Pak. j. sci. ind. res., vol. 36, no. 9, September 1993

EFFECT OF PRESERVATION METHODS ON THE QUALITY AND STORAGE STABILITY OF SQUASH PREPARED FROM IRRADIATED MANGOES

MAQBOOL AHMAD, C. HEIJNEN**, J.C.M. HAUSER** AND M.A. CHAUDRY*

Atomic Energy Agricultural Research Centre, Tandojam, Pakistan

(Received on February 28, 1991; revised April 17, 1993)

Chemical and organoleptic characteristics of squashes prepared from unirrdiated and irradiated (0.25, 0.50, 1.00 kGy) Langra and Chonsa mangoes and preserved either by SO_2 (250 ppm) or heat (8° for 10 min.) were studied during storage at room conditions (26-36°, 50-76% RH). Irradiation of mango fruit and heating of mango squash significantly ($P<0.05$) decreased ascorbic acid content of squash. Being richer source, Langra mango squash retained more ascorbic acid (75.6%) than Chonsa squash (60.1%) after 12 weeks storage. Irradiation of mango fruit had no additive effect on the sensory quality of its squash. SO_2 preserved squashes were preferred over heat preserved ones for appearance, odour and taste. Heat preserved squash samples were spoiled after 4 weeks of storage. However, SO_2 preserved samples were in good condition after 12 weeks of storage and were given 68% overall acceptability scores. Langra and Chonsa mango squashes were comparable as for as sensory characteristics were concerned.

Key words : Mango squash, Irradiation, Heating, SO_2, Ascorbic acid, Sensory quality.

Introduction

Good storage stability in squashes in achieved by the addition of chemical preservatives (like SO_2, ascorbic acid, benzoic acid etc.) and the effectiveness of these chemicals is influenced by acid [1] and sugar [2] levels. Chemicals, however, have residual toxic effects and have proven to be injurious to biological systems. Heating and irradiation [3] are non-residual technologies which can be exploited to control spoilage in food systems. Moreover, irradiation can improve the process and quality of fruit products. The yield of juice and the colour intensity of wine from grapes are increased by irradiation [4]. The yield of syrup from fully ripe dates is also increased by irradiation [5]. In the present ivestigation, SO_2 and heat treatments were compared to preserve squashes prepared from unirradiated and irradiated mangoes.

Materials and Methods

Processing of samples. Langra and Chonsa mangoes were procured from the local market, sorted and washed in tap water. Fruits of both cultivars were divided into four equal lots and irradiated in a Gamma Researcher (a Co-60 source of USSR origin) at 0, 0.25, 0.50 and 1 kGy dose levels. Dose rate at the time of irradiation was 5.06 kGy per hr. Mango pulp was removed of manually and mixed in a blender. Following fromulation was used for the preparation of mango squash [6].

Pulp	=	100 parts
Water	=	100 parts
Sugar	=	100 parts
Citric acid	=	3 parts (1%) w/w

All the ingredients were cold mixed thoroughly and passed through a muslin cloth. Squash from unirradiated and irradiated lots of Langra and Chonsa cultivars was divided into two sub-lots. One lot was treated with potassium metabisulphite at the rate of 0.061% (350 ppm SO_2) while the 2nd lot was pasteurized at 80° for 10 min. All the squash samples were then filled in steralized glass bottles, corked, waxed and stored at room conditions (26-36°, 50-76% RH).

Chemical analysis. Ascorbic acid acidity and total soluble solids (TSS) of different squash samples were determined by AOAC [7] methods. Ascorbic acid was determined by titrating against standardized 2, 6 diclorophenol dye to pink end-point which persisted for 15 sec. Results were expressed as mg ascorbic acid per 100g squash. To overcome the reducing effect of SO_2, the combination properties of SO_2 with acetone were expoilted as reported by Mapson [8]. Total acidity was determined and calculated as volume in ml of 0.1N NaOH required to titrate 100g drink to the phenolphthalein end-point and expressed as percent citric acid. Total soluble solids were determined in degrees Brix using refrectometer (K.Fuji Model No.5601). Total soluble solids/acid ratio was calculated. Squash turbidity was measured by the objective method of Chandler and Robertson [9]. A 10 ml aliquot of thoroughly mixed squash sample was centrifuged at 10,000 rpm for 20 mins. The absorbance of the supernatant was measured in a spectrophotometer (Shimatzu UV-120-02) at 660 nm.

