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Full Length Research Paper

Effects of fruit juice blending ratios on kinnow juice preservation at ambient storage condition

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Different fruit juice blends were prepared as (Kinnow juice: *Aonla* juice: Ginger juice in 100: 0: 0, 95: 5: 0, 92: 5: 3 ratio and Kinnow juice: Pomegranate juice: Ginger juice in 90: 10: 0, 87: 10: 3 ration) for improving flavour, palatability, nutritive and medicinal value. The juice blends were preserved by pasteurization (75°C for 15 min) and by addition potassium meta-bi-sulphite (750 ppm). These blends were stored in 200 ml. colourless glass bottles at room temperature (28 ± 4°C) for six months and tested at two months interval for physico-chemical, sensory evaluation and microbial population. It was observed that the kinnow juice blend with pomegranate and ginger juice in ratio of 87:10:3 was most effective juice blend for minimum changes in TSS (12.00 to 14.13°Brix), acidity (0.720 to 0.510%), ascorbic acid (18.38 to 12.90 mg/100 ml juice), and limonin (0.103 to 0.250). Sensory evaluation score was also higher in the same treatment due to better consistency and flavour up to end of storage. The juice blend ratio of Kinnow juice: *Aonla* juice: Ginger juice (92:5:3) was best in view of non-enzymatic browning (0.081 to 0.104) and minimum population of bacteria (4.0×10^3), mould (1.5×10^3) and yeast (2.1×10^3) at end of storage (six months). It contained fair amount of vitamin 'C' (38.95 mg/100 ml juice) at six month of storage. It was also observed that the addition of ginger juice in blends improves the quality and reduces microbial growth. Further, the juice was found acceptable after six months of storage at room temperature.

Key words: Nutritive value, juice blends, physico-chemical, microbial population, organoleptic taste.

INTRODUCTION AND PRACTICAL APPLICATIONS

Kinnow mandarin is quite popular as it has a greater variety of beverage. It is also used for industrial and medicinal purpose due to its attractive colour, distinctive flavour and being rich source of vitamin 'C', vitamin 'B', β-carotene, calcium and phosphorus. Kinnow mandarin juice turns bitter after extraction due to conversion of a chemical compound limonite-a-ring lactone (non-bitter) to limonin (bitter compound). Therefore, blending of two or more fruit juices with spices extract for preparation of nutritive ready-to- serve (RTS) beverages is thought to be a convenient and economic alternative for utilization of kinnow juice.

Among the new exotic citrus cultivars grown in India, kinnow mandarin is undoubtedly the most priced one. In some parts of Rajasthan, particularly in Sri Ganganagar and Hanumangarh districts, kinnow mandarin is being cultivated on large scale. The area under kinnow mandarin in Rajasthan is 8,290 hectares and production is 157,460 metric tonnes with 19.0 metric tonnes productivity (Indian Horticulture Database, 2009). Kinnow mandarin is quite important as it has a great variety of beverage, industrial and medicinal uses due to its attractive colour, distinctive flavour and being rich source of vitamin 'C', vitamin 'B', β-carotene, calcium and phosphorous (Sogi and Singh, 2001). Kinnow mandarin juice turns bitter after extraction due to conversion of limonate-a-ring-lactone (non-bitter) to limonin (bitter compound) during storage (Premi et al., 1994), and makes the processing of this fruit limited. For improving the taste, aroma, palatability, nutritive value and reducing bitterness kinnow juice was blended with some other highly nutritive fruit juices namely pomegranate and *Aonla* juice with spice extracts like ginger. All these fruits are valued very much for their refreshing juice with nutritional, medicinal properties and ginger juice also have anti-bacterial and anti-fungal properties. These

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Table 1. Prepare juice blends as per flowing blending ratio.

S/No.	Types of juice	Blanding ratio	Treatment symbol
1	Kinnow juice: *Aonla* juice: Ginger juice	100: 0: 0	K_1
2	Kinnow juice: *Aonla* juice: Ginger juice	95: 5: 0	K_2
3	Kinnow juice: *Aonla* juice: Ginger juice	92: 5: 3	K_3
4	Kinnow juice: Pomegranate juice: Ginger juice	90: 10: 0	K_4
5	Kinnow juice: Pomegranate juice: Ginger juice	87: 10: 3	K_5

fruits and ginger are also famous for excellent quality with pleasant flavour, rich in sugar, vitamins 'C' and minerals. Therefore blending of two or more fruit juices for the preparation of Ready-To-Serve beverages is thought to be a convenient and economic alternative for utilization of these fruits.

