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STUDIES ON PHYSICO-CHEMICAL, MICROBIOLOGICAL AND SENSORY EVALUATION OF MANGO PULP STORAGE WITH CHEMICAL PRESERVATIVES

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Abstract: Mango pulp was preserved with the help of chemical preservatives as potassium metabisulphite (KMS), sodium benzoate (SB) and potassium sorbate (PS) singly or in various combinations. The pulp samples were partially pasteurized at 82 ± 2 °C for 30 minutes and placed in high-density polyethylene bags with addition of chemicals and kept at 30-45 °C for 150 days. The pulp was tested for physico-chemical, microbiological and sensory characteristics. It was found that chemical treatment containing KMS 1000 ppm, SB 500 ppm and PS 400 ppm was effective against microorganisms and no colonies were formed up to 90 days of storage period. These samples were also physically and organoleptically normal even after 270 days. It was found that pasteurized mango pulp could be stored for extended period of time without any major changes in chemical composition and sensory characteristics.

Keywords: Mango pulp, microbiological and sensory characteristics, micro-organisms, organoleptically normal, physico-chemical.

INTRODUCTION

Mango is the most relished fruit in Indo-Pak subcontinent. It has a prominent position in the fruit processing industry of Pakistan. It is cherished not only due to its pleasant taste, aroma but also for its nutritional contribution to our diet. It serves as a good source of energy and provides us vitamins A, C and minerals like iron and phosphorus [Watt and Merril 1963, Malik *et al.* 1994]. Composition of mango is as given in Table 1. Pakistan produced about 937.7 thousand tons of mangoes sharing 5.86% of total world's production of mangoes during year 1998-99 [Jang.com 2001].

The mango fruit is beneficial in many other forms as pickle in raw form and also used for treatment of nephritis and for kidney stone's removal [Islam 1986]. Mango is highly perishable and short season fruit, which cannot be stored for long period. Various Pakistani mango varieties are suitable for pulp extraction as Langra, Malda, Chounsa, Dosehri, Sindhri, Desi, Fajri and Anwar-retol.

Most of the mango is exported and eaten in fresh form as a dessert but it is also processed in many forms as raw mango is converted into mango pickle; while ripe, it is converted into pulp for further use in various products as jams, jellies, nectars, squashes, juices, paper/chips, mango toffees, ice creams, milk shake, fruit cocktail, canned slices and in topping products. Mango pulp is preserved with the help of chemical preservatives, which are suitable for our climatic conditions and cheap

also [Hassan 1954]. These chemical preservatives are used to stop the food spoilage due to microbial attack and thus are effectively used in combinations for better preservation. No single preservative is completely effective against all microorganisms [Chipley 1983].

Table 1: Composition of Mango (per 100 g of edible portion), (Source: Watt and Merril [1963]).

Contents	Quantity
Water (%)	81.7
Food energy (k cal.)	66.0
Protein (g)	0.7
Fat (g)	0.4
Total CHO (g)	16.8
Fibre (g)	0.9
Ash (g)	0.4
Calcium (mg)	10.0
Iron (mg)	0.4
Phosphorus (mg)	13.0
Sodium (mg)	7.0
Potassium (mg)	189.0
Vitamin A (IU)	4800.0
Thiamine (mg)	0.05
Riboflavin (mg)	0.05
Niacin (mg)	1.1
Ascorbic acid (mg)	35.0

MATERIALS AND METHODS

PROCUREMENT OF SAMPLES

Fully matured desi mangoes were purchased from the local market of Faisalabad. The fruits were washed with potable water for 5 minutes to remove dirt, dust and reduce microbial load.

METHOD OF PULP EXTRACTION

Mangoes were passed through course mango pulper, with the addition of water in 1:1 ratio of water and pulp, having 2 mm mesh size to separate the pulp from stone and skin. The pulp obtained was screened through fine pulper to get uniform textured pulp.