Sensory evaluation. The appearance and odour of pure squashes, taste of diluted squashed (dilution with water in ratio of 1:3) and overall acceptability were judged according to the scoring method of Krum [10]. A scale of 0 - 10 was used where 0 was disliked extremely and 10 was liked extremely.

* Nulear Institute for Food and Agriculture (NIFA), Tarnab, Peshawar, Pakistan.

** State Agricultural University, Wageningen, The Netherlands.

All the data were analysed statistically and Duncan's Multiple Range Test was employed for the comparison of mean values [11].

Results and Discussion

Chemical characteristics. Table 1 and 2 present changes during storage in chemical characteristics of squashes prepared from control and irradiated mangoes and preserved either by SO_2 or heat. Ascorbic acid was significantly ($P<0.05$) decreased by both irradiation and heat treatments. The mean ascorbic acid content (mg/100g) of squashes prepared from the irradiated Langra mangoes (0, 0.25, 0.50 and 1.00 kGy doses) and preserved by SO_2 were 55.95 52.70, 49.79 and 46.15; and that of heat treated samples were 53.80, 49.05, 47.47 and 44.16, respectively. The mean ascorbic acid content of samples prepared from irradiated Chonsa mango (0, 0.25, 0.50 and 1.00 kGy doses) and preserved by SO_2 were 13.48, 12.78, 12.14 and 12.35 and that of heat preserved were 12.70, 11.49, 10.87 and 11.32 respectively. Ascorbic acid is the least stable of all the vitamins and is labile to irradiation and heat treatments [12-14]. However, SO_2 checks ascorbic acid degradation during storage [14]. While studying the effect of chemicals (sodium benzoate, cafffeine) and temperature (60-80°) on orange juice, Ukhun *et al.* [15] found that elevated temperatures destroyed ascorbic acid but chmicals mitigated its storage loss. The mean retention of ascorbic acid was 75.6% in Langra mango squash and 60.1% in Chonsa mango squash after 12 weeks storage. Difference in retention could be due to higher initial Langra squash ascorbic acid content (57.51 mg/100g) compared to that of Chonsa mengo squash (16.81 mg/100g) [14].

In langra mango squash, non-significant changes in the TSS were observed whereas Chonsa mango squash showed a significant ($P<0.05$) increased of TSS during storage. Total

TABLE 1. STORAGE STABILITY OF MANGO SQUASH (LANGRA), CHEMICAL CHARACTERISTICS.

		Addition of SO_2					Heat treatment				
Weeks of storage		0	4	8	12	Mean	0	4	8	12	Mean
Dose (kGy)											
Ascorbic	0	63.38	59.27	54.28	46.83	55.95^{a}	59.11	57.13	53.25†	45.66†	53.80^{a}
acid	0. 25	58.37	55.33	51.88	45.01	52.70^{b}	53.76	53.12	47.00	41.73	49.05^{b}
mg/100g	0.50	56.83	53.12	47.86	41.33	49.79^{c}	52.22	51.52	47.43	38.71	47.47^{c}
	1.0	51.46	48.40	44.95	39.77	46.15^{d}	48.9	48.40	44.01	35.84	44.16^{d}
	Mean	57.51^{a}	54.08^{b}	49.74^{c}	43.25^{d}	–	53.38^{a}	52.54^{a}	48.07^{b}	40.40^{c}	–
Acidity	0	1.00	0.93	0.94	0.94	0.95^{d}	1.03	0.97	0.92†	0.94+	0.97^{d}
% citric	0.25	1.01	0.97	0.96	0.93	0.96^{c}	1.12	1.09	1.03	1.06	1.08^{a}
acid	0.50	1.03	0.99	0.97	0.98	0.99^{b}	1.11	1.05	1.01	1.05	1.06^{c}
	1.0	1.06	1.01	1.04	1.01	1.04^{a}	1.12	1.10	1.03	1.02	1.07^{b}
	Mean	1.03^{a}	0.98^{b}	0.98^{c}	0.97^{d}	–	1.10^{a}	1.06^{b}	1.00^{d}	1.02^{c}	–
TSS	0	40.1	40.5	41.1	41.0	40.7^{b}	43.9	44.6	44.1†	44.2†	4.2^{a}
oBx	0.25	40.8	40.7	41.2	41.2	41.0^{ab}	43.1	42.0	42.0	41.8	42.2^{c}
	0.50	41.8	41.0	41.3	41.5	41.4^{a}	42.9	42.9	43.5	43.6	43.2^{b}
	1.0	40.5	40.2	40.6	40.8	40.6^{b}	43.5	44.5	43.7	43.9	43.9^{ab}
	Mean	40.8	40.6	41.1	41.1	–	43.4	43.5	43.3	43.4	–
TSS/acid	0	40.0	43.5	43.7	43.6	42.7^{a}	42.4	46.0	46.5†	46.3†	45.3^{a}
	0.25	40.3	42.0	42.9	44.3	42.4^{a}	38.5	38.5	4.8	39.4	39.3^{c}
	0.50	40.8	41.4	42.6	42.3	41.7^{a}	38.6	40.5	43.1	41.5	40.9^{b}
	1.0	38.2	38.7	39.0	40.4	39.1^{b}	38.8	40.4	42.4	43.0	41.2^{b}
	Mean	39.8^{c}	41.4^{b}	42.1^{ab}	42.7^{a}	–	39.6^{c}	41.4^{b}	43.2^{a}	42.6^{b}	–
Optical	0	1.020	0.989	1.160	0.518	0.911	1.058	1.062	1.097†	1.118†	1.083
density	0.25	0.342	1.279	1.161	0.963	0.936	0.855	1.396	1.175	1.331	1.139
	0.50	0.381	1.259	1.115	0.707	0.866	0.877	1.375	1.148	1.034	1.008
	1.0	0.589	0.850	0.745	0.494	0.657	0.939	1.061	1.036	1.057	1.023
	Mean	0.583^{c}	1.094^{a}	1.034^{ab}	0.658^{bc}	–	0.932^{b}	1.224^{a}	1.114^{ab}	1.135^{ab}	–

