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## Studies on the Development of Whey Based Mango Beverage

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#### ABSTRACT

Whey based mango beverage (WMB), whey powder based mango beverage dry mix (WPMB), and whey protein concentrate based mango beverage dry mix (WPCMB) were prepared with different combinations. Based upon the sensory analysis, one formulation for each beverage was replicated thrice. The storability of the beverage was studied at  $4 \pm 1^\circ\text{C}$  for 30 days. The storage study showed that there is an increasing trend in the acidity and a decreasing trend in the pH and but fat, protein and total sugar had a non significant effect during storage for all the three samples.

Total viable count, yeast and mold count, coliform count was analysed using standard methods. The Total Viable Counts (TVC) was ranging from  $2.38 \times 10^4$  to  $2.60 \times 10^4$  cfu/mL in WMB, while it ranged from  $2.40 \times 10^4$  to  $2.30 \times 10^4$  and  $2.55 \times 10^4$  to  $2.45 \times 10^4$  in WPMB and WPCMB respectively. Yeast and mould count was found to be maximum in WPCMB samples. Faecal coliform count was found to be minimum in WMB and WPCMB, while non-faecal coliform was found to be higher in WPCMB. Overall acceptability of the product showed a decrease in case of WMB, while it showed a non significant effect on the other two samples.

### INTRODUCTION

Whey is a by-product obtained during coagulation of milk by using acid and/or rennet or physico-chemical process for the preparation of cheese, paneer, chhana, chakka and casein. Whey contains about 80-90% of the volume of milk that is used for production these products. It contains about half of the milk solids in which nutritional components such as lactose, protein and minerals are present in large amount <sup>[1]</sup>. The current world production of whey is about 125 million tonnes, in which about 64% is produced in European countries and 24% in North America. In the absence of Systematic surveys/statistics, the predicted value of whey production in India is estimated at 4.84 million tonnes per annum <sup>[2]</sup>. The chhana and paneer whey give the major contribution (about 80%) in total whey production <sup>[3]</sup>. Considerable work has been done throughout the world to utilize whey for production of Whey Protein Concentrate (WPC), whey powder, lactose, lactic acid, whey paste etc. <sup>[4]</sup>. The conversion of whey into beverages through fermentation or without fermentation is one of the most attractive a venues for the utilization of whey for human consumption. Beverages based on fruit and milk products are currently receiving considerable attention as their market potential is growing. Besides being delicious, these beverages are highly nutritious. In terms of functionality, whey protein enhances protein content of beverage while improving its quality.

Mango (*Mangifera indica* L.) is one of the important fruit crops grown in India, which has excellent flavour, attractive colour and delicious taste with high nutritional value. As it contains more than 80 per cent moisture, it has very poor keeping quality and cannot with stand any adverse climatic condition during storage. This results in loss of 30% of fruits every year <sup>[5]</sup>. To overcome this post harvest losses and to increase the shelf life, the surplus mango has to be processed into shelf stable products like sterilized pulp or dried flakes and powders <sup>[6,7]</sup>.

In the present study attempt was made to formulate a whey based mango beverage utilising chhana whey, whey powder and whey protein concentrate.

## MATERIAL AND METHODS

Whey powder, sugar, fructose was procured form local market of Delhi, Whey protein Concentrate (WPC-70) was supplied by Mahaan Proteins, New Delhi. Sodium nitrate was procured from Qualigens, Pectin from Danisco. Mango flavour was supplied by Sonarome, Yellow colour by CHR-Hansen and Mango powder was supplied by Aarkay Foods Pvt. Ltd., Ahmadabad. Lactic, citric and tartaric acid mixture was procured from local market. Sodium chloride was used of Tata Salt. Vitamin premix was supplied by Piramal Healthcare.

