



Stability of mango drink enriched with micro-encapsulated pomegranate peel extract

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ABSTRACT

A mango drink with 19.5% pulp and 15°B TSS was prepared with or without addition of 2% microencapsulated phenolic extract powder (as antioxidant) from wild pomegranate peel. Comparative evaluation of mango drinks revealed significant increase in total phenols and flavonoids with various antioxidant properties after incorporation of microencapsulated pomegranate peel phenolic extract (MEPPE) powder (2%) in enriched drinks. The drinks were packed in PET (transparent) bottles for storage for 6 months under ambient (9.7-24°C; RH 40-50%) and refrigerated temperatures (4-7°C; RH 85-90%). Antioxidant enriched mango drinks can safely be stored for six months without much quality changes under both storage conditions. After 6 months of refrigerated storage drink contained higher ascorbic acid (4.47 mg/100mL), total phenols (161.20 mg GAE/100mL), flavonoids (8.35 mg QE/100), radical scavenging activity (74.93%), metal chelating activity (46.68%), FRAP (11.05µM Fe²⁺/100mL) and reducing power (0.907) besides higher colour scores and sensory acceptability compared to those stored at ambient condition. Hence, phenolic antioxidants from the microencapsulated powder of pomegranate peel could be utilized commercially to produce antioxidant-rich mango drink, thereby utilizing the processing wastes in production of anardana from wild pomegranate.

Keywords: Mango drink, Enrichment, Phenolic extract powder, Antioxidant, Wild pomegranate

INTRODUCTION

Increasing function of dietary natural antioxidants in prevention and curing of various diseases has prompted research in the field of antioxidant-rich beverages. Wild pomegranate (*Punica granatum* L.) locally named as *daru* and due to its extremely acidic character of arils it is a very admired distinctive fruit of the Indian Northern highlands. High amount of lot of polyphenolics including ellagic acid and ellagitannins are abundant in pomegranate fruit peels that impart antioxidant activities (Masci *et al.*, 10). The peel also has excellent therapeutic properties and is used in the various herbal preparation in industry (Murtaza and Ahmad, 12). Besides arils, peels are yet to be fully investigated for their antioxidant potential and because of their greater antioxidant content, they can be used to make a variety of functional foods. The market for nutraceutical beverages, that is, drinks with vitamin and mineral fortification, antioxidant or high polyphenol beverages and drinks with herbs is on the rise continuously along with the health consciousness of the people. Mango fruit is good source of natural carotenoids, vitamins C, B, carbohydrates and mineral contents (Ramdevputra *et al.*, 14). Commercial mango drink only contains 10 to 20% pulp due to that very less amount of bioactive

compounds consumed per serving. Enrichment of mango drink with microencapsulated phenolic extract pomegranate peel (MEPPE) powder improves the phenolics as well as therapeutic value of beverage. This MEPPE enriched juice beverage would offer new particular wholesome benefits over the plain beverage to the customer or consumers due to its higher phenolics, flavonoids and antioxidant activity. Therefore, the attempts were made in the present investigation to develop the nutritionally phenolics enriched mango RTS beverages with better acceptability. Thus core aim of work was to assess the antioxidant potential, sensory acceptability and storage stability of phenolics/antioxidant enriched mango based beverage.

MATERIALS AND METHODS

Matured fruits of wild pomegranate after harvesting were procured in October 2018 from district Mandi (Karsog location 1265 m above mean sea level) of state Himachal Pradesh. Peels from fruits were further separated followed by immediate drying (at 50 °C) in mechanical cabinet dehydrator. Further peels were subjected to extraction of phenolic with 60 per cent ethanol at 30 °C for 6 h. In vacuum rotatory evaporator (50 °C) the obtained extract was further concentrated (until 1/4th volume) and maltodextrin (20DE) was added to it in the ratio 1:2

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(extract to maltodextrin) followed by continuous homogenization (2h) for microencapsulation. The mixture after complete freezing (-20 °C for 24h) was lyophilized in lyophilizer (LABCONCO-FreeZone USA) (-30 °C temperature and vacuum pressure of 0.04 mbar) and obtained MEPPE samples were converted into powder form using a mortar and pestle (Hamid *et al.*, 7).