† Computer intrapolated data because samples were spoiled. Storage temperature = 26-30°C. Relative humidity = 50-76%. Figures followed by different letters are significantly different at 5% level.

soluble solids of both heated Langra and Chonsa squashses were siginifcantly ($P<0.05$) higher than that of SO_2 treated squashses probably due to the decomposition of insoluble macromolecules into smaller water soluble molecules by heating. The acidity of both mango squashes decreased significantly ($P<0.05$) during storage. The acidity was higher in heated squash samples as compared to that of preserved by SO_2. An increase in TSS and a decrease in total acidity during storage resulted in significant ($P<0.05$) increase in TSS/acid ratio of different squash samples. The change in acidity, TSS, TSS/acid ratio due to different irradiation doses were not consistent (Tables 1 and 2).

Turbidity. The Chandler and Robertson [9] procedure when applied to shaken drink gives a measure of its ability to maintain resuspended cloud in suspension. In case of Langra squash optical density increased upto 4 weeks storage, then there was a gradual decrease in the remaining storage period in SO_2 and heat preseved squash samples. A gradual decrease of optical density was observed in all Chonsa squash samples throughout the storage period of 3 months (Tables 1 and 2). Optical density values of SO_2 and heat treated squash samples were comparable. Effect of irradiation of mangoes on the optical density of squash was inconsistent (Tables 1 and 2).

Organoleptic characteristics. Results regarding the organoleptics of mango squashes are give in Tables 3 and 4. Effect of irradiation of mango fruit on the sensory characteristics of squashes were not consistent. The judges could not distinguish the squashes made from unirradiated and irradiated mangoes. Present results are not in agreement with previous findings on other fruits where irradiation of fruits enhanced colour in guava drink [6] and wine [4].

The heated squash samples secured lower sensory scores than SO_2 preserved squashes. Mean overall acceptability scores were from 7.11 to 7.13 in SO_2 preserved squashes but ranged from 6.47 to 6.69 in heat preserved squashes. Organoleptic evaluation of heated squash was discontinued after

TABLE 2. STORAGE STABILITY OF MANGO SQUASH (CHONSA), CHEMICAL CHARACTERISTICS.

