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DS Satpute
Post Graduate Student, Department of Food Science and Technology, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, Maharashtra, India

UD Chavan
Head Department of Food Science and Technology, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, Maharashtra, India

AA Pawar
Post Graduate Student, Department of Food Science and Technology, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, Maharashtra, India

PM Kotecha
Sr. Cereal Food Technologist, Sorghum Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, Maharashtra, India

MR Patil
5Associate Professor, Department of Statistics, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, Maharashtra, India

Corresponding Author:
DS Satpute
Post Graduate Student, Department of Food Science and Technology, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, Maharashtra, India

Studies on dehydration and preservation of safflower green leafy vegetables

DS Satpute, UD Chavan, AA Pawar, PM Kotecha and MR Patil

Abstract
The present research was carried out to study the effect of storage on ascorbic acid and β-carotene content of dehydrated safflower leaves. Fifteen genotypes of safflower leaves including SSF-1240, SSF-708, SSF-658, SSF-748, SSF-1507, SSF-1602, A-1, SSF-733, SSF- 1565, PBNS-12, GMU-7363, GMU-4430004, SSF-1371, SSF-1708 and CO-1 were selected for the present study. Safflower leaves blanching with chemical at 600C was selected and dehydrated in tray dryer at the temperature of 55 °C for time of 7-8 hours. These dehydrated leafy vegetables were packed in low density polyethylene bags and stored at (30+2 °C) ambient temperature for a period of 3 months. The stored samples were chemically analyzed for ascorbic acid and β-carotene content at monthly intervals. The ascorbic acid content of dehydrated safflower leaves was recorded minimum in SSF-708 (6.23 mg/100 g) and maximum in A-1 (8.62 mg/100 g). The β-carotene content was observed highest in SSF-1507 (4.43 mg/100 g) and lowest in SSF-1371 (3.90 mg/100 g).

Keywords: Safflower, dehydration, LDPE, storage

Introduction
Green leafy vegetables are important part of our balanced diet as they are main natural sources of vitamins like ascorbic acid, folic acid, tocopherols, β-carotene, riboflavin and minerals like iron, calcium, magnesium and phosphorous. They increase the resistance power and improve health of human beings. Their consumption provides taste, palatability, increases appetite and provides fibre for digestion and prevents constipation (Seidu, 2012) [12]. Role of ascorbic acid in human body is necessary for the growth, development and repair of all body tissues. It's involved in many body functions, including formation of collagen, absorption of iron, the proper functioning of the immune system, wound healing and the maintenance of cartilage, bones and teeth. In the human body β-carotene converts into vitamin A (retinol). We need vitamin A for good vision and eye health, for a strong immune system and for healthy skin and mucous membranes. Taking big doses of vitamin A can be toxic but your body only converts as much vitamin A from β-carotene as its needs. Young safflower leaves, on the other hand, are cooked and eaten as a vegetable green in some areas of the world and they might be a good source of nutrition for malnourished people. Moisture (91.1%), Protein (2.5%), Fat (0.6%), Mineral (1.3%), Crude fibre (9.61%), Carbohydrates (4.5%), Calories (33 Kcal), Ca (185 mg), Iron (5.7 mg) and Phosphorus (35mg) are all present in fresh safflower leaves (Gopalan *et al.*, 2011) [2]. Safflower is mostly consumed in India and Afghanistan as a herbal remedy (made from safflower blossoms) and as tea to treat female infertility, sterility, and abortion problems (Weiss *et al.*, 1983) [2]. Locally available green leafy vegetables rich in micronutrients are highly perishable and are cheapest source of raw materials. Production of those leafy greens is seasonal and market will be over flooded during peak seasons at particular period resulting in spoilage of large quantity. The market glut and huge wastage can be prevented by preserving the vegetables. Considering the lower bulk density of dried leafy greens, drying is considered as most suitable and easy method of preservation providing nutrients in concentrated form throughout the year (Singh *et al.* 2007) [10]. To a large population of the world, balanced diets are not accessible and this is particularly seen in developing countries. The health of vulnerable groups of population is severely affected by malnutrition and micronutrient deficiency. Rehydrating dehydrated veggies returns them to a fresh like state and they may be used for throughout year (Karva, 2010) [4]. Keeping this in view, present research was undertaken to study effect of storage duration on ascorbic acid and β-carotene content in dried safflower leaves samples.

Materials and Methods

Study area

The present study was conducted at the Department of Food Science and Technology, Post Graduate Institute, MPKV, Rahuri in the year of 2020-2022.

Sample collection and preparation

The safflower leaves of fifteen genotypes were collected from Sorghum Improvement Project MPKV, Rahuri for further research study. Safflower leaves were dehydrated at the temperature of 55 °C for time of 7-8 hours in tray dryer. After dehydration, safflower leaves samples were packed in low density polyethylene bags and stored for 3 months duration for further study. The samples were chemically analyzed for ascorbic acid and β-carotene content at 30 days interval.