Fruit drink was prepared by incorporating constant amount of mango fruit pulp (19.50%) in constant concentrations of sugar syrup. Canned mango pulp (Ratnagiri Alphonso) was used in the preparation of drink. TSS was kept constant (15 °B) and to attain the required concentration of citric acid (0.40%) in beverage, citric acid was further added. KMS (122 ppm) as a preservative was also added at the last step of beverage preparation. Before selecting one treatment of enriched drink, different pre-trials were done with 0.5 to 6% microencapsulated pomegranate peel phenolic extract (MEPPE). Addition of 2 per cent MEPPE powder was found suitable on the basis of high overall acceptability (Hamid *et al.*, 7). The best recipe (19.50 % pulp, 15 °B TSS, 0.41 % titratable acidity with 2 % MEPPE powder) was selected on the basis of sensory parameters for storage studies. The drink was packed in pre-cleaned (using hot water method) transparent PET bottles (200 mL), properly labeled and stored at ambient (9.7-24 °C) and refrigeration (4-7 °C) conditions for storage of 6 months. All the parameters including sensory distinctiveness of beverage were estimated on regular intervals (0, 3 and 6 months) during storage.

Colour values were analyzed in Lovibond Colour series spectrophotometer and which gives CIE i.e. L*, a* and b* values along with RYBN colour units (Hamid *et al.*, 7). TSS (Total soluble solids) in degree brix (°B) were measured by digital refractometer (range 0 to 80 °B) (Model Milwaukee MA871 Europe, Romania) at 20 °C. Acid content, sugars with ascorbic acid content were determined according to procedure given in Ranganna (15) and a digital pH meter of CRISON Instrument, Ltd, Spain make was used for pH determination. A method described by Singleton and Rossi (18) using Folin-Ciocalteu procedure was followed for total phenol determination. Total flavonoids and DPPH (2, 2-Diphenyl-1-picrylhydrazyl) free radical scavenging activity were analyzed using standard methods of Ilahy *et al.* (7) and Brand-Williams *et al.* (3). Reducing power was analyzed by process of Oktay *et al.* (13) and absorbance at 700 nm of the extract taken as to assess reducing power. In other antioxidant activities Dinis *et al.* (5), Benzie and Strain (2) procedure were followed to analyzed metal chelating activity and FRAP (ferric reducing antioxidant power).

The sensory estimation of various parameters of drink were carried out to evaluate the consumer preferences using 9 point Hedonic scale. The screening of samples was carried out for sensory acceptance on the foundation of various parameters (colour, body, taste, aroma, overall acceptability). A team of judges including faculty and post graduate members were elected randomly to evaluate the sensory parameters.

The comparison of two means of both control (without MEPPE) and MEPPE powder enriched drink was done using t-test. During storage, physico-chemical and antioxidants parameters data of drink were statistically analyzed by Completely Randomized Design using two way analysis of variance (ANOVA). Whereas, data pertaining to sensory analysis of MEPPE powder enriched drink were statistically analyzed using Randomized Block Design as per Mahony (9). The parameters for various characteristics of drink were recorded in triplicate. The critical difference (CD) at $p < 0.05$ with 95% confidence interval was compared to find considerable significant divergence.

