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Effect of Pretreatments and Drying Methods on Quality of Ber During Storage

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Abstract: The effects of methods of drying and storage on viability of ber were studied at Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu. Different pretreatments were subjected to ber fruits before dehydration, viz. blanching in boiling water for six minutes to inactivate enzyme activity followed by one per cent KMS dip for five minutes, sulphur fumigation for two hours @ 3.5 g kg^{-1} fruit and then dying by sun and oven methods. Dried ber were stored at room temperature and analysed after 2, 4 and 6 months to study changes in physico-chemical characteristics. During bimonthly studies an increasing trend was observed in rehydration ratio, browning and iron content, where as ascorbic acid, phosphorus and calcium content decreased. After six months of storage sulphur treated fruits (8.00, 7.00 and 6.80) followed by KMS treated fruit (7.80, 6.80 and 6.50) in color, texture and flavour were found to be the best in oven-dried samples as compared to sun-dried samples.

Key words: Ber, drying, storage, quality.

Ber (*Ziziphus mauritiana* Lamk.) is an ideal fruit for cultivation in arid and semi-arid regions of India. It is rich in nutritive value, popular and cheap, hence is often called a poor man's fruit. It is a rich source of vitamin C, protein and minerals such as phosphorus and calcium. It can be grown easily in wastelands and adverse climatic conditions where most other fruit plants cannot be grown successfully.

The ber fruits are mostly consumed fresh, but due to increased production of ber during the season, there is glut in the market and the farmers get low price for their produce. Moreover, the post-harvest losses in our country are about 20 to 30% because of poor post-harvest management practices and lack of proper storage and cool chain transportation facility. The increased production of ber fruit needs to be supplemented by the proper utilization that would be achieved through drying and processing. A very small quantity of the ber fruit is, however, preserved by drying in the open sun by the local people, but method adopted is very crude, unhygienic and results in contamination, discolouration and deterioration in taste of the dried fruits. To overcome these problems and for better utilization, artificial dehydration technique is used. The present studies were therefore, undertaken to study the effect of various pretreatments and methods of drying on the quality and storability of ber.

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Materials and Methods

The present investigations were carried out in Department of Post-harvest Technology, SKUAST, Jammu. The washed fruits of *cv. Umran* were subjected to different pretreatments like blanching in boiling water for six minutes, potassium metabisulphite (KMS) dip (one per cent for five minutes) and sulphur-fumigation @ 3.5 g kg^{-1} of fruit and their combinations. The treated fruits were divided into two lots, one lot was dried in sun and the other lot was dried in oven at 55±2°C. The dried fruits were packed in 250 g food grade jars and were stored at room temperature (20-40°C) for a period of six months (May-October) and analyzed at interval of two months for chemical characteristics using standard methods (Ranganna, 1986 and AOAC, 1990). The data were analyzed statistically using three factor CRD factorial design (Gomez and Gomez, 1984).

Results and Discussion

Rehydration ratio and browning

The oven-dried fruits recorded higher rehydration ratio than sun-dried fruits. After six months of storage in oven drying method the rehydration ratio was maximum in sulphur fumigated fruits (4.13) followed by KMS treated fruits (3.88), whereas it was minimum (3.82) in control (without pretreatment). In sun-drying method, highest rehydration ratio (3.99) was found in sulphur fumigated fruits followed by KMS treated fruits (3.69), whereas it was lowest (3.56) in control (without pretreatment) after six months

Table 1. Effect of pretreatments, drying methods and storage on some physical aspects of dehydrated ber

