Indian Journal of Ecology (2023) 50(5): 1569-1574
DOI: https://doi.org/10.55362/IJE/2023/4098

Manuscript Number: 4098
NAAS Rating: 5.79

Utilization of Waste Unripe Mango for Preparation of Candy with Enhanced Bioactive and Mineral Composition

Sahil Kamboj, Julie Dogra Bandral*, Monika Sood and Neeraj Gupta

Division of Post Harvest Management, Faculty of Horticulture and Forestry
Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu
Jammu and Kashmir Jammu-180 009, India
**E-mail: jdbandralpht@gmail.com*

***Abstract*:** In the present study, waste (dropped) raw/unripe local mangoes were utilized to prepare highly nutritious fruit candy as functional food. The raw mango pulp was blended with different concentration of gelatin, pectin, brown sugar (gur) and sugar to prepare candy having chewy texture. The fruit candy was analyzed for its bioactive components and overall acceptability scores during storage under ambient conditions. Significant decrease in total phenols (98.92 to 95.17 GAE/100g), antioxidant activity 16.64 to 15.57 %), ascorbic acid (31.47 to 26.31 mg/100g) and total flavonoid content (15.31 to 14.69 mg Catechin/100 g) of raw mango candy was observed during storage period of 90 days, Highest amount of mean calcium (48.82 mg/100g) and phosphorus content (27.86 mg/100g) were in T_6(RMP + 4.5 g gelatin + 3.5g pectin + 45g brown sugar). Sensory evaluation of raw mango candies showed that candy prepared using 4 g gelatin, 3g pectin and 40g sugar scored the best with respect to overall acceptability scores. Thus, mango fruit candy having rich flavour of raw/unripe mango can emerge as a highly acceptable confectionery product liked by almost all age groups as a snack for gaining quick energy thereby adding economic value and enhanced utilization of the waste mango and higher monetary returns to the farmers/small scale food processors.

Keywords: Unripe mango, Gelatin, Pectin, Candy, Bioactive component, Overall acceptability

Fruits are highly perishable because of various enzymatic as well as non-enzymatic reactions that occur during different stages of fruit maturation and storage causing changes in nutritional and sensorial properties (Baldwin and Bai 2010). Providentially, mango fruit can be used in all stages of maturity as a dessert, table fruit and can be processed into numerous value added products. Different conventional mango products have been developed so far and significant demand has been built up by the processing industry, both for domestic and export market (Ravani and Joshi 2013). The international market has become more competitive and many other mango producing countries are also entering the market. Therefore, there is a pressure on the industry for the development of newer category of products, so as to hold on to the monopoly in the international market. Fully mature but unripe mango fruits which drop down from the trees are acidic in taste and are generally used to prepare products like pickles, chutney, *amchoor* etc. These fresh fruit have a very poor shelf life and post-harvest losses occur due to numbers of problems posing difficulty in preserving of the freshness of produce for longer duration. With increasing awareness regarding the food value and dietary significance of various food constituents, people are now highly conscious in selecting food products. The general tendency of the consumers has shifted towards selecting those products prepared from natural ingredients. Local mango fruits are poor in size, having small amount of pulp and does not have market value besides having limited shelf life. But the nutritional composition and flavour is remarkable and can be effectively used to prepare fruit candy. Fruit candies can be better utilized as a vehicle to promote consumption and utilization of local mango (which usually drop from trees). The osmo-dried or fruit candies are a popular and highly acceptable confectionery products and are liked by almost all age groups as a snack for gaining quick energy. Fruit toffees contain original nutrients like vitamins and minerals present in the real fruit and are nutritionally superior to those prepared from sugar or syrup. Therefore study was planned to utilize waste unripe/raw mango to produce pulpy toffee with chewable texture using gelatin and pectin along with sugar/honey as sweetening agents.

MATERIAL AND METHODS

Preparation of pulp: The raw mangoes were peeled and converted into pulp using mixer grinder. The pulp was divided into two lots. One lot was cooked with sugar (100g/kg pulp) and the second lot was cooked using brown sugar i.e. *gur* (100g/kg pulp). The pulp was cooled and stored in jar under refrigerated condition for further use.