RESULTS AND DISCUSSION

MEPPE powder used for enrichment of drink had high phenolics content (78.47 ± 0.39 mg GAE/g), total flavonoids content (4.18 ± 0.03 mg QE/g) and high DPPH antioxidant activity (71.25 ± 0.14 %) as complete study published previously (Hamid *et al.*, 7). Data in Table 1 indicate that mango drink (P_1) without enrichment had higher (40.21) L* value than MEPPE enriched drink (P_2). Higher a* (1.81) value was recorded in P_2 and lower (1.26) in P_1 . Whereas, higher (32.74) b* value was also recorded in P_1 and lower (27.38) was recorded in P_2 . The data in same Table show that TSS of both samples were kept constant, whereas, P_2 had higher (0.41%) titratable acidity and lower (0.40%) was recorded in P_1 . The non-significant effect was observed by the addition of MEPPE powder on acid content, pH, ascorbic acid content, reducing and total sugars content of drink. However, higher phenols (164.27 mg GAE/100mL), flavonoids (9.16 mg QE/100mL), DPPH antioxidant activity (76.34%), metal chelating activity (47.39%), FRAP ($14.30 \mu\text{MFe}^{2+}/100\text{mL}$) and reducing power (0.928) were recorded in P_2 and lower were recorded in P_1 . The higher total phenolic content in enriched drink was clearly owing to the existence of high phenolics in MEPPE, which significantly improved the total phenols and antioxidant properties of the enriched beverage. From the above outcomes it was observed that enriched drink maintained best sugar-acid pulp blend after incorporation of 2 per cent MEPPE as it was statistically at par with mango drink

Table 1. Physico-chemical and sensory parameters of control and antioxidant rich mango drink.

Physico-chemical characteristics	P ₁	P ₂	t _{cal}	
Colour values	L	40.21	31.75	8.67
	a	1.26	1.81	2.41
	b	32.74	27.38	4.62
TSS (°B)	15.00	15.00	0.01	
Titrateable acidity (% citric acid)	0.40	0.41	0.06	
pH	4.74	4.72	0.20	
Ascorbic acid (mg/100mL)	5.21	5.24	0.12	
Reducing sugars (%)	6.70	6.74	0.19	
Total sugars (%)	11.52	11.58	0.20	
Total phenols (mg GAE/100mL)	17.43	164.27	48.03	
Total flavonoids (mg QE/100mL)	1.14	9.16	12.68	
DPPH antioxidant activity (%)	20.31	76.34	29.41	
Metal chelating activity (%)	11.92	47.39	19.77	
FRAP (µM Fe ²⁺ /100mL)	5.63	14.30	8.58	
Reducing power (Absorbance at 700nm)	0.160	0.928	5.37	
Sensory (Scores)				
Colour	8.40	8.20	0.77	
Body	8.27	8.00	0.87	
Taste	8.39	8.16	0.64	
Aroma	8.31	8.10	0.78	
Overall acceptability	8.32	8.14	0.69	

P₁: Mango drink (control), P₂: MEPPE powder enriched drink (2%), L* (Lightness), a* (Redness), b* (Yellowness), T_{tab}=2.57 [6df(at 5% level of significance)]

without enrichment with regards to various sensory parameters. However, the non-significant differences were recorded in sensory parameters scores among both the treatments after sensory evaluation.

Data pertaining to visual colour of enriched mango drink during storage has been given in the Table 2. The consequence of storage period (S) on the L* value of drink reveal that L* value raised from 31.75 to 34.68 during six months of storage. Higher (33.77) increase in L* value was recorded in ambient with lower (32.14) in low temperature storage while comparing the effect of treatments (T). The combined effect of T and S on L* value of drink was significant. However, storage period effect on a* value of drink reveals that it decreased (1.81 to 1.07) during storage. Higher (1.55) a* value was recorded in refrigeration with lower (1.30) in ambient storage. The combined effect of T×S interactions on a* value of drink was found to be significant. The b* value of drink decreased from 27.38 to

24.03 during storage, while found higher (26.33 in refrigeration and lower (25.04) in normal conditions. The combined effect of T×S interactions was found to be significant. The reason for increased L* value with decline in a* and b* values of drink throughout storage period might be attributed to carotene degradation, but the carotenoids degraded at very slow rate under refrigeration. This may happen because of very slow speed of chemical reactions in beverage under PET bottles stored in refrigerated conditions due to difference in storage temperatures. Our results were in accordance with the outcomes reported by Balaswamy *et al.* (1) in RTS prepared from mango.