Safflower leaves of fifteen genotypes selected for study are

V1 = SSF-1240	V2 = SSF-708	V3 = SSF-658	V4 = SSF-748	V5 = SSF-1507
V6 = SSF-1602	V7 = A-1	V8 = SSF-733	V9 = SSF-1565	V10= PBNS-12
V11 = GMU-7363	V12 = GMU-443004	V13= SSF-1371	V14 = SSF-1708	V15 = C0-1

Pretreatments of Safflower leaves

Table 1: Selection of pretreatments

Treatments	Blanching		Chemicals	Drying Temperature (°C)
	Temp (°C)	Time (sec)		
T0	45	30	Blanching with plain water	55
T1	60	30	Blanching with chemicals (KMS, MgO, Citric Acid, NaHCO3, NaCl)	55
T2	80	30	Blanching with chemicals (KMS, MgO, Citric Acid, NaHCO3, NaCl)	55

The results presented in Table 1 indicated that safflower leaves of SSF-1507 genotype was used for testing the blanching treatment. All fifteen genotypes were given pre-treatments which were named as T0 (Blanching with plain water), T1 (Blanching with chemical), T2 (Blanching with chemicals). T1 blanching treatment was found very good according organoleptic characteristics (Table 2). This treatment (Blanching with chemical at 600C) was used for further study.

Table 2: Organoleptic evaluation of safflower leaves dried by different pretreatments

Treatments	Colour and appearance	Texture	Flavour	Taste	Overall acceptability	Rank
T0	8.3	8.4	8.5	8.5	8.42	2
T1	8.5	8.5	8.7	8.7	8.6	1
T2	8.3	8.1	8.4	8.3	8.27	3

*All values are mean of ten replications. Maximum score out of 9-point hedonic scale.

Whereas;

T0: Blanching with plain water

T1: Blanching with chemical at 600C T2: Blanching with chemical at 800C

The results presented in table 2 shows the best treatment was selected by panel of judges during sensory evaluation. The treatments selected for safflower leaves was T1 with temperature for dehydration was 55 °C, respectively. The standardized treatments after drying were stored at ambient temperature conditions in packaging materials (LDPE). Hence T1 (Blanching with chemicals) is used for storage factor. This treatment was followed for all genotypes and these sample kept for storage period.

Determination of Vitamin

Vitamins and minerals are considered essential nutrients because acting in concert they perform hundreds of roles like normal growth and nutrition in the body. Vitamins are required in small quantities in diet because they cannot be synthesized by the body.

Determination of ascorbic acid content

Amount of ascorbic acid observed in dehydrated leafy vegetables was estimated by using 2,6-dichlorophenol indophenol dye as described by Ranganna *et al.* (1986) [9] as follows:

Reagents

1. Metaphosphoric acid (3%): 3g metaphosphoric acid was suspended into 100 ml distilled water.
2. Dye solution: Sodium salt of 2,6-dichlorophenol indophenol dye (50 mg) and 42 mg sodium bicarbonate were dissolved in about 150 ml distilled water making the final volume of 200ml by adding and mixing distilled water.
3. Standard ascorbic acid solution (0.1 mg/ml): L-ascorbic acid (100 mg) was dissolved in 100 ml volume of 3% metaphosphoric acid. From this stock solution, 10 ml was diluted with 3% metaphosphoric acid to 100 ml.

Procedure Standardization of dye

5 mm standard ascorbic acid solutions were taken in conical flask and added 5 millimetre three per cent metaphosphoric acid taken. These solutions were titrated against dye solution till pink colour persisted for fifteen seconds. Dye factor was determined by the following formula:

Formula

$$\text{Dye factor} = \frac{0.5}{\text{Titre}}$$

Sample preparation

1g of vegetable sample was crushed with 3% HPO_3 in mortar and pestle and final volume was adjusted to 100 ml with 3% HPO_3. The sample was centrifuged in the centrifuge machine for five minutes after that content were strained through Whatman No. 4 filter paper.

Evaluation of ascorbic acid

10 mm aliquot was pipetted out in conical flask. Titrated against dye solution till pink colour persisted for 15 seconds. The volume of dye solution required for titration was recorded.

Formula

$$\text{Ascorbic acid (mg/100 mg)} = \frac{\text{Titre x dye factor x Volume of extract made}}{\text{Volume of sample taken for titration (ml) x Weight of sample taken (g)}} \times 100$$

Determination of β-carotene content

β-carotene content of the selected samples was determined by the method of A. O. A. C. (1980) [1].

Reagents

Water and n-butanol were mixed in the ratio 6: 2 and shake well and then allowed to stand till it separates into two phases and the upper clear layer with bubbles was used as water saturated n-butanol.