Treatments	Storage period (Months)				Storage period (Months)			
	0	2	4	6	0	2	4	6
	Rehydration ratio				Browning			
Control	3.20 (3.47)	3.34 (3.61)	3.46 (3.71)	3.56 (3.82)	3.53* (3.23)	4.81 (4.40)	7.39 (6.20)	10.33 (8.68)
Sulphuring	3.62 (3.79)	3.75 (3.92)	3.89 (4.01)	3.99 (4.13)	3.03 (2.77)	4.23 (3.54)	5.22 (4.47)	6.08 (5.54)
KMS	3.37 (3.59)	3.49 (3.69)	3.60 (3.8)	3.69 (3.88)	2.85 (2.74)	3.62 (3.41)	4.48 (4.38)	5.39 (5.42)
Blanching	3.26 (3.51)	3.40 (3.64)	3.54 (3.76)	3.6 (3.83)	2.48 (2.47)	3.32 (3.29)	4.46 (4.32)	5.24 (5.18)
Blanching + sulphuring	3.50 (3.68)	3.6 (3.82)	3.69 (3.96)	3.88 (4.08)	2.72 (2.64)	3.46 (3.4)	4.54 (4.38)	5.48 (5.42)
Blanching + KMS	3.32 (3.56)	3.46 (3.67)	3.58 (3.78)	3.64 (3.86)	2.7 (2.64)	3.4 (3.34)	4.5 (4.38)	5.43 (4.40)
CD at 0.05								
Blanching × drying	NS	NS	0.01	0.01	0.03	0.02	0.01	0.02
Blanching x pretreatment	0.01	0.01	0.01	0.01	0.04	0.02	0.02	0.02
Pretreatment x drying	0.01	0.01	0.01	0.01	0.04	0.02	0.02	0.02
Blanching x pretreatment x drying	NS	0.02	0.02	0.01	0.05	0.03	0.02	0.03
	Color				Texture			
Control	7.20 (7.50)	7.00 (7.30)	6.90 (7.00)	6.60 (6.80)	7.30* (7.80)	6.83 (7.50)	6.60 (7.00)	5.00 (5.80)
Sulphuring	8.60 (8.70)	8.00 (8.50)	8.00 (8.00)	7.80 (8.00)	8.60 (8.80)	8.30 (8.50)	7.20 (8.00)	6.20 (7.00)
KMS	8.30 (8.50)	8.20 (8.40)	7.90 (8.00)	7.60 (7.80)	8.47 (8.70)	8.10 (8.30)	7.00 (7.60)	6.00 (6.80)
Blanching	7.80 (8.00)	7.60 (7.80)	7.50 (7.70)	7.20 (7.40)	8.00 (8.30)	7.80 (8.00)	6.80 (7.40)	5.60 (6.40)
Blanching + sulphuring	8.20 (8.40)	8.00 (8.10)	7.70 (7.90)	7.60 (7.70)	8.30 (8.60)	8.00 (8.20)	6.70 (7.60)	5.80 (6.60)
Blanching + KMS	8.10 (8.30)	8.00 (8.10)	7.60 (7.80)	7.40 (7.50)	8.20 (8.50)	7.90 (8.10)	6.50 (7.40)	5.70 (6.57)
CD at 0.05								
Blanching x drying	NS	NS	NS	NS	(NS)	(NS)	(NS)	(NS)
Blanching x pretreatment	0.15	0.20	0.20	0.19	0.14	0.23	0.21	0.22
Pretreatment x drying	NS	NS	NS	NS	(NS)	(NS)	(NS)	(NS)
Blanching x pretreatment x drying	NS	NS	NS	NS	(NS)	(NS)	(NS)	(NS)

Values of oven-dried samples are in parenthesis.

of storage. Effect of interactions of blanching, pretreatment and drying after 2, 4 and 6 months storage were significant (Table 1). Rehydration ratio increased with increase in storage period. The loss of moisture during storage might be one of the reasons for increase in rehydration ratio of dried ber fruits. The rehydration ratio was lower in sun-dried fruits. It might be due to more damage to the structure of the cells. Jen *et al.* (1989) reported rehydration ratio reflects the textural quality of dehydrated product. Higher rehydration ratio indicates more absorption of water (Devaraju *et al.,* 2003) and lesser damage to cells during dehydration, which helps in better absorption of water during rehydration (Srivastava and Kumar, 2003).

Browning increased in all stored fruits irrespective of the drying method (Table 1). The general trend of browning along with their absorbance at 440 nm immediately after drying in increasing order was 2.48> 2.70> 2.72> 2.85> 3.03> 3.53 in product dried under sun. Similar trend was also observed in oven-dried product at 0 month storage. Trend in browning with increased discoloration was similar at the end of 2 and 4 month storage. The values in increasing order after six months storage were found in blanching,

Table 2. Effect of pretreatments, drying methods and storage on iron, phosphorus, calcium and ascorbic acid on dehydrated ber