An increasing trend in TSS (Table 2) of drink from 15.00 to 15.64 °B (4.26 % increase) during advancement of storage (S) was observed. While effect of treatments (T) shows that higher 3.06 % (15.46 °B) increase in TSS was found in ambient and lowers 1.66 % (15.25 °B) in refrigerated conditions. The combined effect of interactions on the TSS value was significant. Small increase in this parameter may be owing to polysaccharides breakdown into monosaccharide. More increase in TSS under ambient conditions may be owing to the faster reactions rate as reported by Gupta (6) and Chalke *et al.* (4). Data presented in Table 2 indicates decreasing trend in acid content of beverage from 0.41 to 0.34% (20.58 % decrease) during storage (S). The higher 0.39% (95.13% retention) was retained in drink stored under refrigeration as compared to ambient 0.36% (87.81% retention) storage while comparing effect of treatments (T) on acidity. The acid content of drink decreased throughout storage may be owing to organic acids co-polymerization (with amino acids and sugars) as reported by Chalke *et al.* (4).

An increasing trend in reducing sugars (Table 2) of drink was observed from 6.74 to 7.22% (7.12% increase) during storage in both the treatments. Higher 7.08% (94.96 % retention) in ambient storage and lower 6.89% (97.78% retention) in refrigeration was observed after storage. The combined effect of T×S interactions was recorded to be significant. While total sugars of drink unveil that it raise slightly from 11.58 to 12.08% (4.31 % increase) during storage. This raise usually ascribed to the hydrolysis of polysaccharides during storage (Gupta, 6) and more enhancements may be due to the rapid reaction rate at normal temperature as reported by Chalke *et al.* (4) in mango beverage and Gupta (6) in karonda-beet RTS beverage. Further there was a general increasing trend in the pH of enriched drink from 4.72 to 4.80% (1.69 % increase) during entire storage period, which was recorded higher 4.77

Table 2. Effect of storage on color values and chemical parameters of MEPPE powder enriched mango drink.

Characteristics	Treatment	Storage interval (months)			Mean (T)
		0	3	6	
L*	T ₁	31.75	32.94	36.61	33.77
	T ₂	31.75	31.90	32.76	32.14
	Mean (S)	31.75	32.42	34.68	
	CD _{0.05}		T= 0.15, S= 0.19, T×S= 0.26		
a*	T ₁	1.81	1.19	0.89	1.30
	T ₂	1.81	1.57	1.26	1.55
	Mean (S)	1.81	1.38	1.07	
	CD _{0.05}		T= 0.06, S= 0.08, T×S= 0.11		
b*	T ₁	27.38	25.14	22.60	25.04
	T ₂	27.38	26.15	25.47	26.33
	Mean (S)	27.38	25.64	24.03	
	CD _{0.05}		T= 0.22, S= 0.27, T×S= 0.38		
TSS(°B)	T ₁	15.00	15.57	15.82	15.46
	T ₂	15.00	15.28	15.46	15.25
	Mean (S)	15.00	15.42	15.64	
	CD _{0.05}		T= 0.04, S= 0.05, T×S= 0.07		
Acidity (%)	T ₁	0.41	0.34	0.32	0.36
	T ₂	0.41	0.39	0.36	0.39
	Mean (S)	0.41	0.36	0.34	
	CD _{0.05}		T= 0.02, S= 0.03, T×S= NS		
Reducing sugars(%)	T ₁	6.74	7.12	7.38	7.08
	T ₂	6.74	6.87	7.06	6.89
	Mean (S)	6.74	6.99	7.22	
	CD _{0.05}		T= 0.08, S= 0.10, T×S= 0.14		
Total sugars(%)	T ₁	11.58	11.88	12.21	11.89
	T ₂	11.58	11.73	11.95	11.75
	Mean (S)	11.58	11.80	12.08	
	CD _{0.05}		T= NS, S= 0.18, T×S= NS		
pH	T ₁	4.72	4.78	4.82	4.77
	T ₂	4.72	4.76	4.78	4.75
	Mean (S)	4.72	4.77	4.80	
	CD _{0.05}		T= 0.01, S= 0.02, T×S= NS		

T₁: Drink stored in ambient conditions, T₂: Drink stored in refrigerated conditions, T: treatments, S: storage period, NS: non-significant

(1.05 % increase) in drink stored under ambient temperature as compared to refrigerated 4.75 (0.63% increase). This may be due to the more degradation of organic acids as reported by Chalke *et al.* (4) in RTS beverage.