		Addition of SO_2					Heat treatment				
Weeks of storage		0	4	8	12	Mean	0	4	8	12	Mean
Dose	(kGy)										
Ascorbic	0	17.50	15.05	11.00	10.38	13.48^{a}	17.25	12.86	10.92	10.01	12.76^{a}
acid	0.25	16.75	43.30	10.70	10.36	12.78^{ab}	14.75	11.64	9.93	9.63	11.49^{b}
mg/100g	0.50	16.25	11.99	10.66	9.65	12.14^{b}	13.25	11.90	9.29	9.04	10.87^{b}
	1.0	16.75	12.55	10.92	9.18	12.35^{b}	15.75	11.64	9.10	8.78	11.32^{b}
	Mean	16.81^{a}	13.22^{b}	10.82^{c}	9.89^{d}	–	15.25^{a}	12.01^{b}	9.81^{c}	9.37^{c}	–
Acidity	0	1.02	0.97	0.95	0.93	0.97	1.10	1.09	1.02	1.01	1.06
%citric	0.25	1.04	0.95	0.93	0.92	0.96	1.11	1.06	1.01	1.03	1.05
acid	0.50	1.03	0.95	0.92	0.93	0.96	1.12	1.05	1.00	1.02	1.05
	1.0	1.05	0.98	0.93	0.95	0.98	1.11	1.01	1.01	1.02	1.04
	Mean	1.04^{a}	0.96^{b}	0.93^{c}	0.93^{c}	–	1.11^{a}	1.05^{b}	1.01^{d}	1.03^{c}	–
TSS	0	39.1	40.0	40.4	40.3	40.0^{b}	45.8	46.0	47.3	47.4	46.6^{a}
oBx	0.25	40.1	40.8	41.2	41.1	40.8^{a}	45.9	46.4	47.7	47.2	46.8^{a}
	0.50	40.1	40.9	41.3	41.2	41.1^{a}	46.3	47.0	46.8	47.0	46.8^{a}
	1.0	39.5	40.1	40.7	40.6	40.2^{b}	44.5	45.0	45.4	45.8	45.2^{b}
	Mean	39.7^{c}	40.5^{b}	40.9^{a}	40.8^{ab}	–	45.6^{b}	46.1^{b}	46.8^{a}	46.9^{a}	–
TSS/acid	0	38.3	41.2	42.5	43.3	41.3^{b}	41.6	42.2	46.4	45.6	44.0
	0.25	38.6	42.9	44.3	44.7	42.6^{a}	41.4	43.8	47.2	45.8	44.6
	0.50	38.9	43.1	44.9	44.3	42.8^{a}	41.3	44.8	46.8	46.1	44.8
	1.0	37.6	40.9	43.8	42.7	41.2^{b}	40.1	44.6	45.0	44.9	43.7
	Mean	38.4^{c}	42.0^{b}	43.9^{a}	43.8^{a}	–	41.1^{c}	43.9^{b}	46.4^{a}	45.6^{a}	–
Optical	0	0.969	1.010	1.129	0.579	0.922^{a}	0.879	0.803	0.290	0.182	0.539^{b}
density	0.25	0.769	0.723	0.481	0.339	0.578^{c}	0.870	0.549	0.174	0.207	0.450^{b}
	0.50	0.885	0.948	0.736	0.462	0.758^{b}	0.876	0.632	0.480	0.320	0.577^{b}
	1.0	1.012	1.157	0.987	0.804	0.990^{a}	0.952	1.211	0.764	0.742	0.917^{a}
	Mean	0.909^{a}	0.960^{a}	0.833^{a}	0.546^{b}	–	0.894^{a}	0.799^{a}	0.427^{b}	0.363^{b}	–

Storage temperature = 26-36°C. Relative humidity = 50-76%. Figures followed by different letters are significantly different at 5% level.

TABLE 3. STORAGE STABILITY OF MANGO SQUASH, ORGANOLEPTIC CHARACTERISTICS.

Quality characteristics	Weeks of storage				Dose (kGy)				
(0-10)†	0	4	8	12	0	0.25	0.50	1.0	Mean
LANGRA (Add. of SO_2)									
Appearance	7.36^{c}	7.91^{a}	7.04^{d}	7.60^{b}	7.47	7.47	7.44	7.92	7.48
Odour	7.82^{a}	7.36^{a}	6.91^{b}	6.39^{c}	7.31^{a}	6.78^{b}	6.85^{b}	6.94^{b}	6.98
Taste	6.66^{b}	7.29^{a}	7.07^{c}	6.50^{b}	7.08^{a}	6.88^{ab}	6.89^{ab}	6.66^{b}	6.98
Overall acceptability	7.03^{b}	7.53^{a}	6.99^{bc}	6.83^{c}	7.30^{a}	7.05^{b}	7.06^{b}	7.02^{b}	7.11
CHONSA (add. of SO_2)									
Appearance	7.19^{b}	7.77^{a}	7.47^{b}	7.53^{ab}	7.63	7.56	7.65	7.57	7.58
Odour	6.86^{ab}	7.11^{a}	7.00^{ab}	6.24^{b}	6.89^{bc}	8.81^{c}	7.25^{a}	7.95^{ab}	8.33
Taste	7.25^{a}	6.89^{b}	6.37^{b}	6.25^{c}	6.33^{a}	6.81^{ab}	6.91^{a}	6.63^{b}	8.34
Overall acceptability	7.22^{a}	7.26^{a}	7.16^{a}	6.34^{b}	7.11^{b}	7.03^{b}	7.24^{a}	7.11^{b}	7.12

† 0 = disliked extremely: 10 = liked extremely. Figures followed by different letters are significantly different at 1% level.