PASTEURIZATION

Pulp was then pasteurized in a water bath at a temperature of 82 ± 2 °C for 30 minutes. A preliminary trial to find out suitable temperature and time was conducted also for mango pulp [Senesi *et al.* 1988, Kirk and Sawyer 1991].

ADDITION OF ACID

Acidity was increased by addition of 1% commercial grade citric acid.

ADDITION OF CHEMICAL PRESERVATIVES

Pulp was divided into sub lots and preserved with chemical preservatives as per plan given in Table 2.

Table 2: Plan for addition of chemical preservatives in mango pulp.

Lot No.	Preservative	Concentration (ppm)
T1	Control	0.00
T2	Potassium metabisulphite	200
T3	Potassium metabisulphite	1000
T4	Sodium benzoate	200
T5	Sodium benzoate	500
T6	Potassium sorbate	100
T7	Potassium sorbate	400
T8	Potassium metabisulphite + Potassium sorbate	200 + 200
T9	Potassium metabisulphite + Potassium sorbate	200 + 100
T 10	Sodium benzoate + Potassium sorbate	200 + 100
T11	Potassium metabisulphite + Sodium benzoate + Potassium sorbate	100 + 200 + 200
T12	Potassium metabisulphite + Sodium benzoate + Potassium sorbate	200 + 100 + 100
T13	Potassium metabisulphite + Sodium benzoate + Potassium sorbate	100 + 100 + 100

PACKING AND STORAGE

Pulp was then packed in polyethylene bags and stored in laboratory cupboard at ambient temperature (30-45 °C) for 150 days.

EVALUATION OF PROCESSED PULP

Pulp was evaluated for physico-chemical analysis (acidity, pH, total soluble solids, reducing sugars and total sugars) as descried by Kirk and Sawyer [1991].

MICROBIOLOGICAL ANALYSIS

All the samples of mango pulp were examined for the total viable count of microorganisms at different storage intervals as described by Lambert *et al.* [1991].

SENSORY EVALUATION

Ready to serve mango drinks were prepared with selected treatments and were evaluated by a panel of judges for sensory characteristics like color, flavor, taste, cloudiness and over all acceptability as described by Larmond [1977].

STATISTICAL STUDIES

Finally the data obtained for each parameter were subjected to statistical analysis using the techniques of Steel *et al.* [1996].

RESULTS AND DISCUSSION

The present study was carried out to select suitable chemical preservative doses either in single or in combination for satisfactory storage of mango pulp at room temperature. Information regarding quality parameters, preservatives efficacy and storage behavior of mango pulp are as under:

ACIDITY AND pH

The data on acidity of mango pulp has been depicted in Table 3. It was observed that acidity increased from 0-90 days. Initially the acidity

observed at 0 day was the same in all the samples (1.29%), after 90 days it was increased gradually up to 1.49% in the sample containing potassium sorbate 100-ppm (T6) while the minimum increase was 1.34% in sample containing (potassium metabisulphite (KMS) 100-ppm (T11), plus sodium benzoate (SB) 200-ppm plus potassium sorbate (PS) 200-ppm). After 270 days maximum increase in acidity was 1.59% in sample without any preservative (T1) and minimum increase was in the sample with combination of (potassium metabisulphite 200-ppm plus sodium benzoate 100-ppm plus potassium sorbate 100-ppm).

Table 3: Effect of storage on percent acidity in chemically preserved partially pasteurized mango pulp