The effect of storage period (S) (Table 3) unveils that ascorbic acid of drink declined from 5.24 to 4.05 mg/100mL (22.70 % decrease) during six months

of storage. While comparing the overall effect of treatments (T), higher 4.83 mg/100mL (7.82 % decrease) content was retained in drink stored under refrigeration as compared to normal conditions 4.34 mg/100mL (17.18 % decrease). The combined effect of interactions was found to be significant. This decrease may be due to main compounds degradation into dehydro-ascorbic acid with furfural. The decrease

Table 3. Effect of storage on antioxidants and antioxidant activities of MEPPE powder enriched mango drink.

Characteristics	Treatment	Storage interval (months)			Mean (T)
		0	3	6	
Ascorbic acid (mg/100mL)	T ₁	5.24	4.15	3.64	4.34
	T ₂	5.24	4.78	4.47	4.83
	Mean (S)	5.24	4.47	4.05	
	CD _{0.05}		T= 0.09, S= 0.11, T×S= 0.16		
Total phenols (mgGAE/100mL)	T ₁	164.27	158.61	156.46	159.78
	T ₂	164.27	162.35	161.20	162.61
	Mean (S)	164.27	160.48	158.83	
	CD _{0.05}		T= 2.50, S= 3.06, T×S= NS		
Total flavonoids (mgQE/100mL)	T ₁	9.16	8.23	7.43	8.27
	T ₂	9.16	8.82	8.35	8.78
	Mean (S)	9.16	8.52	7.89	
	CD _{0.05}		T= 0.15, S= 0.19, T×S= 0.26		
DPPH antioxidant activity (%)	T ₁	76.34	71.29	69.58	72.40
	T ₂	76.34	75.61	74.93	75.63
	Mean (S)	76.34	73.45	72.26	
	CD _{0.05}		T= 0.56, S= 0.68, T×S= 0.97		
Metal chelating activity (%)	T ₁	47.39	46.62	45.23	46.41
	T ₂	47.39	47.05	46.68	47.04
	Mean (S)	47.39	46.83	45.96	
	CD _{0.05}		T= 0.26, S= 0.32, T×S= 0.45		
FRAP (µM Fe ²⁺ /100mL)	T ₁	14.30	10.65	9.50	11.48
	T ₂	14.30	12.14	11.05	12.50
	Mean (S)	14.30	11.39	10.28	
	CD _{0.05}		T= 0.81, S= 1.00, T×S= NS		
Reducing power (abs at 700nm)	T ₁	0.928	0.902	0.771	0.867
	T ₂	0.928	0.926	0.907	0.920
	Mean (S)	0.928	0.914	0.839	
	CD _{0.05}		T= 0.037, S= 0.045, T×S= 0.064		

T1: Drink stored in ambient conditions, T2: Drink stored in refrigerated conditions, T: treatments, S: storage period, NS: non-significant

in this parameter of MEPPE powder enriched mango drink was significantly lower under refrigeration due to its high sensitivity to high temperature, therefore low quantity retained in ambient conditions as reported by Chalke *et al.* (4). A decrease in phenols of enriched drink during entire storage (S) period as 3.31 % (164.27 to 160.48 mg/100mL), which was slower under refrigeration conditions 1.01 % decrease (162.61 mg/100mL) than ambient conditions 2.73 % (159.78 mg/100mL). This decrease was due to oxidation of these compounds during storage and formation of complex polymeric compounds by polymerization with proteins (Liu *et al.*, 8). Less

changes of phenols in refrigeration might be owing to slow reaction rate in low temperature conditions. Similar trend in polyphenols by Saci *et al.* (17) in mango beverage during 90 days of storage was observed.