Sandhu and Sindhu (1992), Saxena et al. (1996), Attri et al. (1998), Langthasa (1999), Deka (2000) and Deka and Sethi (2001) reported that two or more fruits juice/pulp may be blended in various proportions for the preparation of nectar, RTS beverages etc. The blending of juice may also improve aroma, taste and nutrients of the beverages. Moreover, one could think of a new product development through blending in the form of a natural health drink, which may also be served as an appetizer. So far, no more work has been carried out on mixed fruit juice and spiced beverages. Keeping these in view, the present study was conducted to note the changes in physio-chemical and microbial parameters, hunter colour and volatile flavouring compounds of kinnow juice blends during ambient storage condition.

MATERIALS AND METHODS

The fully matured, freshly harvested kinnow, pomegranate and *Aonla* fruits and well-developed ginger rhizomes were procured from Lal kothi mandi, Jaipur and brought to the Post Harvest Technology Laboratory, S.K.N. College of Agriculture, Jobner.

Juice preparations

Fruits were washed with clean running water to remove dust particles and to reduce the microbial load on the surface of the fruits and ginger rhizomes. Peeled kinnow fruits were crushed in screw type juice extractor machine for extraction of juice. Pomegranate fruits were cut into pieces and arils were separated. These arils were passed through the juicer for extraction of juice. *Aonla* and ginger were sliced with the help of stainless steel knives and crushed with mixer cum juicer for the extraction of juice. The juices were kept for 24 h in refrigerator (4 ± 2°C) for sedimentation. Then the clear juice was siphoned off. The juice was filtered through muslin cloth and divided into 5 lots (Table 1).

The blend juice was heated to 75°C for 15 min in a double-jacketed stainless steel kettle. A calculated quantity of potassium meta-bi-sulphite (750 ppm) was dissolved in small quantity of water according to the treatments and well mixed in the blended juice with the help of stirrer. Treated juice blends were filled into pre-sterilized 200 ml capacity, 60 bottles {Treatment (5) × Observations (4) × Replication (3) = 60} as soon as possible and tightly closed using crown corking machine. The bottles containing blended juice were stored at room temperature (28 ± 4°C) for further storage studies and analyzed at 60 days intervals for six months.

Methods of analysis

The physico-chemical parameters including Total Soluble Solids (TSS) of the fruit juice was determined by Zeiss Hand Juice Brix Refractometer, values corrected to 20°C and expressed as °Brix. Acidity (as citric acid) was determined by using standard N/10 NaOH solution in the presence of phenolphthalein as an indicator, AOAC (1984). The vitamin 'C' (ascorbic acid) content of the juice was estimated by visual titration method with 2, 6-dichlorophenol-indonenol dye solution (AOAC, 1984). Total sugars in the juice were determined by the method of Lane and Eynon (1923), and limonin of the juice was estimated using the modified Burulian reagent (Vaks and Litshitz, 1981) method. The non-enzymatic browning in the juice was determined by alcohol extraction method (Klin and Nagy, 1988). Microbiological study was carried out by a series of dilution and spread plate method (Ranganna, 1994). In order to find out the consumer preference juice blend ratio on the organoleptic evaluation of juice was done by a panel of ten semi-trained judges using 9 point hedonic scale (Amerine et al., 1965). All estimations were carried out in triplicate, determinations were made for each attribute and data pertaining to the physico-chemical, sensory and microbial population were statistically analyzed by using completely randomized design (Cocharan and Cox, 1950).

RESULTS AND DISCUSSION

Microbial population

It has been observed that the untreated fruit juices and pulp were highly contaminated with bacteria, yeast and mould. The data in Table 3 depicts minimum increase in bacteria, yeast and mould population, on kinnow juice blending with ginger juice. This might be due to the inhibitory effect of spices (ginger juice) towards micro-organisms. Deka (2000) reported negligible growth of moulds and yeasts in lime – aonla and mango- pineapple spiced RTS beverages, which got further reduced during storage due to inhibitory effect and antioxidative properties of spices. Deka and Sethi (2001) reported that no bacterial growth was observed in the spiced mixed fruit juice, RTS beverages. These results were supported by several researchers, Ejechi et al. (1998) in spiced mixed fruit juices, Dhaliwal and Hira (2001) in mixed

vegetable juice.