TABLE 4. STORAGE STABILITY OF MANGO SQUASH, ORGANOLEPTIC CHARACTERISTICS.

Quality characteristics	Weeks of storage		Dose (kGy)				
(0-10)†	0	4	0	0.25	0.50	1.0	Mean
LANGRA (heat treatment)							
Appearance	7.11	6.72	6.97	7.04	6.79	6.88	6.92
Odour	6.58	6.69	7.10	6.54	6.51	6.41	6.64
Taste	6.47	6.54	6.81	6.41	6.47	6.32	6.50
Overall acceptability	6.72	6.66	6.96	6.67	6.61	6.51	6.69
CHONSA (heat treatment)							
Appearance	6.92^{a}	6.39^{b}	6.72	6.88	6.54	6.50	6.66
Odour	6.41	6.30	5.91	6.38	6.82	6.32	6.36
Taste	6.18	6.19	6.22	6.38	6.10	6.03	6.18
Overall acceptability	6.60^{a}	6.34^{b}	6.46	6.58	6.49	6.36	6.47

† 0 = disliked extremely. 10 = liked extremely. Figures followed by different letters are significantly different at 1% level.

4 weeks of storage because the samples were spoiled. Organoleptic scores of squashes made from Langra and Chonsamangoses were comparable. Quality deterioration was observed during storage in both Langra and Chonsa mango squashes.

Conclusion

Irradiation of mango fruit showed no additive effect on the quality of mango squash. Squash samples preserved by SO_2 proved better than heat treated samples.

Acknowledgements. The authors are indebted to Dr. A.G. Arain, Dr. K.A. Siddiqui (Director) and Dr. A.R. Azmi (Ex-Director) of Atomic Energy Agricultural Research Centre, Tandojam, for critically reviewing the manuscript.

References

1. V.L.S Charley, Fd. Technol., **17**, 987 (1963).
2. K. Vidyasagar and S.S.Arya, J. Agric. Fd. Chem., **31**, 1262 (1983).
3. WHO, Report of a Joint FAO/IAEA/WHO Expert Committee, Geneva, Oct. 27-Nov.3 (1980), Technical Report Series No.659, World Health Organization, Geneva, Switzerland (1981).
4. I.Kis, J.Farkas, S.Fernezi, B.Kalaman and J. Beczner, *Improvement of Food Quality by Irradiation* (International Atomic Energy Agency (IAEA), Vienna, 1974).
5. J. Farkas, F. Al-Charchafchy, M.H. Al-Shaikhaly, J. Mirjan and H. Auda, Acta Aliment. Acad. Sci. Hung, **3**, 151 (1974).
6. M. Ahmad, M.A. Chaudry and I. Khan, The Nucleus, **23**, 41(1986).
7. A.O.A.C., *Official Methods of Analysis* (Benjamin Franklin Station, Washington, D.C., 1980), 13th ed.
8. L.W. Mapson, Biochemical J., **36**, 196 (1942).
9. B.V. Chandler and G.L. Roberston, J. Sci. Fd. Agric., **34**, 599 (1983).
10. J.K. Krum, Fd. Eng., **27**, 74 (1955).
11. R.G.D. Steel and J.H.. Torrie, *Principles and Procedures of Statistics* (MaGraw Hill Book Co., New York, 1980).
12. M. Ahmad, M.H. Naqvi, A. Hussain, M. Mohyuddin, A. Sttar and M. Ali, Pak. j. sci. ind. res., **15**, 314 (1972).
13. I. Muhammad, M.A. Chaudry, M. Ahmad, J. Mohammad and I. Khan, The Nucleus, **23**, 15 (1986).
14. M. Ahmad, M. Ismail, M.A. Chaudry and B. Hussain, Pakistan J. Agric. Res., **9**, 198 (1988).
15. M.E. Ukhun, O.O. Sodeke and Y.S. Izuagbe, Nutr. Rep. Int., **38**, 331 (1988).