### Preparation of chhana whey

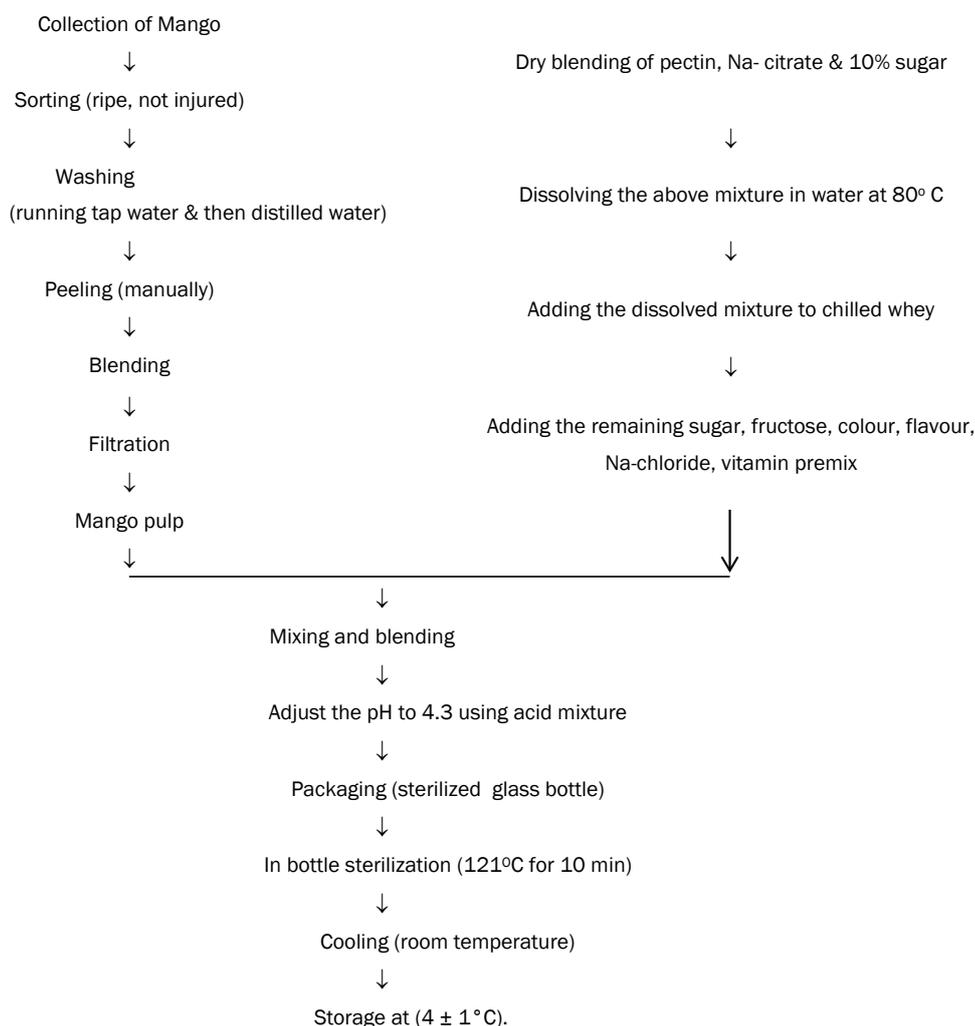
The chhana whey was obtained during the manufacture of chhana using milk containing 3.5% and 8.5% solid not fat (SNF). Milk was coagulated using 1.5% citric acid (Eagle Brand) solution as coagulant. The whey was filtered and centrifuged to remove the fat. Fat separation was done at 45 °C. To precipitate proteins whey was heated to 105 °C at pH 4.6 and then was filtered and stored under refrigerated condition until use.

### Preparation of Mango Pulp

Totapuri mangoes having uniform colour and maturity were selected for the experimental work. Ripe mango fruits were washed with running water, hand peeled and cut. The fruits were manually peeled and juice was extracted. The pulp was strained through muslin cloth to remove stone cells, to avoid coarse pulp particles and to have only fine particles of almost colloidal consistency. The pulp was kept under refrigerated condition for further use.

### Preparation of Whey based mango beverage (WMB)

The whey based mango beverage was prepared by the methods mentioned in **Figure 1**. Mango pulp was added in five different levels of addition (2, 4, 6, 8, 10%), the best result obtained on sensory basis is given in **Table 1**. In each lot about 2-3 lit. of beverages were prepared and experiment was repeated for three times. Bottles containing beverages were stored at refrigerated temperature ( $4 \pm 1^\circ\text{C}$ ) for 30 days. Samples were drawn at intervals of 10 days and evaluated for microbial properties.



