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Effect of ripening stages on physico-chemical characteristics of fresh and osmo-dehydrated mango slices

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ABSTRACT

Fresh mango fruits were kept at ambient conditions (25-35°C, 50-60%. RH) till 10 days and analyzed for various quality parameters. Sensory analysis was also carried out both in fresh and osmo-dehydrated slices. It was observed that 6th day after harvest was the best ripening stage for dehydration of mango slices on the basis of better firmness, optimum physiological loss in weight and better yield recovery in the finished product. Acidity, pH, ascorbic acid and β-carotene content of the both fresh and dehydrated slices were also found superior when the dehydration was done after 6th day after harvest.

Key words: Mango, ripening, β-carotene, osmo-dehydration, ascorbic acid, sensory quality.

INTRODUCTION

India is the second largest producer of fruits after China with an annual production of 71.5 million tonnes in an area of 56.3 million hectares (Anon, 2). Approximately up to 30 per cent of the total produce gets spoiled due to improper post-harvest management practices like handling, packaging, transportation and processing. Besides, their shelf-life at ambient conditions and susceptibility to microbiological and physiological disorders limit their storage life. Mango, plays a pivotal role in Indian diets and occupies premier position in Indian economy with an annual production of 15.03 million tonnes (MT) of fruits in an area of 2.31 million hectare (Anon, 1). The fruit is rich in important nutrients and vitamin A but the prices and the availability are highly fluctuating. Among the major processing techniques employed on industrial scale to preserve fruits and vegetables dehydration of perishables is best suited for developing countries, which have poorly established low temperature and thermal processing facilities (Suresh Kumar and Sagar, 12). Canning has become a costly proposition due to increasing cost of tin cans and therefore, dehydration of fruits is being popularized (Sagar and Khurdiya, 9). Advances in different dehydration techniques in recent years have enabled the production of wide range of dehydrated products and convenience foods from horticultural commodities which is meeting the quality, stability and functional requirements of people coupled with economy. The fruit and vegetable preservation industry has developed to a considerable extent and significant demand exists for canned mango slices in syrup, canned mango nectar, juice and pulp, mango squash, mango jam, mango preserve, mango pickle, and mango chutney (Pruthi, 6). The mango products exported constituted a major chunk which was reported to be 64.5 percent of total export of all the categories of fruit products from India. Since the mango is the climacteric fruit and harvested early in maturity before ripening, there is an urgent need to conduct basic studies to investigate and find out the optimum stage of ripening for the best dehydration of mango slices. Keeping these points in view, the present investigation was undertaken to study the influence of ripening stages on osmo-dehydration of mango.

MATERIALS AND METHODS

The mature fruits (water sinkers) of mango cv. Amrapali were procured from Experimental Orchard, IARI, New Delhi. Fresh, firm fruits were selected, washed thoroughly with water, dried under the fan, wrapped in news paper and kept in plastic crates for ripening at room temperature (25-35°C, 60% RH). The fruits were withdrawn at an interval of two days until ten days. The fruits were peeled manually with stainless steel knife and six slices were made longitudinally from each fruit. The slices were immersed for six hours in a solution containing 60°Brix sugar, 0.05 per cent KMS and 0.1 per cent citric acid at 60°C in 1:4 ratio (fruit slices: osmotic solution) without any agitation. The samples at the end of immersion period were withdrawn from osmotic solution, washed and blotted on filter paper to remove the adhering water. Osmotic dehydrated mango slices were loaded into aluminum trays (1.05

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× 0.45 m) at 1.5 kg/sq m for further drying in a cabinet drier (Kilburm make model - 0248, New Delhi) at 58 ± 2°C till the final drying. Physical constituents like physiological loss in weight (PLW), specific gravity, pressure, percentage of peel, pulp and stone and preparatory losses were estimated. Moisture, pH, titratable acidity, ascorbic acid and β-carotene were determined in fresh fruit as well as dehydrated slices as per procedure given by Ranganna (8). The sensory quality was evaluated on 9 point Hedonic scale. The experiment was laid out in completely randomized block design. The data obtained were subjected to statistical analysis, using AGRES software. The critical difference (CD) value at 5% level of probability with 3 replications was compared for making the comparison among different treatments.