Procedure

1. One gm of dehydrated vegetable sample was mixed with 50 ml of water saturated n-butanol to make a homogenous suspension.
2. It was shaken gently and allowed to stand for overnight (16 hours) at room temperature in dark.
3. The suspension was stirred over again then strained through Whatman filter paper no. 1.
4. 100 ml of filtrate volume was made by adding water saturated n-butanol solution.
5. The absorbance (A) of the clear filtrate was measure at 440 nm in spectronic-20 using saturated n-butanol as a blank.

Formula

$$\beta\text{-carotene content (ppm)} = 0.0105 + 23.5366 \times A$$

Where,
A = Optical density at 440 nm.

Results and Discussion

The dehydrated safflower leaves samples were packed in low density polyethylene bags and stored for 3 months storage study at ambient temperature conditions. The results pertaining the studies on effect of storage duration on ascorbic acid and β-carotene content of dehydrated safflower leaves for fifteen genotypes are discussed under this topic.

Effect of storage period on ascorbic acid content of dehydrated safflower leaves for fifteen genotypes

The result presented in Table 3 shows the changes in the chemical composition of the safflower leaves fifteen genotypes. During the 90-day storage period, the product was kept in LDPE packaging at room temperature. The statistical results showed that the ascorbic acid content of the LDPE packaging material non-significant during the storage trial. The genotypes had a non-significant effect on ascorbic acid. The ascorbic acid content decreased in SSF- 1240 from 7.39 to 6.63 (mg/100 g), in SSF-708 from 6.23 to 5.48 (mg/100 g), in SSF-658 from 7.18 to 6.44(mg/100 g), in SSF-748 from 6.26 to 5.51 (mg/100 g), in SSF-1507 from 6.90 to 6.13 (mg/100 g), in SSF-1602 from 7.57 to 6.84 (mg/100 g), in A-1 from 8.62 to 7.86 (mg/100 g), in SSF-733 from 8.11 to 7.31 (mg/100 g), in SSF-1565 from 7.91 to 7.14 (mg/100 g), in PBNS-12 from 6.49 to 5.17 (mg/100 g), in GMU-7363 from 7.39 to 6.64 (mg/100 g), in GMU- 443004 from 8.13 to 7.31 (mg/100 g), in SSF-1371 from 8.41 to 7.67 (mg/100 g), in SSF-1708 from 6.45 to 5.67 (mg/100 g), in CO-1 from 8.08 to 7.35 (mg/100 g) in LDPE was observed within a storage period of 90 days. During storage period of 0 to 90 days, initially at 0 days storage period of A-1 had highest ascorbic acid content 8.62 mg/100 g whereas, at end of the storage on 90th days SSF- 748 had lowest ascorbic acid content 5.48 (mg/100 g) packaged in LDPE bags (Table 3).

Similar findings were given by Singh *et al*. (2006) [11]. They assessed that the retention of ascorbic acid content for treated and untreated samples of methi was maximum in microwave drying (51.19 and 67.84 mg/100 g) followed by tray drying (14.8 and 42.24 mg/100 g), open sun drying (10.23 and 17.93 mg/100 g) and vacuum oven drying (23.68 and 63.36 mg/100 g), respectively. Retention of ascorbic acid in mustard, mint and spinach recorded higher as 13-38% by Kaur *et al*. (2009) [5]. These results are in agreement with the finding of Uadal and Sagar (2006) [11].

Table 3: Ascorbic acid content of dehydrated safflower leaves for fifteen genotypes

Ascorbic acid (mg/100 mg)					
Verities	**Storage Period (days)**				**Mean**
	0	**30**	**60**	**90**	
V1	7.39	7.14	6.91	6.63	7.01
V2	6.23	5.98	5.70	5.48	5.84
V3	7.18	6.94	6.72	6.44	6.82
V4	6.26	6.04	5.76	5.51	5.89
V5	6.90	6.63	6.37	6.13	6.50
V6	7.57	7.33	7.05	6.84	7.19
V7	8.62	8.38	8.10	7.86	8.24
V8	8.11	7.84	7.60	7.31	7.71
V9	7.91	7.63	7.38	7.14	7.51
V10	6.49	6.22	5.97	8.71	6.09
V11	7.39	7.11	6.87	6.64	7.00
V12	8.13	7.85	7.59	7.31	7.72
V13	8.41	8.17	7.91	7.67	8.04
V14	6.45	6.17	5.93	5.67	6.05
V15	8.08	7.84	7.57	7.35	7.71
Mean	7.90	7.15	6.89	6.84	7.07
	V	S	V × S		
S.Em (±)	0.07	0.01	0.02		
CD@5%	0.21	0.04	NS		

All values are mean of three replications.