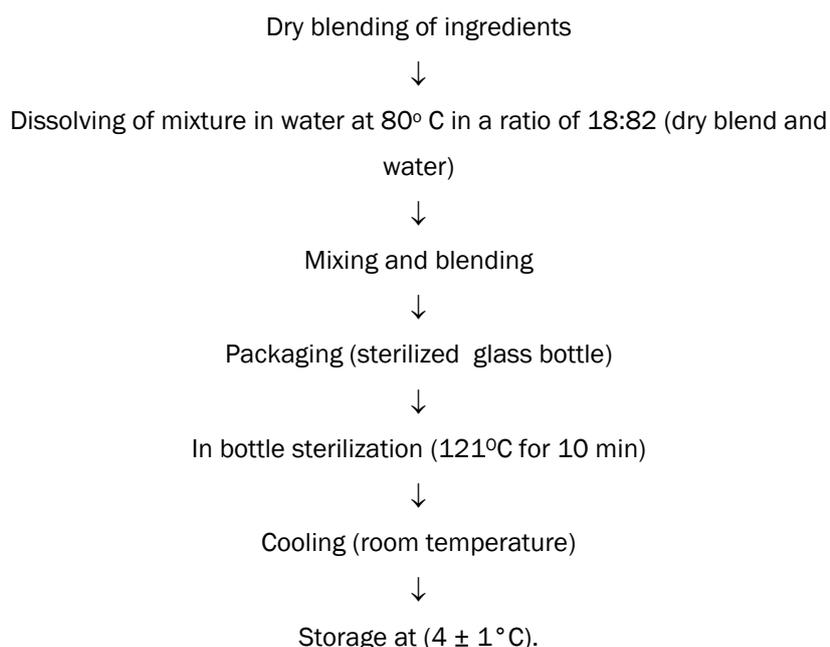
**Figure 1.** Manufacturing protocol for whey based mango beverage.

### Preparation of whey powder based mango beverage dry mix (WPMB)

The best combination of the whey powder based mango beverage dry mix is shown in **Table 1**. All of the ingredients were weighed and dry mixed in a planetary mixer. Three different levels each of whey powder (35, 40, 45%) and Mango powder (10, 15, 20%) were used. The powdered dry mix was hermitically sealed in laminate pouches and stored at room temperature for further use. The dry mix is used at the rate of 18% and 82% water to serve a ready to serve drink (**Figure 2**). The prepared drink was then filled in pre-sterilised glass bottles, followed by crowning. In-bottle sterilization was done at 121 °C for 10 min. Bottles were cooled at room temperature and then stored under refrigerated conditions ( $4 \pm 1^\circ\text{C}$ ). In each lot about 2-3 lit. of beverages were prepared and experiment was repeated for three times.

**Table 1.** Formulations for whey based mango beverage.

Ingredients	Whey Based Mango Beverage (gms)	Whey Powder based mango beverage dry mix (gms)	Whey protein concentrate based mango beverage dry mix (gms)
Whey	77.24	-	-
Whey powder	-	42	-
Whey protein concentrate (WPC-70)	-	-	28
Sugar	8.66	10	12
Mango pulp	8.65	-	-
Mango powder	-	14	17
Fructose	3.85	31	41
Sodium citrate	0.38	0.45	0.4
Sodium chloride		0.35	0.4
Pectin	0.29	0.3	0.16
Citric, lactic and tartaric acid Mixture	0.67	0.7	0.6
Mango flavour	0.19	0.25	0.25
Yellow colour	0.03	0.05	0.05
Vitamin Premix	0.04	0.9	0.14
Total	100	100	100



**Figure 2.** Manufacturing protocol for whey based mango beverage by using whey powder and whey protein concentrate dry mix

### Preparation of whey protein concentrate (WPC 70) based mango beverage dry mix (WPCMB)

The best combination of the whey protein concentrate based mango beverage dry mix is shown in **Table 1**. All of the

ingredients were weighed and dry mixed in a planetary mixer. Three different levels each of whey protein concentrate (25, 30, 35%) and Mango powder (10, 15, 20%) were used. The powdered dry mix was hermetically sealed in laminate pouches and stored at room temperature for further use. The dry mix is used at the rate of 18% and 82% water to serve a ready to serve drink. In each lot about 2-3 lit. of beverages were prepared and experiment was repeated for three times. The prepared drink was then filled in pre-sterilised glass bottles, followed by crowning. In-bottle sterilization was done at 121 °C for 10 min (**Figure 2**). Bottles were cooled at room temperature and then stored under refrigerated conditions ( $4 \pm 1^\circ\text{C}$ ).

**Table 2.** Chemical constituents of fresh and stored whey based mango beverage.

Parameters	Storage (Days)											
	0			10			20			30		
	WMB	WMPMB	WPCMB	WMB	WMPMB	WPCMB	WMB	WMPMB	WPCMB	WMB	WMPMB	WPCMB
Fat (%)	0.13	0.14	1.08	0.12	0.11	1.04	0.12	0.10	1.00	0.12	0.10	1.00
Protein (%)	0.75	2.7	11.16	0.72	2.66	11.10	0.70	2.61	11.07	0.68	2.57	11.01
Total Solids (%)	17.80	17.10	16.99	17.75	17.04	16.95	17.65	16.95	16.90	17.60	16.85	16.83
Total sugar	14.00	13.41	3.32	13.95	13.36	3.30	13.92	13.34	3.2	13.88	13.25	3.18
Titratable acidity	0.405	0.408	0.412	0.409	0.410	0.418	0.421	0.422	0.432	0.435	0.425	0.440
pH	4.3	4.68	4.95	4.25	4.58	4.88	4.18	4.49	4.78	4.11	4.33	4.47