RESULTS AND DISCUSSION

The data indicated that PLW varied from 3.23 to 9.44 per cent during the ripening of Amrapali mango (Table 1). An increase in PLW was highly significant with the advancement of ripening. Similar result was also reported by Selvaraj *et al.* (10) and Suresh Kumar *et al.*, (13). Specific gravity of the fruits decreased with ripening stages though it was non-significant. Initial specific gravity of 1.06 decreased to 0.98 on the 10th day as the ripening progressed. Specific gravity of 1.00 and above are generally not considered good for processing, resulting in products with a hard texture, cooked flavour and comparatively greater metallic absorption and discolouration (Kapur *et al.*, 5). Fruit firmness decreased slowly up to 6th day, thereafter, a fast decrease was noticed as fruit ripens. The contents of peel and stone decreased gradually with the increase in ripening period, while edible portion was increased. An analogous finding has been reported by Gowda and Huddar (4) in dehydrated mango slices. Preparatory loss decreased until 4 days after harvest and then increased significantly as the ripening period prolonged. Maximum preparatory loss was recorded on 10th day (9.16%) after harvest, which may be due to disintegration of pulp tissues and its adherence to peel and stone as fruit enters senescence stage. Similar observations were recorded by Sharma *et al.* (11) in apricot.

Moisture showed increasing trend with the increase in ripening period and the maximum moisture was observed on 10th day (85.24%) after harvest (Table 2). This could be due to a higher respiration rate and greater water holding capacity of sugars and pectin in soft ripe fruits compared to starch and protopectin in hard and unripe fruits. Similar results were observed by Gowda and Huddar (4). TSS increased from 11.43 to 21.9 on the 8th day and then decreased. The increase in TSS might be due to hydrolysis of polysaccharides into simple sugars. Maximum titratable acidity (1.07%) was on the day of harvest which decreased to 0.15% on 10th day. Selvaraj *et al.* (10) have also recorded a decrease in acidity of ripe fruits. Increase in ripening period correspondingly increases the pH. A gradual decrease in ascorbic acid content was noticed as the ripening period prolonged. The reduction in the content of ascorbic acid might be due to its oxidation and enzymatic degradation during ripening. The decrease in ascorbic acid content has also been reported by Khurdiya and Roy (6) in mangoes and Suresh Kumar *et al.*, (13) in guava. Total and reducing sugars increased with the increase in ripening period. There was a slight reduction in total sugars upon further ripening after 8th days. These observations are in conformity with those of Bulk *et al.*, (3) in guava. Significant increase in content of the total sugars from unripe to ripe stage may be due to starch breakdown into simple sugars (Selvaraj *et al.,* 10). A rapid increase in β-carotene was observed as the ripening period prolonged. Maximum (13,227 µg/100 g) β-carotene content was observed on the 10th day after harvest, while the minimum β (8936 µg/100 g) was observed at harvest. Gowda and Huddar (4) reported similar findings when working on the blending ability of different mango varieties and hybrids. The observations on organoleptic quality of ripening fruits are presented in Table 3. Pulp colour increased with the increasing period of time and was highest (8.6) on 6th day. Similarly, flavour and texture scores were also higher on 6th day after harvest. The better score on texture in the optimum stage may be due to conversion of proto-pectin into pectin, however, further increase in ripening period might have led to change of pectin into pectinic acid which disintegrated the cell structure and so scored very less. Similar observation was made by Sharma *et al.* (11) in apricot. Over all acceptability score was also recorded higher on 6th day after harvest.

The moisture content of dehydrated mango slices showed increasing trend with an increase in ripening period and the maximum moisture was observed on the 10th day (9.25%) after harvest. Similar observation was made by Suresh Kumar and Sagar (12) in osmo-dehydrated guava slices. It was evident from (Table 4) that titrtable acidity decreased significantly with the increase in ripening period. The change in acidity of dehydrated products has direct correlation with the acidity of fresh fruit. A decreasing trend in ascorbic acid content with increase in ripening period was noticed in dehydrated mango slices. This may be due to the gradual decline of ascorbic acid in the fresh fruit as the ripening stage advance. Maximum (34.95%) reducing sugars in the dehydrated slices were observed when the product was prepared after 10th day of fruit

Table 1. Effect of ripening stages on physical characteristics of mango.

