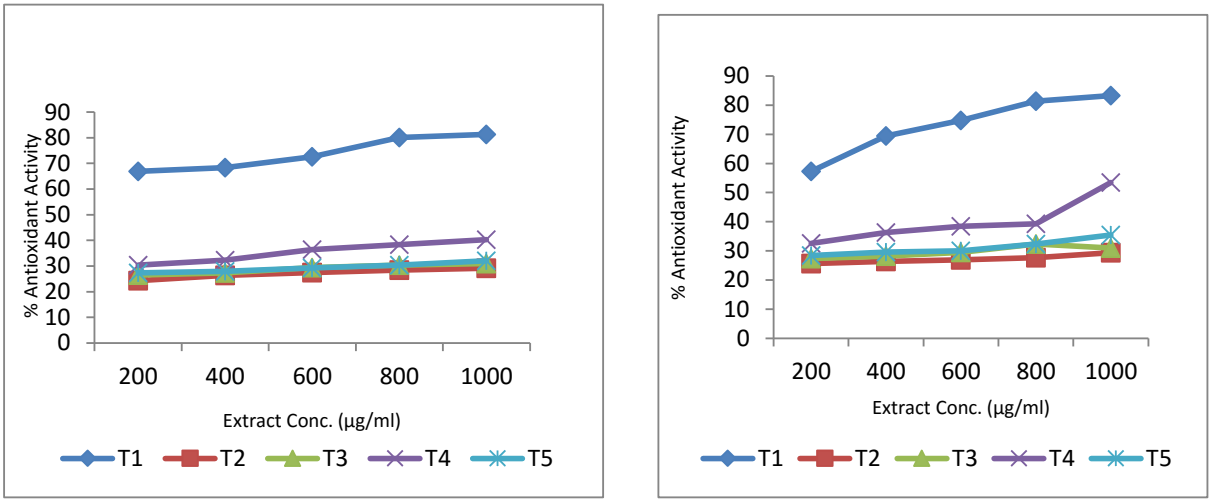
Moisture (%)	61.60±0.02	80.10±0.02
Fat (%)	0.27±0.01	0.16±0.01
Protein (%)	1.12±0.01	0.79±0.01
Total ash (%)	0.80±0.01	0.62±0.01
Fiber	3.27±0.01	6.31±0.02
(TPC) (mgGA /100g)	75.34±0.03	86.72±0.02

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

Table 2 proximate composition of dehydrated fruit powders by different drying techniques

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
β-Carotene content (µg/100g)	1964.74±0.64	1134.88±0.02	1291.08±0.05	818.62±0.04	2111.59±0.42
(TPC) (GA)/1g)	11.65±0.12	11.85±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
β-Carotene content (µg/100g)	1333.66±0.05	2201.80±0.04	2571.51±0.23	617.55±0.01	2647.19±1.03
(TPC) (GA)/1g)	5.57±0.06	5.87±0.07	6.27±0.08	5.41±0.07	7.32±0.06

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



a b.

Figure 1: DPPH radical scavenging activity a) Dehydrated Bael (*Aegle marmelos)* b) Palmyra (*Borassus flabellifer)* fruit powders

T1: Vacuum drying; T2: Sun drying; T3: Solar drying; T4: Freeze for one hour prior to drying in air oven; T5: Drying using lab scale air oven

The DPPH radical scavenging assay is an easy rapid and accurate method for determine the antioxidant activity in plant extracts. Among number of methods available, using 1, 1-diphenyl-2-picryl hydrazyl radical (DPPH) has received the maximum attention owing to its ease of use and its convenience [6]. The DPPH scavenging activity was done methanol as a solvent. In the present study the radical scavenging activity of vacuum dried bael fruit powder recorded the highest scavenging activity ranged from 66.87% -81.33% at the concentration 200- 1000 µg/ml of extracts and lowest was recorded by sun dried sample that was given the scavenging activity ranged from 24.31% - 29.21% at the concentration 200- 1000 µg/ml of extracts (Figure 1a). The radical scavenging activity of vacuum dried palmyra fruit powder recorded the highest scavenging activity ranged from 57.32% - 83.25% at the concentration 200- 1000 µg/ml and the lowest was given by sun dried fruit powder(Figure 1b). Vacuum dried fruit powders of palmyra and bael were given highest radical scavenging activity and the scavenging activity of palmyra fruit powder is higher than the bael.

4. Conclusions and Recommendations:

Moisture content of fruit powders varied from 6.34% to 9.62% (dry weight basis) .Fat content of Palmyra was found in the range of 3.69 to 3.95% and bael was not recorded a significant level of fat content after dehydration. Higher concentration of β –Carotene and total phenolic content and maximum retention of antioxidant properties were recorded in vacuum dried samples both in bael and Palmyra fruit powders and it significantly different (α= 0.05) from other treatments. Therefore vacuum drying can be recommended as the most effective drying method to protect chemical characteristics and retention of antioxidant in fruit powders.

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