Treatments	Storage period (Months)				Storage period (Months)			
	0	2	4	6	0	2	4	6
	Iron (ppm)				Ascorbic acid (mg/100 g)			
Control	4.46 (4.55)	4.74 (4.96)	5.26 (5.68)	5.72 (5.76)	28.43* (32.53)	20.05 (23.97)	12.53 (14.73)	7.87 (8.92)
Sulphuring	4.45 (4.50)	4.70 (4.90)	5.23 (5.62)	5.66 (5.70)	36.68 (43.50)	25.12 (34.34)	15.26 (23.54)	10.54 (11.54)
KMS	4.43 (4.48)	4.67 (4.86)	5.18 (5.58)	5.62 (5.65)	37.67 (44.43)	27.19 (35.58)	16.76 (25.62)	12.62 (13.62)
Blanching	4.32 (4.35)	4.60 (4.64)	5.12 (5.50)	5.51 (5.56)	39.72 (47.52)	29.19 (37.64)	20.84 (28.76)	16.74 (19.76)
Blanching + sulphuring	4.40 (4.46)	4.64 (4.82)	5.17 (5.54)	5.60 (5.62)	36.56 (42.64)	24.34 (34.28)	14.52 (24.56)	11.82 (14.56)
Blanching + KMS	4.39 (4.45)	4.63 (4.80)	5.16 (5.55)	5.58 (5.61)	38.94 (46.26)	28.46 (36.54)	18.34 (26.48)	15.84 (18.48)
CD at 0.05								
Blanching x drying	0.01	0.01	0.02	NS	NS	0.01	0.01	0.01
Blanching x pretreatment	0.02	0.01	0.02	0.02	1.55	0.01	0.01	0.01
Pretreatment x drying	NS	0.01	NS	NS	1.55	0.01	0.01	0.01
Blanching x pretreatment x drying	0.02	0.02	NS	NS	NS	0.01	0.02	0.02
	Phosphorus (mg/100 g)				Calcium (mg/100 g)			
Control	0.003 (.006)	0.003 (.005)	0.003 (.004)	0.002 (.003)	101.67* (101.70)	101.60 (101.72)	100.68 (100.78)	100.00 (100.16)
Sulphuring	0.008 (.008)	0.007 (.008)	0.006 (.006)	0.006 (.005)	109.70 (110.80)	109.35 (110.34)	108.80 (109.64)	108.62 (109.20)
KMS	0.006 (.007)	0.006 (.007)	0.006 (.006)	0.005 (.006)	107.90 (109.85)	107.54 (109.46)	106.74 (108.76)	106.36 (108.32)
Blanching	0.004 (.005)	0.003 (.003)	0.001 (.003)	0.001 (.002)	105.33 (106.24)	105.16 (106.00)	104.00 (105.65)	104.00 (105.24)
Blanching + sulphuring	0.005 (.006)	0.005 (.006)	0.003 (.005)	0.003 (.004)	107.57 (108.46)	107.32 (108.12)	106.56 (107.54)	106.18 (107.16)
Blanching + KMS	0.004 (.005)	0.004 (.005)	0.004 (.005)	0.003 (.004)	106.42 (107.52)	106.28 (107.24)	105.64 (106.62)	105.28 (106.42)
CD at 0.05								
Blanching x drying	NS	NS	NS	NS	0.02	0.01	0.004	0.004
Blanching x pretreatment	NS	NS	NS	NS	0.02	0.01	0.005	0.005
Pretreatment x drying	NS	NS	NS	NS	0.02	0.01	0.005	0.005
Blanching x pretreatment x drying	NS	NS	NS	NS	0.03	0.02	0.01	0.01

Values of oven-dried samples are in parenthesis.

KMS, blanching + KMS, blanching + sulphuring, sulphuring and control, respectively, in sun-drying method. Similarly in oven-drying method the values in descending order of preference were 8.68, 5.54, 5.42, 5.42, 5.18 and 4.40. On comparing the blanching, pretreatment and drying methods interaction effects differed significantly at 5% level. Kumar (1990) gave a detailed mechanism for the formation of brown pigment in the stored products, which was attributed to the degradation of sugars, ascorbic acid and proteins. Kalsi (1998) also reported an increase in browning in guava powder during storage. Fruits treated with sulphur dioxide and KMS recorded less browning in dried ber due to inactivation of enzymes during blanching and addition of antioxidants (Ranganath and Dubash, 1981). Among dehydration methods, sun-dried fruits recorded more browning than oven-dried fruits. The oven-dried ber fruits depicted light brown color than sun-dried fruits. Loss of bright color in sun dried fruits could be due to photo-oxidation of carotenoids because of long exposure to light and oxygen (Jen and Thomas, 1978). Non-enzymatic reactions and oxidation of various phenolic and other compounds were responsible for the formation of brown pigments and the loss

of ascorbic acid might also be one of the reasons for increase in non-enzymatic browning (Fenemma, 1976).

Iron and ascorbic acid

The oven-dried ber fruits had the highest iron content (4.96 ppm) in control treatment, followed by sulphuring, KMS, blanching + sulphuring, blanching + KMS and blanching. In sun-dried fruits after 2 month of storage the highest and lowest iron content of 4.74 and 4.60 ppm was recorded in control and blanching, respectively. After 6 months of storage in sun-drying method, the maximum iron content was in control (5.72 ppm) and the minimum in blanching treatments (5.51 ppm). While as in oven-dried fruits the maximum and minimum iron content of 5.76 and 5.56 ppm were recorded in control and blanching treatment, respectively. However, significant differences have been observed in blanching, preservative and drying interactions after 4 and 6 months of storage.