After harvest (days)	PLW (%)	Specific gravity	Pressure (kg/cm^2)	Peel (%)	Edible portion (%)	Stone (%)	Preparatory loss (%)
0	0.00^a	1.06	2.14^d	13.47	69.81	9.31	7.41^a
2	3.23^b	1.03	2.09^d	12.91	70.35	9.11	7.63^a
4	6.41^c	1.01	2.01^{cd}	12.34	71.22	9.01	6.67^a
6	7.32^d	0.99	1.75^c	12.06	72.04	8.99	6.91^a
8	8.91^e	0.98	0.63^b	12.00	71.13	8.42	8.45^b
10	9.44^f	0.98	0.04^a	11.88	70.67	8.29	9.16^b
$CD_{0.05}$	0.92	NS	0.30	NS	NS	NS	1.20

*In each column, means with similar alphabets do not vary significantly at P = 0.05 by separated DMRT.

Table 2. Effect of ripening stages on the chemical characteristics of mango.

Days after harvest	Moisture (%)	TSS (°B)	Titratable acidity (%)	pH	Ascorbic acid (mg/100 g)	Reducing sugars (%)	Total sugars (%)	β-carotene (µg/100 g)
0	83.10	11.43^a	1.07^e	2.71^a	44.36^d	2.06^a	10.94^a	8,936^a
2	83.62	13.31^a	0.73^d	3.25^a	39.81^d	3.15^b	13.08^{ab}	9,842^{ab}
4	84.23	17.58^b	0.45^c	4.07^b	32.74^c	3.84^c	15.69^{bc}	11,074^{bc}
6	84.3	21.4^c	0.27^b	4.87^c	27.83^b	4.69^d	16.45^c	12,721^{cd}
8	85.21	21.9^c	0.21^{ab}	4.91^c	21.05^a	5.31^e	16.98^c	13,011^d
10	85.24	19.8b^c	0.15^a	4.99^c	17.11^a	6.08^f	16.81^c	13,227^d
$CD_{0.05}$	NS	2.85	0.09	0.65	4.36	0.60	2.70	1092.74

In each column, means with similar alphabets do not vary significantly at P = 0.05 separated by DMRT

Table 3. Effect of ripening stages on the sensory characteristics of mango.

Days after harvest	Colour	Flavour	Texture	Over all
0	5.0^a	5.6^a	4.6^a	5.1^a
2	6.3^b	7.1^b	6.8^{ab}	6.7^b
4	7.4^{bc}	7.6^b	7.9^{bc}	7.6^c
6	8.6^d	8.8^c	8.8^c	8.7^d
8	7.8^{cd}	8.2^b	8.2^{bc}	8.1^{cd}
10	7.7^{cd}	8.0^b	7.9^{bc}	7.9^c
$CD_{0.05}$	0.42	0.85*	1.05*	0.65*

In each column, means with similar alphabets do not vary significantly at P = 0.05 by DMRT.

harvest. Similarly, total sugars, also increased with the increase in ripening period. However, slight reduction in total sugars was noticed in the slices prepared from 10 day ripe fruit to β-carotene increased with an increase in ripening period. Maximum (63,847 µg/100 g) β-carotene content in the dehydrated slices was observed on the 10th day after harvest, while the minimum β-carotene (56,832 µg/100 g) was observed on the day of harvest. The sensory score of dehydrated slices on colour, flavour, texture and over all acceptability were also higher on the 6th day of fruit ripening (Fig. 1). Selvaraj *et al.* (10) have also observed similar trend during ripening of mango fruits. The sensory score was poor in dehydrated product prepared from unripe fruits. This may be due to poor and non uniform colour, thick texture of fruit slices and less flavour while on the other hand at later stage this may be due to it's over ripeness, soft tissues, which make them unsuitable for drying of slices and cause poor sensory score.

Table 4. Effect of ripening stages on the quality of dehydrated mango slices.

Days after harvest	Moisture (%)	Titratable acidity (%)	Ascorbic acid (mg/100 g)	Reducing sugars (%)	Total sugars (%)	β-carotene (µg/100 g)
0	8.23[a]	1.90[e]	212.58[d]	20.51[a]	55.67[a]	56,832[a]
2	8.46[ab]	1.42[d]	180.02[c]	25.02[b]	60.84[ab]	59,067[a]
4	8.67[b]	1.09[c]	163.31[bc]	26.14[b]	64.76[b]	60,245[b]
6	9.09[c]	0.85[b]	155.43[ab]	33.26[c]	71.31[c]	62,723[c]
8	9.17[cd]	0.71[ab]	142.82[a]	34.37[c]	76.09[c]	63,095[d]
10	9.25[d]	0.66[a]	134.76[a]	34.95[c]	75.25[c]	63,847[d]
$CD_{0.05}$	0.16	0.19	17.94	5.01	8.25	791.38

In each column, means with similar alphabets do not vary significantly at P = 0.05 by DMRT.