Preparation of raw mango candy: The raw mango pulp

(RMP) was mixed with different ingredients as per the treatment (Table 1). The candy was prepared as per the procedure described by Revanwar and Sakhlae (2003) with certain modification. The prepared mango pulp was heated till it remained one half of its original volume and other ingredients viz. pectin, gelatin, sugar/brown sugar were added as per the treatment details. The pulp was further cooked (concentrated) until one third of its original volume. Addition of edible fat (15g) and skim milk powder (50ml) was done after dissolving in small amount of warm water. The pulp was further concentrated up to 78° Brix and then molded into cuboid shape (candy shape approximately 3g in weight). After cooling it for 2 hours, the candy was wrapped in butter paper and transparent plastic film and finally placed in laminated pouches (100g) and stored in air tight containers.

Bioactive Components

Ascorbic acid: Titrimetric method using 2,6-dichlorophenol indophenol dye was used to estimate ascorbic acid (AOAC 2012).

Total phenols: The total phenolic content was determined by method of Folin-Ciocalteu (FC) which is an electron transfer based assay (Ahmed and Abozed 2015).

Total flavonoids: Total flavonoids content (mg Catechin/100 g) was estimated using aluminum chloride method (Zhishen et al 1999).

Total carotenoids: Two grams of sample was macerated in 10 ml of 80 per cent acetone in pestle and mortar and centrifuged at 5000 rpm for 15 minutes. The remaining pellets in the centrifuge tube were repeatedly extracted with 10 ml of 80 per cent acetone until it became colourless. All the extracted supernatant (acetone extracts) were pooled together and its final volume was made up to 100 ml with 80 per cent acetone. The filtrate was then transferred to separating funnel. Added 10 to 15 ml of petroleum ether and the separating funnel was shaken for mixing of pigments into petroleum ether phase. The petroleum ether extract was shaken layer were measured using UV-spectrophotometer at 440 nm using petroleum layer as a blank (Carvalho et al 2012). The results were calculated as µg/100g.

$$\text{Carotene} = \frac{\text{Conc. of carotene in soln. from standard curve} \times \text{Final volume} \times \text{Dilution} \times 100}{\text{Weight of sample}}$$

Antioxidant activity: Free radical scavenging activity was determined by DPPH (diphenylpicryhydrazyl) method. Five hundred micro liters of 0.5 Mm DPPH solution and 2ml of 80 per cent methanol aqueous solution were mixed with 25µl of methanolic extract of sample, and absorbance were determined under 517nm blank as 80 per cent methanol and tris buffer after maintaining at 20°C for 30 minutes. The free radical scavenging activity was evaluated by comparing the absorbance of the sample solution with control solution to which distilled water was added instead of sample (Luo et al 2009).

$$\text{Radical scavenging activity (\%)} = \frac{\text{Control OD (0 min) - Sample OD (30 min)} \times 100}{\text{Control OD (0 min)}}$$

Minerals: Phosphorus content was determined with the help of Spectrophotometer (UV-1601) by using Vandate-molybedete reagent yellow colour method described by Ahmed and Abozed (2015). The phosphorus content was calculated by plotting against the standard curve obtained by taking known amount of potassium di-hydrogen phosphate (KH_2PO_4) salt. The result was expressed as mg/l00g. For estimation of calcium content a known volume of sample (1ml) extract was titrated with standard EDTA (N/50) solution using ammonium perpurate (Mure oxide) as an indicator in the presence of 4 N NaOH solution. The end point is a change in color from orange-red to purple.

$$\text{Meq Ca/100g of sample} = \frac{\text{Volume of EDTA x Volume of sample made x N of EDTA} \times 100}{\text{Weight of sample} \times \text{volume aliquot (ml)}}$$

Sensory evaluation: The samples were evaluated for acceptability by semi-trained panels of 7-8 judges using 9 point hedonic scale assigning scores 9 - like to 1- dislike extremely The score of 5.5 and above was considered acceptable (Amerine et al 1965).

RESULTS AND DISCUSSION

Bioactive composition of fresh raw mango fruit: Illustrates bioactive component and Mineral characteristics of fresh raw mango fruit. The antioxidant percentage in fresh raw mango fruit was 12.06 and total flavonoids of 21.16 mg Catechin/100 g) (Table 1).