After two months storage in sun-dried fruits the ascorbic acid content was maximum in blanching and minimum in control treatments (Table 2). In oven drying method the maximum and minimum values for the same were in blanching and control treatments. Ascorbic acid content during six months storage declined significantly from their initial levels both in sun and oven-dried fruits. There was a significant difference between blanching, pretreatments and drying interactions. Ascorbic acid content decreased in all the treatments over a six-month period at ambient conditions and the decrease was to the tune of 72.3 (control) to 57.8% (blanching) in sun-dried fruits. In oven-dried fruit the decrease was 73.5 (sulphuring) to 58.4% (blanching). The decreasing trend in ascorbic acid during storage has also been reported by Kumar *et al.* (1992) and Singh (1992). This reduction in ascorbic acid could be due to oxidation by trapped oxygen in polythene bags, which might have resulted in formation of dehydroascorbic acid (Kumar *et al.,* 1992). Gadakh *et al.* (1999) reported higher ascorbic acid content in blanched fruits as compared to unblanched dehydrated ber fruits.

Phosphorus and calcium

After two months of storage phosphorus content was maximum in sulphuring and minimum in blanching in sun-dried fruits (Table 2). In oven-dried fruits, maximum and minimum phosphorus content was found in sulphuring and blanching treatments, respectively. There was marginal decrease in phosphorus content after 4 to 6 months of storage. However, differences among treatments were non-significant. The phosphorus content of dried ber decreased slightly with increase in duration of storage.

Table 3. Effect of pretreatments drying methods and storage on mean score evaluation of flavour of dehydrated ber

	Storage period (Months)			
	0	2	4	6
	Flavour			
Control	7.60 (7.80)	7.00 (7.20)	6.40 (7.00)	5.80 (6.20)
Sulphuring (S)	8.40 (8.60)	7.80 (8.00)	7.00 (7.40)	6.60 (6.80)
KMS	8.20 (8.40)	7.60 (7.80)	6.80 (7.20)	6.20 (6.50)
Blanching (B)	7.80 (8.00)	7.20 (7.40)	6.40 (6.73)	5.60 (6.00)
B + S	8.10 (8.30)	7.60 (7.90)	6.60 (7.10)	6.10 (6.40)
B = KMS	7.90 (8.20)	7.50 (7.80)	6.50 (6.90)	6.00 (6.30)
CD at 0.05				
B x D	NS	NS	NS	NS
B x P	0.16	0.13	NS	NS
P x D	NS	NS	NS	NS
B x P x D	0.23	NS	NS	NS

Values of oven-dried samples are in parenthesis

After 2 months of storage the calcium content was highest (110.34 mg/100 g) in sulphuring in oven-drying method and the minimum (101.60 mg/100 g) in control in sun-drying method (Table 2). In second phase, after six months of storage the highest calcium content of 109.20 mg/100 g was retained in sulphuring in oven-dried fruits and lowest of 100.00 mg/100 g by control in sun-dried fruits. It is evident that over a period of six months the maximum decrease of 0.94% was recorded in blanching in oven-dried fruits and minimum loss of 1.64% was recorded in control treatment in sun-dried fruits. On comparing the blanching and drying, blanching and pretreatment, pretreatment and drying and blanching, pretreatment and drying interactions, all the treatments differed significantly at 5% level of significance.

Color and texture

The color scores of dehydrated ber fruits declined slightly upon storage (Table 1). After six months of storage in sun-dried fruits the minimum and the maximum color scores were recorded in control and sulphuring treatments, respectively. Whereas in oven-dried fruits, the maximum and

minimum color score were received by sulphuring and control treatments, respectively.

On assessing the overall mean score; it was evident that the color score declined significantly during six months of storage.

The texture score decreased during storage of dehydrated ber fruits (Table 1). In oven-dried ber the maximum score of 7.00 was in sulphuring treatment, followed by 6.80, 6.60, 6.57, 6.40 and 5.80 in KMS, blanching + sulphuring, blanching + KMS, blanching and control treatments, respectively, after six months of storage. Whereas in sun-dried ber control and sulphuring treatments received the lowest and highest score of 5.00 and 6.20, respectively, after six months of storage.

Flavor

Table 3 pertains to the mean score awarded to the quality attributes of aroma. On first schedule of analysis after two months in oven-dried fruit, sulphuring treatment received the highest score of 8.00, which was reduced to 6.80 after six months of storage, but was adjudged to have the best aroma. It was followed by blanching+sulphuring scoring 7.90 points, which decreased to 6.40. In sun-drying method the minimum and maximum score of 7.00 and 7.80 were given to control and sulphuring treatments, which decreased to 5.80 and 6.60, respectively, after six months of storage. All the treatments differed significantly as far as overall mean score evaluation of flavor was concerned.

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