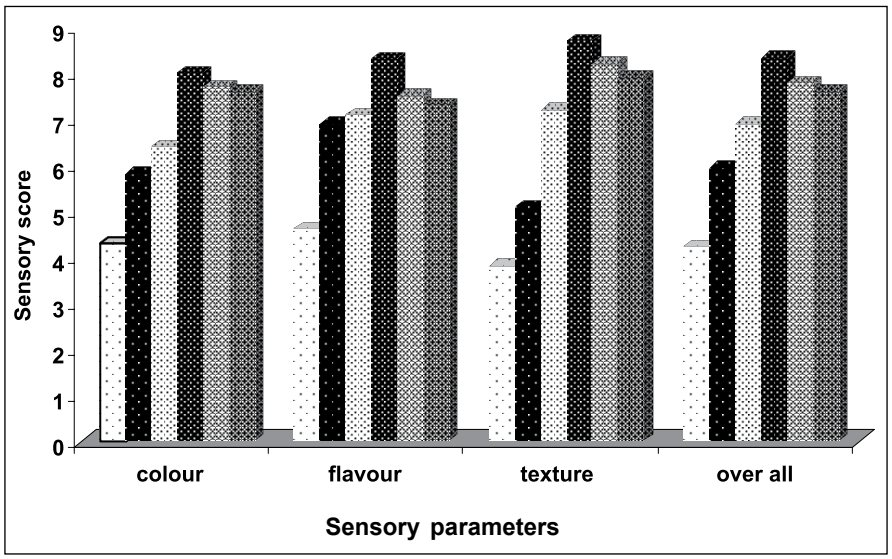

Fig. 1. Effect of ripening stages on sensory score of dehydrated mango slices.

REFERENCES

1. Anon, 2011. http:// www.gktoday.in/ primary-sector-Indian-economy/India% E.2%80%99s-fruit-production/ dated 17/12/2011
2. Anon. 2011. *Indian Horticulture Database*. National Horticulture Board, Gurgaon, India. http:// www.nhb.gov.in/statistics/area-production-statistics. html/ dated 17/12/11
3. Bulk, E.L.R.E., Balsiker, E.F.E. and Tinay, A.H. 1997. Changes in chemical composition of guava fruits during development and ripening. *Food Chem.* **59**: 395-99.
4. Gowda, I.N.D. and Huddar, A.G. 2004. Investigations on processing quality of some mango varieties, hybrids and their blends. *J. Food. Sci. Tech.* **41**: 154-59.
5. Kapur, K.L., Verma, R.A. and Tripathi, M.P. 1985. Effect of maturity and processing quality of pulp, slices and juice of mango cv. Dashehari. *Indian Fd. Pack.* **39**: 60-67.
6. Khurdiya, D.S. and Roy, S.K. 1986. Studies on ripening and canning of mangoes. *Indian Fd. Pack*. **40**: 45-48.
7. Pruthi, J.S. 1992. *The Mango Book 1. Production, Post Harvest Technology and Export marketing*. Brief description of existing 20 commercial varieties of mango. Agricultural Processed Food Products Export Development Authority (APEDA), Govt. of India, New Delhi.
8. Ranganna, S. 2002. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products* (2nd Edn.), Tata McGraw Hill Publication, Co. Ltd., New Delhi

9. Sagar, V.R. and Khurdiya, D.S. 1999. Studies on dehydration of Dashehari mango slices. *Indian Fd. Pack.* **53**: 5-9.

10. Selvaraj, Y., Kumar, R. and Pal, D.K. 1989. Changes in sugars, acid, amino acids, lipid constituents and aroma characteristics of ripening mango fruit. *J. Fd. Sci. Tech.* **26**: 308-13.

11. Sharma, K.D., Kumar, R. and Kaushal, B.B.L. 2004. Mass transfer characteristics, yield and quality of five varieties of osmotically dehydrated apricot. *J. Fd. Sci. Tech.* **41**: 264-75.

12. Suresh Kumar, P. and Sagar, V.R. 2009. Effect of osmosis on chemical parameters and sensory attributes of mango, guava slices and *aonla* segments. *Ind. J. Hort.* **66**: 53-57

13. Suresh Kumar, P., Sagar, V.R. and Singh, Uadal. 2008. Effect of ripening stages on osmo-dehydrated guava slices. *J. Fd. Sci. Technol.* **45**: 546-48.

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