V1 = SSF-1240	V2 = SSF-708	V3 = SSF-658	V4 = SSF-748	V5 = SSF-1507
V6 = SSF-1602	V7 = A-1	V8 = SSF-733	V9 = SSF-1565	V10= PBNS-12
V11 = GMU-7363	V12 = GMU-443004	V13= SSF-1371	V14 = SSF-1708	V15 = C0-1

V = Variety, S = Storage period, V × S = Interaction

Effect of storage period on β-carotene content of dehydrated safflower leaves for fifteen genotypes

The result presented in Table 4 shows the changes in the chemical composition of the safflower leaves fifteen genotypes. During the 90-day storage period, the product was kept in LDPE packaging at room temperature. The statistical results showed that the β-carotene content of the LDPE packaging material non-significant during the storage trial. The genotypes had a non-significant effect on β carotene. The β carotene content decreased in SSF-1240 from 4.25 to 3.64 (mg/100 g), in SSF-708 from 4.23 to 3.63 (mg/100 g), in SSF-658 from 3.97 to 3.39 (mg/100 g), in SSF-748 from 3.97 to 3.42(mg/100 g), in SSF-1507 from 4.42 to 3.85 (mg/100 g), in SSF-1602 from 4.17 to 3.56(mg/100 g), in A-1 from 4.35 to 3.75 (mg/100 g), in SSF-733 from 3.93 to 3.33(mg/100 g), in SSF-1565 from 4.02 to 3.42 (mg/100 g), in PBNS-12 from 4.12 to 3.53(mg/100 g), in GMU-7363 from 4.07 to 3.49 (mg/100 g), in GMU-443004 from 3.94 to 3.34 (mg/100 g), in SSF-1371 from 3.89 to 3.32 (mg/100 g), in SSF-1708 from 4.31 to 3.74 (mg/100 g), in CO-1 from 4.21 to 3.84 (mg/100 g) in LDPE was observed within a storage period of 90 days. During storage period of 0 to 90 days, initially at 0 days storage period of SSF- 1507 had highest β-carotene content 4.42 mg/100 g whereas, at end of the storage on 90th days SSF-1371 had lowest β-carotene content 3.32 mg/100 g packaged in LDPE bags (Table 4). Similar changes were recorded in leafy vegetables by Negi and Roy (2001 a) -. Khatoon *et al*. (2011) [6] reported 5.29 mg/100 g β-carotene in dehydrated curry leaves.

Table 4: β-carotene content of dehydrated safflower leaves for fifteen genotypes

β-carotene (mg/100 mg)					
Verities	**Storage Period (days)**				**Mean**
	0	**30**	**60**	**90**	
V1	4.25	4.05	3.82	3.64	3.94
V2	4.23	4.03	3.82	3.63	3.94
V3	3.97	3.77	3.59	3.39	3.68
V4	3.97	3.79	3.59	3.42	3.69
V5	4.42	4.22	4.03	3.85	4.13
V6	4.17	3.95	3.75	3.56	3.86
V7	4.35	4.14	3.94	3.75	4.04
V8	3.93	3.72	3.52	3.31	3.64
V9	4.02	3.81	3.61	3.42	3.71
V10	4.12	3.92	3.73	3.53	3.82
V11	4.06	3.88	3.68	3.49	3.78
V12	3.94	3.73	3.53	3.34	3.80
V13	3.89	3.69	3.51	3.32	3.60
V14	4.31	4.12	3.92	3.74	4.02

V15	4.21	4.03	3.84	3.64	3.98
Mean	4.12	3.92	3.72	3.53	3.84
	V	S	V × S		
S.Em (±)	0.01	0.03	0.06		
CD@5%	0.04	0.08	NS		

All values are mean of three replications.

V1 = SSF-1240	V2 = SSF-708	V3 = SSF-658	V4 = SSF-748	V5 = SSF-1507
V6 = SSF-1602	V7 = A-1	V8 = SSF-733	V9 = SSF-1565	V10= PBNS-12
V11 = GMU-7363	V12 = GMU-443004	V13= SSF-1371	V14 = SSF-1708	V15 = C0-1

V = Variety, S = Storage period, V × S = Interaction

Conclusion

The studies on effect of storage period on ascorbic acid and β-carotene content of dehydrated safflower leaves revealed that all the fifteen genotypes blanched with chemical treatment showed better organoleptic properties. Non- significant effect of storage was found in context to ascorbic acid content as well as β- carotene content in case of all fifteen genotypes. Higher ascorbic acid content was found in A-1 with 8.62 mg/100 mg while β-carotene content was found higher in SSF-1507 with 4.43 mg/100 mg. It can be also concluded that ascorbic acid and β-carotene content were better preserved by low density polyethylene packaging material in dried form of safflower leaves.

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