Treatments	Preservatives (ppm)	Storage (days)					
		0	30	60	90	270	Mean±S.D
T1	Control (0.00)	1.29	1.42	1.43	1.44	1.59	1.43±0.09
T2	Potassium metabisulphite (200)	1.29	1.29	1.35	1.35	1.42	1.34±0.48
T3	Potassium metabisulphite (1000)	1.29	1.32	1.41	1.43	1.56	1.40±0.90
T4	Sodium benzoate (200)	1.29	1.38	1.46	1.48	1.36	1.39±0.06
T5	Sodium benzoate (500)	1.29	1.31	1.38	1.43	1.35	1.35±0.04
T6	Potassium sorbate (100)	1.29	1.42	1.48	1.49	1.47	1.43±0.07
T7	Potassium sorbate (400)	1.29	1.25	1.31	1.35	1.35	1.31±0.03
T8	Potassium metabisulphite + Potassium sorbate (200 + 200)	1.29	1.25	1.34	1.35	1.42	1.33 ±0.05
T9	Potassium metabisulphite + Potassium sorbate (200 + 100)	1.29	1.24	1.34	1.35	1.47	1.33 ±0.07
T10	Sodium benzoate + Potassium sorbate (200 + 100)	1.29	1.39	1.51	1.35	1.49	1.44 ±0.09
T11	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (100 + 200 + 200)	1.29	1.27	1.30	1.34	1.40	1.32 ±0.04
T12	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (200 + 100 + 100)	1.29	1.29	1.31	1.35	1.23	1.29 ±0.03
T13	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (100 + 100 + 100)	1.29	1.31	1.33	1.37	1.51	1.36 ±0.07
Mean ± S. D.		1.29 ± 0.00	1.31± 0.06	1.38± 0.06	1.40± 0.06	1.43± 0.09	

The pH values affected by various treatments and storage are given in Table 4. The pH values were 2.90 in all samples at 0 day. With the passage of time, pH values showed a declining trend in all treatment combinations. Hence after 90 days of storage the maximum decrease in pH (2.14) was observed in sample having potassium metabisulphite 1000 ppm (T3) and potassium sorbate 400 ppm (T7), whereas minimum decrease was noticed in T13 that contained potassium metabisulphite plus sodium benzoate and potassium bromate 100 ppm each. After 270 days, the results of the samples were surprisingly reverse showing increase in pH. The maximum increase was (3.22) in T13 while minimum increase (2.16) was in T1 having no preservatives.

TOTAL SOLUBLE SOLIDS

The data regarding total soluble solids is presented in Table 5. The degree of brix was the same at 0 day in all treatments. After 90 days of

storage brix showed an increase (14.4%) in the control (T1). Similarly, minimum value was 12.3 % in the treatment having potassium metabisulphite 1000 ppm (T3). However, after 270 days samples showed heterogeneous results with decreased value in treatments. The statistical analysis showed non-significant influence for treatment while highly significant behavior for increasing total soluble solids during storage. This increasing trend might be due to formation of water soluble pectin from insoluble protopectin as reported by Khalil *et al.* [1979] and Riaz *et al.* [1988] in communited lime squash and communited fruit bases, respectively.

Table 4: Effect of storage on pH in chemically preserved partially pasteurized mango pulp.

Treatment	Preservatives (ppm)	Storage (days)					
		0	30	60	90	270	Mean±S.D.
T1	Control (0.00)	2.90	2.21	2.19	2.15	2.16	2.32 ± 0.28
T2	Potassium metabisulphite (200)	2.90	2.28	2.27	2.24	2.22	2.38 ± 0.25
T3	Potassium metabisulphite (1000)	2.90	2.25	2.15	2.14	2.20	2.32 ± 0.28
T4	Sodium benzoate (200)	2.90	2.27	2.26	2.23	2.25	2.38 ± 0.25
T5	Sodium benzoate (500)	2.90	2.33	2.30	2.23	2.43	2.44 ± 0.23
T6	Potassium sorbate (100)	2.90	2.25	2.15	2.14	2.50	2.38 ± 0.28
T7	Potassium sorbate (400)	2.90	2.32	2.28	2.25	2.68	2.48 ± 0.25
T8	Potassium metabisulphite + Potassium sorbate (200 + 200)	2.90	2.32	2.32	2.29	2.65	2.49 ± 0.24
T9	Potassium metabisulphite + Potassium sorbate (200 + 100)	2.90	2.28	2.28	2.25	2.72	24.8 ± 0.27
T10	Sodium benzoate + Potassium sorbate (200 + 100)	2.90	2.25	2.23	2.20	2.90	2.49 ± 0.33
T11	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (100 + 200 + 200)	2.90	2.28	2.27	2.25	2.94	2.52 ± 0.32
T12	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (200 + 100 + 100)	2.90	2.31	2.30	2.28	3.11	2.58 ± 0.35
T13	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (100 + 100 + 100)	2.90	2.37	2.36	2.33	3.22	2.63 ± 0.36
Mean ± S. D.		2.90 ± 0.00	2.28± 0.04	2.25± 0.06	2.23± 0.05	2.61± 0.34	