There was decrease of flavonoids (Table 3) as 13.86 % (9.16 to 7.89 mgQE/100mL) in MEPPE powder enriched drink during entire storage (S), which was slow under refrigeration 4.14 % (8.27 mg QuE/100mL) than ambient conditions 9.71 % (8.78 mgQE/100mL). This decrease might be due to sensitive nature of flavonoids towards temperature as reported earlier that they are biosynthesized from

the phenylpropanoid pathway (Rapisarda *et al.*, 16). Decrease in flavonoids content was also recorded by Saci *et al.* (17) in mango drink during storage.

A regular decrease in radical scavenging activity of beverage (Table 3) during storage (S) from 76.34 to 72.26% (5.34 % decrease) was observed which was slow under refrigeration conditions 0.93 % decrease (75.63%) than ambient conditions 5.16 % decrease (72.40%). This may be owing to oxidation degradation of ascorbic acid, phenols and flavonoids in storage. Decrease in antioxidant activity was also recorded by Saci *et al.* (17) in mango drink. Metal chelating activity of drink decreased from 47.39 to 45.96% (3.02% decrease) during entire storage (S) which was slower in low temperature 47.04% (0.73 % decrease) than ambient conditions 46.41% (2.06 % decrease). Loss of ascorbic acid might be responsible for this decrease in storage. FRAP (Table 3) of drink decreased from 14.30 to 10.28 $\mu\text{MFe}^{2+}/100\text{mL}$ (28.11% decrease) in storage. However effect of treatments (T) shows higher FRAP was retained in beverage stored under refrigeration (12.58 % decrease) as compared to ambient (19.72% decrease). This decrease in FRAP

might be due to loss of polyphenols and flavonoids present in drink during storage. Reducing power of drink decreased from 0.928 to 0.839 (10.60 % decrease) during six months of storage. The higher decline in reducing power was observed in beverage stored under normal conditions (6.57 % decrease) as compared to refrigeration (0.86 % decrease) conditions. This slight decrease was due to loss of polyphenols and flavonoids present in drink during storage which exhibits antioxidant activity. Similar decrease in reducing power was also recorded by Saci *et al.* (17) in mango drink.

The colour (Table 4) of drink declined from 8.20 to 7.54 during six months of storage. While effect of treatments (T) shows higher (8.18) colour score was retained in drink stored under refrigeration besides ambient (7.65) conditions which was due to the slight degradation of colour pigment (carotene) as well as browning by copolymerization of acids of the beverage. The higher colour scores retained in beverage under low temperature conditions is due to less reduction of colour pigment as compared to normal ambient conditions. The body score of drink decreased from 8.00 to 7.66 during six months of

Table 4. Effect of storage on sensory scores of MEPPE powder enriched mango drink.

Characteristics	Treatment	Storage interval (months)			Mean (T)
		0	3	6	
Colour	T ₁	8.20	7.75	7.00	7.65
	T ₂	8.20	8.26	8.07	8.18
	Mean (S)	8.20	8.01	7.54	
	CD _{0.05}		T=0.11, S=0.14, T×S=0.20		
Body	T ₁	8.00	7.63	7.50	7.71
	T ₂	8.00	7.90	7.82	7.90
	Mean (S)	8.00	7.76	7.66	
	CD _{0.05}		T=0.12, S=0.15, T×S=NS		
Taste	T ₁	8.16	7.58	7.20	7.65
	T ₂	8.16	8.04	7.78	7.99
	Mean (S)	8.16	7.81	7.49	
	CD _{0.05}		T= 0.14, S=0.17, T×S=0.25		
Aroma	T ₁	8.10	7.58	7.00	7.56
	T ₂	8.10	7.94	7.87	7.97
	Mean (S)	8.10	7.76	7.43	
	CD _{0.05}		T=0.11, S=0.14, T×S= 0.20		
Overall acceptability	T ₁	8.14	7.78	7.30	7.74
	T ₂	8.14	8.02	7.82	8.00
	Mean (S)	8.14	7.90	7.56	
	CD _{0.05}		T=0.08, S=0.10, T×S=0.14		