In view of the microbiological analysis of the stored juice samples it was observed that all the samples were contaminated with a large variety of bacterial, fungal and mould species but within the acceptable limit. The juice blended with 3% ginger juice was lowest in bacterial (4.0×10^3), mould (1.5×10^3) and yeasts (2.1×10^3) population as recorded at the end of storage period (six months).

Physico-chemical characteristics

Total soluble solids

The TSS increased with gradual passage of storage time, which might be due to hydrolysis of polysaccharides into monosaccharide and oligosaccharides. The minimum increase (17.75%) in TSS was recorded in K_5 treatment, which was statistically superior to other treatments (Table 2). It might be due to the fact that the ginger juice checked the microbial growth, which may be responsible for higher metabolic rate. Similar results were also reported by Deka and Sethi (2001) in juice blends and Deka (2000) found an increasing trend in total soluble solids during storage at ambient and low temperature in lime - aonla and mango-pineapple spiced RTS beverages.

Acidity

There was a significant decrease in titratable acidity content during storage (Table 2). This might be due to conversion of acids into salts and sugars by enzymes particularly invertase (Kumar et al., 1992). It was observed that maximum acidity 0.530% was recorded in the kinnow juice was blended with ginger juice and *Aonla* juice (K_3). The minimum decrease (29.16%) in acidity was showed in K_5 treatment which might be due to inhibitory effect of ginger juice on conversion of acids into sugars and salts by enzymes. Deka (2000) found that the acidity of the RTS beverage prepared from lime- aonla, mango- pineapple, guava- mango blends decreased with addition of spices with advancement of storage period up to six months under different storage conditions. Similar results were found by Tiwari (2000) in guava and papaya blended RTS, and Dhaliwal and Hira (2001) in carrot juice blends.

Ascorbic acid

The ascorbic acid (vitamin 'C') content of the juice decreased during storage with the advancement of storage period (Table 2), which was probably due to the fact that ascorbic acid being sensitive to oxygen, light and heat was easily oxidized in presence of oxygen by both enzymatic and non-enzymatic catalyst (Mapson, 1970). Among the beverages prepared with *Aonla* juice were better in ascorbic acid content but rate of decrease was very slow with ginger juice blend because ginger juice might have reduced the oxidation process. Maximum ascorbic acid (38.95 mg/100 ml juice) was recorded in kinnow juice blended with *Aonla* juice that is 5% and ginger juice that is 3% (K_3). These findings are in conformity with the studies of Jain and Khurdiya (2005) reported that the Indian gooseberry juice contained the highest vitamin 'C' (478.56 mg / 100 ml. juice). Hence, when gooseberry juice was blended with other fruit juices for the preparation of blended ready-to-serve beverages, it boosted their nutritional quality in terms of vitamin 'C' content.

Total sugar

The results revealed that the total sugars content was significantly affected as a result of juice blending with ginger juice (Table 2). The total sugars content in the juice increased apparently during storage, which might be due to hydrolysis of polysaccharides in to monosaccharide and oligosaccharides. The minimum increase (7.44 to 11.11%) in total sugar content was recorded in K_3 treatment. It might be due to fact that the ginger juice checked the microbial growth, which may be responsible for higher metabolic rate of juice. The change in total sugar content of beverage was almost negligible during storage for 6 months in bael: papaya (2:3) pulps blend (Tandon et al., 2007). Earlier, similar results were also reported by Deka and Sethi (2001) in mango juice blends.

Limonin

A gradual increase in limonin in juice blends with increase in storage period might be due to conversion of a chemical compound limonate-a-ring lactone (non-bitter) in to limonin (bitter) in the juice (Premi et al., 1994). Among the juice blend prepared with ginger, *Aonla* and pomegranate juice exhibited significantly lesser limonin as compared to pure kinnow juice because blending of non-bitter juice with bitter juice in proper ratio reduced the quantity of limonin in juice. Minimum limonin (0.250 mg/ml juice) was recorded when the juice blended with pomegranate juice (10%) and ginger juice (3%) at the end of storage. Guadagni et al. (1993) reported that blending of citrus juice with sugar in proper ratio also reduced bitterness. A similar result was observed by Berry (2001) in citrus juice.

Non-enzymatic browning

A linear increase in non-enzymatic browning was

Table 2. Effects of juice blending on the physico-chemical characteristics of kinnow juice (A) before storage (juice processed at 75°C+750 ppm kms[2]).