SUGARS

The effects of storage and preservative treatments on reducing and non-reducing sugars (Sucrose) are shown in Table 6 and 7 respectively. The statistical analysis given in tables indicates non-significant impact of different preservative treatments on the reducing sugars (%) and significant influence on sucrose contents. Side by side sucrose contents at 0 day ranged from 5.74 to 6.25 percent in sample No. T11. After 90 days of storage the reducing sugars increased from 4.47 to 4.48 percent and maximum increase was observed in the control sample (TI), whereas minimum increase was 4.47 % observed in T5 and T11. After 270 days a decreasing trend was observed in T1, T6 and T10 that might be due to revival microbial spoilage leading to the fermentation. Reducing sugars increased during storage and comparatively the trend was slightly higher

in pulp having no preservative. It showed also increasing effect in samples except T1, T6 and T10 after 270 days of storage. On the other

Table 5: Effect of storage on degree of Brix in chemically preserved partially pasteurized mango pulp.

Treatment	Preservatives (ppm)	Storage (days)					
		0	30	60	90	270	Mean±S.D.
T1	Control (0.00)	10.20	12.5	13.1	14.4	8.30	11.70±2.17
T2	Potassium metabisulphite (200)	10.20	12.0	12.3	13.6	12.4	12.10±1.09
T3	Potassium metabisulphite (1000)	10.20	11.1	11.4	12.3	12.6	11.52±0.86
T4	Sodium benzoate (200)	10.20	11.9	12.7	13.8	12.2	12.16±1.17
T5	Sodium benzoate (500)	10.20	11.7	12.1	13.4	12.3	11.94±1.03
T6	Potassium sorbate (100)	10.20	11.9	12.3	13.5	7.50	11.08±2.07
T7	Potassium sorbate (400)	10.20	11.3	12.1	13.3	12.30	11.84±1.03
T8	Potassium metabisulphite + Potassium sorbate (200 + 200)	10.20	11.7	12.2	13.7	12.30	12.02±1.12
T9	Potassium metabisulphite + Potassium sorbate (200 + 100)	10.20	11.5	12.1	13.7	12.40	11.98±1.14
T10	Sodium benzoate + Potassium sorbate (200 + 100)	10.20	11.7	12.5	13.3	9.50	11.44±1.41
T11	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (100 + 200 + 200)	10.20	11.8	12.6	13.4	12.30	12.06±1.06
T12	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (200 + 100 + 100)	10.20	11.5	12.4	13.0	12.50	11.92±0.98
T13	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (100 + 100 + 100)	10.20	11.6	12.8	13.5	12.50	12.12±1.13
Mean ± S. D.		10.20 ± 0.00	11.70 ±0.33	12.35 ±0.40	13.45 ±0.46	11.46 ±1.71	

Table 6: Effect of storage on % reducing sugars in chemically preserved partially pasteurized mango pulp.