Effect of pectin, gelatin and sweetening agents on bioactive composition of raw mango fruit candy: Ascorbic acid content of raw mango candy showed a decreasing trend over storage period of 90 days at ambient temperature. Storage had significant effect on ascorbic acid content of raw mango blended candy with highest mean ascorbic acid content of 31.47 mg/l00g at zero day which decreased to 26.31 mg/100 after 90 days storage. After 90 days of storage the highest ascorbic acid content of 27.17 mg/l00g was in T_2 (RMP+ 4g gelatin + 3g pectin + 40g sugar) and lowest ascorbic acid content of 26.01 mg/l00g was in T_4 (RMP+ 3.5g gelatin + 2.5g pectin + 45g brown sugar).

Significant reduction in vitamin C content of guava jelly bar and blended toffee (bottle gourd and strawberry) due to oxidation of ascorbic acid into dehydro ascorbic acid by oxidase enzyme like ascorbic acid oxidase during storage (Kuchi et al 2014, Norzom et al 2018). The ascorbic acid content decreased more rapidly in the initial stages but the decrease was slow in the later stages with increase in storage period (Nayak et al 2012). The total flavonoid content decreased with the advancement of storage period. After 90 days of storage, treatment T_6 recorded the highest flavonoid content of 14.86 mg Catechin/100g and treatment T_1 lowest flavonoid content of 14.54 mg Catechin/100g. Highest mean total flavonoid content of 15.31mg Catechin/100gwas at initial day of storage which decreased to 14.69mg Catechin/100g after 90 days storage. Decrease in flavonoid content might be due to ingress of oxygen and dilution of flavonoid content due to moisture gain during the storage of candies (Mir et al 2015). The results are in close proximity with the findings of Yadav (2020) on jamun and bael blended cheese.

Significant decrease in phenol content was observed during storage of raw mango candy and the total phenol decreased from initial mean value of 98.92 to 95.17 GAE/100g during 90 days storage (Table 2). After 90 days of storage, the highest total phenol content of 100.05 mg/100g was noticed in treatment T_6whereas, lowest total phenol content of 91.72 GAE/100g was in treatment T_1). Accumulation of phenols during the storage of raw mango candy has been observed by some researchers. The phenolic compounds are highly volatile and are easily oxidized to give brown product of high molecular weight. The decline in total phenols during the period of storage might be owing to their condensation into brown pigments. Decrease in the total phenolic content with increased storage period was observed in case of researches carried out on freeze dried whole strawberries (Bandral et al 2022). Decrease in **t**he total carotenoids content was noticed with the advancement of storage and after 90 days treatment T_6 (RMP+ 4.5g gelatin + 3.5g pectin + 45g brown sugar) recorded the highest carotenoid content of 62.68 µg/100g and T_1 (RMP+ 4g gelatin + 3g pectin + 45g brown sugar) lowest carotenoid content of 60.49 µg/100g. In the presence of light, the carotenoids were destroyed or altered by acids to form cis-isomers form all the trans structure. The pigments were easily oxidized in the presence of oxygen. The oxygen content in the storage medium is the crucial factor acting on carotene discoloration and a small percentage of oxygen contact with carotene had a dramatic effect on its shelf life (Kumar et al 2017). Trilokia et al (2022) also reported significant reduction in total carotenoid content of freeze dried carrot pomace with the advancement in storage period. Antioxidant activity of raw mango showed a decreasing trend during storage and there was significant influence of storage and the results for interaction between treatments and storage were also found to be significant. The mean antioxidant activity decreased from 16.64 to 15.57 per cent during 90 days of storage. Phenolic compounds and ascorbic acid content were responsible for the antioxidant activity of fruits. This loss in antioxidant activity could be attributed to oxidation or loss of ascorbic acid and phenolic compounds with the passage of time in quince candy during storage at ambient condition (Mir et al 2015).