Juice blends	TSS[3] (^{0}Brix)	Acidity (%)	Ascorbic acid (mg/100 ml juice)	Total sugars (%)	Limonin (mg/ml juice)	NEB[1]
(A) Before storage (juice processed at 750 C+750 ppm kms[2])						
K_1	11.50	0.755	21.15	7.50	0.220	0.078
K_2	12.00	0.800	45.70	7.50	0.150	0.084
K_3	12.00	0.795	45.30	7.44	0.137	0.081
K_4	12.50	0.715	18.94	8.23	0.115	0.080
K_5	12.00	0.720	18.38	8.11	0.103	0.078
(B) After two months of storage (juice processed at 75°C +750 ppm KMS)						
K_1	13.29	0.620	18.67	8.85	0.309	0.078
K_2	12.58	0.680	43.45	8.85	0.249	0.084
K_3	12.42	0.680	43.63	8.71	0.236	0.080
K_4	14.08	0.600	17.18	9.64	0.212	0.067
K_5	13.29	0.620	16.89	9.46	0.198	0.063
S EM±	0.112	0.007	0.379	0.086	0.003	0.001
P< 5%	0.320	0.019	1.084	0.246	0.006	0.003
(C) After four months of storage (juice processed at 75°C +750 ppm KMS)						
K_1	14.29	0.500	14.44	10.38	0.348	0.087
K_2	13.42	0.580	40.18	10.33	0.283	0.092
K_3	13.08	0.600	40.64	10.06	0.267	0.088
K_4	14.92	0.490	13.98	11.09	0.241	0.075
K_5	13.75	0.560	14.28	10.82	0.224	0.067
S EM±	0.130	0.005	0.456	0.089	0.002	0.001
P< 5%	0.373	0.014	1.303	0.254	0.007	0.003
(D) After six months of storage (juice processed at 75°C +750 ppm KMS)						
K_1	14.79	0.390	11.52	11.65	0.387	0.117
K_2	14.72	0.500	37.88	11.54	0.317	0.110
K_3	14.50	0.530	38.95	11.11	0.301	0.104
K_4	15.38	0.400	12.10	12.25	0.273	0.118
K_5	14.13	0.510	12.90	11.93	0.250	0.105
S EM±	0.132	0.007	0.419	0.126	0.003	0.001
P< 5%	0.377	0.019	1.197	0.360	0.006	0.004

1= Non-enzymatic browning, 2= potassium meta-bi-sulphite, 3= Total Soluble Solids, K_1= 100 % Kinnow juice, K_2= 95 % Kinnow juice+5 % *Aonla* juice, K_3= 92 % Kinnow juice + 5 % *Aonla* juice +3 % Ginger juice, K_4= 90% Kinnow juice+10 % Pomegranate juice, K_5= 87 % Kinnow juice+10 % Pomegranate juice + 3% Ginger juice.

observed during 6 months of storage irrespective of juice blend. The increase in non-enzymatic browning during storage might be due to non-enzymatic reaction of organic acid with sugars or oxidation of phenols, which leads to the formation of brown pigments. Khurdiya and Anand (1981) also reported a gradual increase in browning and formulation of hydroxyl methylfurfural (dark pigment) in stored phalsa beverage. The minimum increase (28.39%) in non-enzymatic browning in the juice blended with *Aonla* juice (5%) and ginger juice (3%) might be due to suppression of polyphenol oxide activity by ascorbic acid (Arogba et al., 1998), which is abundantly found in the *Aonla* juice. Similar results were reported by Jain et al. (2003) in *Aonla* juice. The pomegranate juice was also effective in the reduction of non-enzymatic browning due to higher sugar content.

Sensory evaluation

In the present study, results indicate that flavour, colour and organoleptic taste scores of juice blends, decreased with the advancement of storage period (Table 3). The colour, flavor and organoleptic taste of the blended

Table 3. Effects of juice blending on the sensory evaluation and microbial population of kinnow juice. (A) Before storage (juice processed at 75°C + 750 ppm KMS).