Treatment	Preservatives (ppm)	Storage (days)					
		0	30	60	90	270	Mean±S.D.
T1	Control (0.00)	4.27	4.47	4.75	4.88	2.19	4.11 ±0.98
T2	Potassium metabisulphite (200)	4.21	4.38	4.48	4.62	5.09	4.55 ±0.29
T3	Potassium metabisulphite (1000)	3.95	4.29	4.44	4.65	6.52	4.77 ±0.90
T4	Sodium benzoate (200)	4.05	4.36	4.52	4.65	6.05	4.72 ±0.69
T5	Sodium benzoate (500)	4.12	4.22	4.35	4.47	5.85	4.60 ±0.63
T6	Potassium sorbate (100)	4.11	4.30	4.42	4.53	1.47	3.75 ±1.15
T7	Potassium sorbate (400)	4.07	4.31	4.51	4.68	5.78	3.67 ±0.59
T8	Potassium metabisulphite + Potassium sorbate (200 + 200)	4.10	4.38	4.56	4.71	7.27	5.00 ±1.15
T9	Potassium metabisulphite + Potassium sorbate (200 + 100)	4.10	4.29	4.41	4.58	6.52	4.78 ±0.88
T10	Sodium benzoate + Potassium sorbate (200 + 100)	4.08	4.38	4.62	4.81	3.39	4.25 ±0.49
T11	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (100 + 200 + 200)	3.95	4.19	4.34	4.47	3.61	4.71 ±0.96
T12	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (200 + 100 + 100)	4.09	4.28	4.37	4.48	6.97	4.83 ±0.07
T13	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (100 + 100 + 100)	3.82	4.09	4.31	4.52	6.61	4.67 ±0.99
Mean ± S. D.		4.07 ±0.11	4.30 ±0.04	4.46 ±0.119	4.61 ±0.12	5.40 ±1.79	

hand sucrose contents decreased constantly through out the storage period except for the treatment T11 and T12.

Table 7: Effect of storage on % sucrose in chemically preserved partially pasteurized mango pulp.

Treatment	Preservatives (ppm)	Storage (days)					
		0	30	60	90	270	Mean±S.D.
T1	Control (0.00)	5.85	5.68	5.42	5.32	0.19	4.49 ± 2.15
T2	Potassium metabisulphite (200)	5.79	5.67	5.55	5.47	3.41	5.17 ± 0.89
T3	Potassium metabisulphite (1000)	5.74	5.47	5.33	5.13	4.94	5.32 ± 0.27
T4	Sodium benzoate (200)	5.89	5.60	5.44	5.34	5.13	5.48 ± 0.25
T5	Sodium benzoate (500)	5.77	5.69	5.56	5.64	5.23	5.59 ± 0.18
T6	Potassium sorbate (100)	5.89	5.70	5.61	5.50	2.15	4.97 ± 1.41
T7	Potassium sorbate (400)	5.85	5.70	5.61	5.50	2.15	4.97 ± 1.41
T8	Potassium metabisulphite + Potassium sorbate (200 + 200)	5.89	5.63	5.48	5.31	4.76	5.41 ± 0.37
T9	Potassium metabisulphite + Potassium sorbate (200 + 100)	5.76	5.59	5.48	5.32	4.74	5.37 ± 0.34
T10	Sodium benzoate + Potassium sorbate (200 + 100)	5.81	5.58	5.51	5.15	2.08	4.82 ± 1.38
T11	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (100 + 200 + 200)	6.25	6.05	5.91	5.80	4.22	5.64 ± 0.72
T12	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (200 + 100 + 100)	5.85	6.67	5.59	5.50	5.89	5.70 ± 0.14
T13	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (100 + 100 + 100)	6.16	5.93	5.72	5.57	6.11	5.89 ± 0.22
Mean ± S. D.		5.88 ± 0.15	5.68± 0.14	5.54± 0.14	5.41± 0.18	4.14± 1.76	

Table 8: Effect of preservatives on the micro flora of mango pulp after 30, 60 and 90 days storage.