Mineral composition of raw mango candy: The phosphorus contents of raw mango candy decreased significantly during 90 days of storage period and the lowest mean phosphorus content of 6.69 mg/100g was in treatment T_1 (RMP+ 3.5g gelatin + 2.5g pectin + 40g sugar) whereas highest value of 27.86 was recorded in treatment T_6 (RMP+ 4.5g gelatin + 3.5g pectin + 45g brown sugar). Similar results were reported while developing fruit based preserved products (wood apple fruit bar, strawberry bottle gourd blended fruit toffee) and the possible reason for the decrease might be due to its heat sensitiveness even at the ambient

Table 1. Bioactive and Minerals composition of raw mango pulp (RMP)

Parameter	Content
Ascorbic acid (mg/100g)	29.55
Total carotenoids (µg/100g)	68.45
Total phenols (GAE/100g)	113.50
Total flavonoids (mg Catechin/100 g)	21.16
Total Antioxidant activity (%)	12.06
Phosphorus (mg/100g)	19.34
Calcium (mg/100g)	10.00

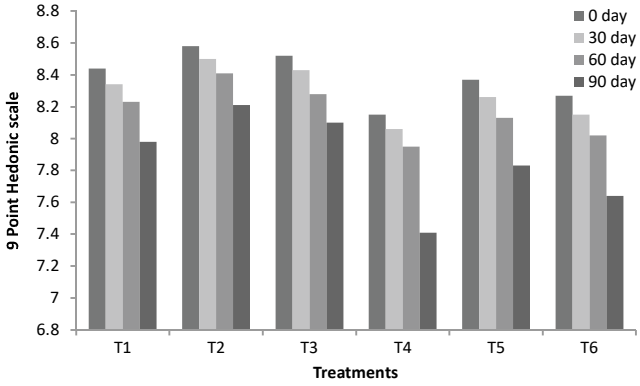

Fig. 1. Effect of various treatments and storage periods on overall acceptability scores of raw mango candy

temperature which causes the destruction of minerals during storage. There was significant decrease in the calcium content of raw mango candy with the advancement of storage period and it decreased from 38.15 to 36.82mg/100g during 90 days of storage (Table 3). After 90 days of storage, T_1 recorded the lowest calcium content of 24.24 mg/100g whereas highest calcium content of 48.82 mg/100g was in T_6. Calcium content of candy was significantly influenced by storage period and the results for interaction between treatments and storage. These findings are in line with those observed for bael-jamun blended cheese (Yadav 2020), iron rich toffees (Mewada et al 2013) and chickpea nuggets (Choton et al 2022).

Overall acceptability raw mango candy: General decrease in overall acceptability scores was observed in all the treatments with the advancement of storage period (Fig. 3). After 90 days of storage the highest overall acceptability score of 8.21 was in T_2 (RMP+ 4g gelatin + 3g pectin + 40g sugar), whereas, the lowest over all acceptability score of 7.41 was in T_4 (RMP+ 3.5g gelatin + 2.5g pectin + 45g brown sugar). Storage studies on guava papaya mix toffee have indicated a

Table 1. Effect of various treatments and storage on Ascorbic acid and Total flavonoids content of raw mango candy

Treatments	Ascorbic acid (mg/100g)					Total flavonoids (mg atechin/100g)				
	Days after storage					Days after storage				
	0	30	60	90	Mean	0	30	60	90	Mean
T_1 (RMP + 3.5g gelatin + 2.5 g pectin + 40g sugar)	55.22	53.71	52.45	51.19	53.14	15.10	14.98	14.72	14.54	14.83
T_2 (RMP + 4g gelatin + 3 g pectin + 40g sugar)	52.65	51.18	49.86	48.71	50.60	15.19	15.07	14.98	14.60	14.96
T_3 (RMP+ 4.5g gelatin + 3.5 g pectin + 40g sugar)	50.75	49.35	48.10	46.98	48.79	15.25	15.16	15.07	14.79	15.07
T_4 (RMP + 3.5g gelatin + 2.5 g pectin + 45g brown sugar)	45.40	44.05	42.85	41.76	43.51	15.31	15.19	15.03	14.58	15.02
T_5 (RMP + 4g gelatin + 3g pectin + 45g brown sugar)	43.81	42.55	41.41	40.39	42.04	15.48	15.30	15.08	14.77	15.16
T_6 (RMP + 4.5g gelatin + 3.5g pectin + 45g brown sugar)	42.41	41.19	40.12	39.22	40.73	15.51	15.38	15.25	14.86	15.25
Mean	48.37	47.01	45.79	44.71		15.31	15.18	15.02	14.69	

RMP	Raw Mango Pulp	RMP	Raw Mango
Effects	CD ($p \leq 0.05$)	Pulp	
Treatment	0.10	Effects	CD ($p \leq 0.05$)
Storage	0.03	Treatment	0.03
Treatment x Storage	0.07	Storage	0.02
		Treatment x Storage	0.06