T₁: Drink stored in ambient conditions, T₂: Drink stored in refrigerated conditions, T: treatments, S: storage period, NS: non-significant

storage. The effect of treatments (T) shows higher (7.90) body score was retained in drink stored under refrigeration as comparative to normal (7.71) conditions. This might be owing to the formation of phenols and protein interactions precipitates in the product during storage. Taste score of drink decreased from 8.16 to 7.49 during storage, which retained higher (7.99) in beverage stored under refrigeration conditions as comparative to ambient (7.65). Slight decline of sugar and acidic blend during storage was responsible for decrease in taste scores of beverage. High taste scores in refrigeration were owing to superior condition of beverage during entire storage because of slow speed of above mentioned reactions as noticed by Ramdevputra *et al.* (14) in ready to serve beverage.

The storage period (S) effect shows that aroma score of product declined from 8.10 to 7.43 during six months of storage which might be due to aromatic components degradation in the beverage which was higher in refrigeration due to the low degradation of these compounds at this temperature. The overall acceptability scores decreased significantly during storage from 8.14 to 7.56. The higher (8.00) overall acceptability score was retained in beverage stored under refrigeration conditions as comparative to ambient (7.74). The decline in overall acceptance scores may be owing to the slight loss in colour characteristics, flavour components and consistency of product. While higher acceptance in low temperature conditions may be due to the minute loss of colour characteristics, consistency of the product and minute degradation of flavour components during storage as reported by Gupta (6) and Ramdevputra *et al.* (14).

The present study concluded that by-product (peel) of wild pomegranate fruit remained after *anardana* preparation, is rich source of phenolics, flavonoids besides high antioxidant activities. Pomegranate peel could be utilized for enrichment after extracted phenolics microencapsulation. Mango drink with 19.5% mango pulp and 15°B TSS enriched with 2% micro-encapsulated phenolic extract powder had higher phenolics and antioxidant activities as compared to plain drink. A significant increase in total phenols, total flavonoids and various antioxidant properties were observed after incorporation of microencapsulated pomegranate peel phenolic extract in enriched drink. Enriched drink was also found to be acceptable after sensory evaluation. Antioxidants enriched mango drink could be stored successfully without much changes in various quality parameters during 6 months under both refrigeration and ambient storage in transparent PET bottles. However, comparatively minimum changes

in sensory scores in beverage packed in transparent PET bottles and stored under refrigeration conditions were observed as comparative to ambient conditions.

AUTHORS' CONTRIBUTIONS

Hamid: Methodology, Investigation, Original draft- Writing & editing, Statistical analysis. NS Thakur: Conceptualization, Methodology, Validation, Editing -review & original draft, Supervision. Rakesh Sharma: Methodology, Validation, Critical review-original draft & editing. Abhimanyu Thakur: Review-original draft & editing.

DECLARATION

The authors declare no conflict of interest.

ACKNOWLEDGMENT

The authors are thankful to Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh 173230 India and UGC New Delhi - India for providing Laboratory facility and financial support for the study.

REFERENCES

1. Balaswamy, K., Rao, P. P., Rao, G. N., Nagender, A. and Satyanarayana, A. 2014. Production of low calorie ready-to-serve fruit beverages using a natural sweetener, stevia (*Stevia Rebaudiana* L.). *Focus. Modern Food Indus.*, **3**: 59-65.
2. Benzie, I. F. and Strain, J. J. 1996. Ferric reducing ability of plasma (FRAP) as a measure of antioxidant power: the FRAP assay. *Analytical Biochemistry*, **239**: 70-76.
3. Brand-Williams, W., Cuvelier, M. E. and Berset, C. 1995. Use of a free radical method to evaluate antioxidant activity. *LWT-Food Sci. Technol.*, **28**: 25-30.
4. Chalke, P. R., Supe, V. S. and Sonavani, P. N. 2012. Effect of packaging and storage temperature on storage behaviour of ready-to-serve beverage of falling unripe mango fruits. *The Asian J. Hortic.*, **7**: 256-58.
5. Dinis, T. C., Madeira, V. M. and Almeida, L. M. 1994. Action of phenolic derivatives (acetaminophen, salicylate, and 5-aminosalicylate) as inhibitors of membrane lipid peroxidation and as peroxy radical scavengers. *Arch. Biochem. Biophys.*, **315**: 161-69.
6. Gupta N. 2019. Studies on preparation of blended karonda-beet root ready to serve beverage. *Indian J. Hortic.*, **76**: 735-40.