Treatment	Preservatives (ppm)	Viable count (ml^{-1})		
		30	60	90
T1	Control (0.00)	2.6×10^5	3.2×10^8	4.6×10^9
T2	Potassium metabisulphite (200)	1.3×10^3	2.8×10^3	2.6×10^4
T3	Potassium metabisulphite (1000)	0	0	0
T4	Sodium benzoate (200)	0	0	2.7×10^3
T5	Sodium benzoate (500)	0	0	0
T6	Potassium sorbate (100)	0	0	2.4×10^3
T7	Potassium sorbate (400)	0	0	0
T8	Potassium metabisulphite + Potassium sorbate (200 + 200)	0	0	2.2×10^4
T9	Potassium metabisulphite + Potassium sorbate (200 + 100)	0	0	1.8×10^3
T10	Sodium benzoate + Potassium sorbate (200 + 100)	0	0	2.7×10^4
T11	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (100 + 200 + 200)	0	0	1.6×10^3
T12	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (200 + 100 + 100)	0	0	1.5×10^2
T13	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (100 + 100 + 100)	0	0	1.7×10^3

MICROBIOLOGICAL DISCUSSION

The data regarding microbial analysis of stored mango pulp is depicted in Table 8. It is evident from the data that pulp preserved without any chemical preservative showed substantial increase in microbial load with correspondent increase in storage period. Chemical preservatives significantly decreased the microbial load in mango pulp. Mango pulp

samples containing preservatives (T4 to T13) exhibited no sign of microbial growth up to 60 days of storage period. However, there was an indication of slight microbial growth after 90 days of storage period. For long term storage the effective dose of chemical preservatives in combination were found to be KMS 1000-ppm (T3), SB 500-ppm (T5) and PS 400-ppm (T7) as there was no sign of growth even after 90 days.

Table 9: Effect of various treatments on overall acceptability of ready to serve drinks prepared from chemically preserved partially pasteurized mango pulp.

Treatment	Preservatives (ppm)	Judges								
		1	2	3	4	5	6	7	8	Mean
T2	Potassium metabisulphite (200)	21	23	22	23	18	26	28	26	23.37
T3	Potassium metabisulphite (1000)	26	25	24	24	23	26	28	29	25.62
T5	Sodium benzoate (500)	25	21	21	21	25	19	25	25	22.75
T8	Potassium metabisulphite + Potassium sorbate (200 + 200)	26	23	20	25	21	22	28	30	24.37
T9	Potassium metabisulphite + Potassium sorbate (200 + 100)	24	22	22	21	22	20	25	23	22.37
T11	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (100 + 200 + 200)	24	22	21	25	20	22	26	29	23.62
T12	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (200 + 100 + 100)	25	23	20	21	22	24	26	27	23.62
T13	Potassium metabisulphite + Sodium benzoate + Potassium sorbate (100 + 100 + 100)	26	22	20	23	20	25	25	24	23.12

SENSORY EVALUATION

The results regarding overall acceptability are given in Table 9. Results of statistical analysis indicate that various treatments have significant influence on overall acceptability of ready-to-serve drinks prepared from chemically preserved partially pasteurized mango pulp. With the maximum mean score of 25.62, the sample preserved with 1000-ppm potassium metabisulphite (T3) was at the top in the ranking of over all acceptability while the sample containing 200-ppm potassium metabisulphite plus 100-ppm potassium sorbate (T9) was at the lowest rank with minimum mean score of 22.37. These results are in accordance with the early findings reported by Ahmed *et al.* [1986] in sulphited citrus squash.

CONCLUSIONS

In short, the preservative had dual influence on physico-chemical characteristics of mango pulp whereas storage caused an increase in acidity, brix, reducing sugars and decrease in sucrose. Among the chemical preservative tried in single doses of 1000-ppm potassium metabisulphite, 500-ppm sodium benzoate and 400-ppm potassium sorbate showed no sign of micro flora up to 90 days. However, all the samples tried for organoleptic evaluation were satisfactory up to 270 days, whereas a sample containing 1000-ppm potassium metabisulphite (T3) was comparatively better with respect to overall acceptability.

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