Table 2. Effect of various treatments and storage on Total phenols, Total carotenoids and Total antioxidant activity of raw mango candy

Treatment	Total phenols (GAE/100g)					Total carotenoids (µg/100 g)					Total antioxidant activity (%)				
	Days after storage					Days after storage					Days after storage				
	0	30	60	90	Mean	0	30	60	90	Mean	0	30	60	90	Mean
T_1	93.96	93.76	92.52	91.72	92.99	61.81	61.33	60.09	58.74	60.49	15.81	15.34	15.09	14.74	15.24
T_2	95.44	95.24	94.90	92.48	94.51	62.17	61.69	60.33	59.97	61.04	16.17	15.69	15.33	14.97	15.54
T_3	97.76	97.51	96.19	94.83	96.57	62.41	62.05	61.30	60.21	61.49	16.40	16.05	15.69	15.21	15.84
T_4	99.96	99.67	97.31	95.93	98.21	62.65	62.17	61.64	60.82	61.81	16.64	16.17	15.81	15.69	16.08
T_5	101.11	100.82	98.43	96.02	99.09	63.36	63.00	62.70	61.40	62.61	17.36	17.00	16.78	16.31	16.91
T_6	105.28	104.89	102.48	100.05	103.18	63.48	63.36	62.88	61.00	62.68	17.48	17.25	16.94	16.50	17.04
Mean	98.92	98.65	96.97	95.17		62.65	62.26	61.49	60.35		16.64	16.25	15.94	15.57	

Effects	CD ($p \leq 0.05$)	Effects	CD ($p \leq 0.05$)	Effects	CD ($p \leq 0.05$)
Treatment	0.04	Treatment	0.02	Treatment	0.02
Storage	0.02	Storage	0.03	Storage	0.04
Treatment x Storage	0.07	Treatment x Storage	0.07	Treatment x Storage	0.08

Table 3. Effect of combination of pectin and gelatin on calcium and phosphorus content of raw mango candy

Treatments	Calcium (mg/100g)					Phosphorus (mg/100g)				
	Days after storage					Days after storage				
	0	30	60	90	Mean	0	30	60	90	Mean
T_1	25.76	25.23	24.83	24.24	25.02	6.89	6.75	6.64	6.49	6.69
T_2	27.03	26.81	26.44	25.60	26.47	7.23	7.17	7.08	6.98	7.12
T_3	27.73	27.39	26.93	26.45	27.13	7.42	7.33	7.21	7.08	7.26
T_4	48.48	48.21	47.74	47.35	47.95	27.62	27.55	26.96	26.37	27.13
T_5	49.65	49.33	48.82	48.48	49.07	27.94	27.85	27.59	27.30	27.67
T_6	50.23	49.85	49.19	48.82	49.52	28.09	27.99	27.71	27.64	27.86
Mean	38.15	37.80	37.33	36.82		15.42	15.33	15.10	14.84	
RMP	Raw Mango Pulp					RMP				Raw Mango
Effects	CD ($p \leq 0.05$)					Pulp				
Treatment	0.12					Effects				CD ($p \leq 0.05$)
Storage	0.03					Treatment				0.15
Treatment x Storage	0.07					Storage				0.01
						Treatment x Storage				0.07

decrease in the score of different parameters of raw mango blended candy, irrespective of treatments during storage which might be attributed to change in their objective characteristics like loss of colour pigments, breakdown of insoluble solids, change in sugar acid ratio and overall quality loss (Mewada et al 2013). Decreasing trend in organoleptic scores of mango-pumpkin blended toffees (Choudhary 2020), aonla-mango mixed fruit slab (Verma and Chopra 2010) during storage has been reflected in some studies and the product maintained its acceptability up to seven months at ambient storage.

CONCLUSION

On the basis of sensory evaluation raw mango pulp + 4g gelatin + 3g pectin + 40g sugar was the best treatment. The candy can be stored at ambient conditions for 90 days without much loss in nutritional quality. Therefore, by preparing raw mango products, the processing industry can fulfill the dual purpose of better use of these perishable fruits (having high therapeutic value) thus lowering post harvest losses and will also give good returns to the growers.

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Received 28 April, 2023; Accepted 05 September, 2023