Juice blend	Flavour (out of 9)	Colour (out of 9)	Bitterness (out of 9)	Bacterial population (cfu/ml. juice)	Yeast population (cfu/ml. juice)	Mould population (cfu/ml. juice)
(A) Before storage (juice processed at 750 C + 750 ppm kms^2)						
K_1	7.92	8.30	7.81	9.0×10^3	4.2×10^3	3.6×10^3
K_2	7.50	8.30	8.20	8.0×10^3	3.8×10^3	3.3×10^3
K_3	7.50	8.20	8.35	7.6×10^3	3.4×10^3	2.9×10^3
K_4	8.56	8.73	8.70	8.0×10^3	3.6×10^3	3.5×10^3
K_5	8.81	8.71	8.76	7.5×10^3	3.3×10^3	2.8×10^3
(B) After two months of storage (Juice processed at 75°C + 750 ppm KMS)						
K_1	7.13	8.07	7.06	3.2×10^3	1.5×10^3	2.0×10^3
K_2	6.83	8.05	7.49	2.6×10^3	1.2×10^3	1.6×10^3
K_3	6.91	8.00	7.74	1.8×10^3	1.0×10^2	1.3×10^3
K_4	8.11	8.64	8.36	2.9×10^3	1.2×10^3	1.7×10^3
K_5	8.45	8.69	8.69	1.9×10^3	1.0×10^2	1.4×10^3
S EM±	0.047	0.106	0.057	18.79	10.515	17.11
P< 5%	0.134	0.303	0.162	53.72	30.054	48.91
(C) After four months of storage (Juice processed at 75°C + 750 ppm KMS)						
K_1	5.76	6.86	5.75	4.2×10^3	1.7×10^3	2.8×10^3
K_2	5.60	7.32	6.23	3.6×10^3	1.4×10^3	2.3×10^3
K_3	5.77	7.22	6.54	2.8×10^3	1.3×10^3	1.9×10^3
K_4	7.07	8.27	7.44	3.9×10^3	1.5×10^3	2.4×10^3
K_5	7.62	8.48	7.95	3.0×10^3	1.2×10^3	2.0×10^3
S EM±	0.066	0.087	0.058	25.37	15.86	23.88
P< 5%	0.188	0.250	0.165	72.52	45.34	68.25
(D) After six months of storage (Juice processed at 75°C + 750 ppm KMS)						
K_1	4.91	5.10	4.96	5.5×10^3	2.0×10^3	3.0×10^3
K_2	4.99	5.26	5.50	4.9×10^3	1.7×10^3	2.8×10^3
K_3	5.25	5.45	5.83	4.0×10^3	1.5×10^3	2.1×10^3
K_4	6.78	6.91	7.02	4.9×10^3	1.8×10^3	2.7×10^3
K_5	7.43	7.27	7.71	4.2×10^3	1.6×10^3	2.3×10^3
S EM±	0.055	0.078	0.048	37.47	17.37	33.59
P< 5%	0.158	0.224	0.137	107.11	49.64	33.56

K_1= 100 % Kinnow juice, K_2= 95 % Kinnow juice+5% *Aonla* juice, K_3= 92 % Kinnow juice+5 % *Aonla* juice +3 % Ginger juice, K_4= 90% Kinnow juice+10 % Pomegranate juice, K_5= 87 % Kinnow juice+10 % Pomegranate juice + 3% Ginger juice.

juices were found to be superior as compared to juices prepared from individual fruit. The blend of kinnow juice (87%) + pomegranate juice (10%) + ginger juice (3%) recorded higher score for colour (7.27), flavour (7.43) and organoleptic taste (7.71) as compared to other blends at the end of storage. This may be explained as ginger juice checks microbial and enzymatic activities in stored juice, which produce off flavour and change in natural colour and taste. Tandon et al. (2007) reported that addition of papaya pulp with bael pulp was found to be very effective in checking the browning and improving the appearance of the beverage. They also observed that the beverage prepared from 2:3 blend of bael: papaya pulp scored maximum (7.4 out of 10.0) after six months of storage. The result is well supported by Murari and Verma (1989) in case of guava nectar, Gowda (1995) in case of mango and papaya blend.

Conclusion

It was concluded that the juice blend Kinnow juice:

Pomegranate juice: Ginger juice (87:10:3) was most effective juice blend for minimum changes in TSS (12.00 to 14.13°Brix), acidity (0.720 to 0.510%), ascorbic acid (18.38 to 12.90 mg/100 ml juice) and limonin (0.103 to 0.250). Sensory evaluation score was also higher, better consistency and flavour score up to the end of storage. The juice blend ratio of Kinnow juice: *Aonla* juice: Ginger juice (92:5:3) was best of non-enzymatic browning (0.081 to 0.104) and minimum population of bacteria (4.0×10^3), mould (1.5×10^3) and yeast (2.1×10^3) at end of storage (Six months). On the basis of the results revealed in the present study, it may be concluded that formulation of mixed (blend) juice beverage is possible to satisfy consumer taste and preferences. These juice blends can be stored effectively for a period of 6 months at room temperature. It is suggested to extend the findings for future application or the main contribution in its applications.

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