7. Hamid., Thakur, N. S. and Thakur, A. 2020. Microencapsulation of wild pomegranate flavonoid phenolics by lyophilization: Effect of maltodextrin concentration, structural morphology, functional properties, elemental composition and ingredient for development of functional beverage. *LWT-Food Sci. Technol.*, **133**: 110077. <https://doi.org/10.1016/j.lwt.2020.110077>.
8. Ilahy, R., Hdidar, C., Lenucci, M. S., Tlili, I. and Dalessandro, G. 2011. Antioxidant activity and bioactive compound changes during fruit ripening of high-lycopene tomato cultivars. *J. Food Compos. Anal.*, **24**: 588-595.
9. Liu, F., Wang, Y., Li, R., Bi, X. and Liao, X. 2014. Effects of high hydrostatic pressure and high temperature short time on antioxidant activity, antioxidant compounds and color of mango nectars. *Innov. Food Sci. Emerg. Technol.*, **21**: 35-43.
10. Mahony, M .O. 1985. Sensory Evaluation of Food. In: *Statistical Methods and Procedures*. Marcel Dekker, Inc, New York. 512 p.
11. Masci, A., Coccia, A., Lendaro, E., Mosca, L., Paolicelli, P. and Cesa, S. 2016. Evaluation of different extraction methods from pomegranate whole fruit or peels and the antioxidant and antiproliferative activity of the polyphenolic fraction. *Food Chem.*, **202**: 59–69.
12. Murtaza, M. S. and Ahmad, G. S. 2017. *Anardana* (dehydrated wild pomegranate arils) as livelihood option for rural communities in Chenab valley of Jammu and Kashmir. *Indian J. Hortic.*, **74**: 306-309.
13. Oktay, M., Gulein, I. and Kufrevioglu, O.I. 2003. Determination of in vitro antioxidant activity of fennel (*Foeniculum vulgare*) seed extracts. *LWT-Food Sci. Technol.*, **36**: 263-71.
14. Ramdevputra, M. V., Paradva, D. R., Kanzaria, D. R., Kakade, D. K. and Butani, A. M. 2009. Standardization of physical characteristics of recipe for preparation of ready-to-serve beverage (RTS) from Mango (*Mangifera indica* L.) cv. KESAR. *Int. J. Agric. Sci.*, **5**: 378-82.
15. Ranganna, S. 2009. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw Hill, New Delhi. 1112 p.
16. Rapisarda, P., Bianco, M. L., Pannuzzo, P., and Timpanaro, N. 2008. Effect of cold storage on vitamin C, phenolics and antioxidant activity of five orange genotypes [*Citrus sinensis* (L.) Osbeck]. *Postharvest Biol. Technol.*, **49**: 348–54.
17. Saci, F., Meziant, L. and Louailleche, H. 2015. Effect of storage time and temperature on the health-promoting substances and antioxidant activity of two commercial fruit based-beverages. *Int. J. Bioinform. Res. Appl.*, **1**: 118-22.
18. Singleton, V. L. and Rossi, J. A. 1965. Colorimetry of total phenolics with phosphomolybdic phosphotungstic acid reagents. *Am. J. Enol. Vitic.*, **16**: 144-58.

Received : August, 2020; Revised : May, 2021;
Accepted : September, 2021