WMB: Whey based mango beverage; WPMB: Whey powder based mango beverage dry mix; WPCMB: Whey protein concentrate based mango beverage dry mix

## Chemical Analysis

The moisture, fat, total solids and titratable acidity was determined as per the method described in IS: 1165<sup>[8]</sup>. Total Sugar was determined by the methods described by<sup>[9]</sup>. The sensory quality of fresh and stored product was determined by using 5 judges using 9 point hedonic scale.

## Microbiological Analysis

### Preparation of serial dilutions

Representative, 10 ml was aseptically mixed with 90 ml distilled water and homogenized by shaking. Subsequent decimal dilutions were prepared with the same diluents and in all cases duplicate-counting plates were prepared of appropriate dilutions<sup>[10]</sup>.

### Total viable count

Total viable count was carried out using the pour plate method described by<sup>[11]</sup>.

### Total yeast and moulds

Yeasts were enumerated by surface plating on malt extract agar (Oxoid) with 0.01% chloramphenicol as bacterial inhibitor and incubated aerobically at 25°C for 2-3 days<sup>[10]</sup>.

### Coliform bacteria and E.coli

The coliform test was done according to<sup>[11]</sup> by plating one ml sample onto MacConkey broth media. The plates were incubated at 37°C for 48 h and the counts were presented as colony forming units per gram (cfu/g). Plates showing positive coliform were subjected to the confirmed test using Brilliant green bile lactose broth in test tubes with Durham tubes. The test tubes were then incubated at 44°C for 48 h. Each confirmed positive tube was sub cultured into E.C. broth medium and then incubated at 44.5°C for 24 h. Tubes showing any amount of gas production were considered to be positive *E. coli* presence.

## RESULTS AND DISCUSSION

### Chemical Analysis

The changes occurred in three beverages manufactured and stored at refrigeration temperature is depicted in **Table 2**. The final composition of Whey based mango beverage (WMB) is as shown in **Table 2**. A slight increase in acidity and decrease in pH was observed. The average fat content was 0.13%, protein content was 0.75% and concentration of 17.8° Brix. Whey powder based mango beverage dry mix (WPMB) had a average moisture content of 4.5%, fat (0.8%) and protein content of 15%. The drink prepared from WPMB dry mix had a average fat content of 0.14%, protein content of 2.7% and total sugar content of 18.5%. Similarly whey protein concentrate (WPC 80) based mango beverage dry mix (WPCMB) dry mix content for moisture, fat, protein and total sugar was 4.8, 6, 62 and 18.45% respectively. The drink prepared from WPCMB had a fat, protein and total sugar content of 1.08, 11.16 and 3.32% respectively. The results obtained in the present investigation are in confirmation with the results obtained by<sup>[12]</sup>.

The initial acidity of the WMB (0.405%) had increased to 0.435% after 30 days of storage. This increase in acidity was due to the conversion of lactose to lactic acid, and formation of other organic acid by citric acid inherently present in the mango puree. On

storage some of the protein also gets converted into amino acid. The initial pH of 4.3 decreased to 4.11 after 30 days of storage. This decrease in pH is due to increase in acidity content in the stored product. Similar increase in acidity for WPMB and WPCMB was observed which reached a final value of 0.425 and 0.440% respectively. The change in acidity was in conjunction with the results reported by Saravana and Manimegalai [13] and Teotia et al. [14]. Non-significant changes were observed in the fat, protein and total sugar content in all of the beverages after 30 days of storage.

### Microbial Analysis

Total Viable Counts (TVC) were high ranging from  $2.38 \times 10^4$  cfu/mL at zero time and reached  $2.60 \times 10^4$  cfu/mL at the end of storage period in Whey based mango beverage (WMB). Similarly the total viable count in whey powder based mango beverage dry mix (WPMB) and whey protein concentrate based mango beverage dry mix (WPCMB) after 30 days of storage was  $2.30 \times 10^4$  and  $2.45 \times 10^4$  respectively. Yeast count were  $3.8 \times 10^3$  cfu/mL,  $3.9 \times 10^3$  cfu/mL and  $3.95 \times 10^3$  cfu/mL at zero time and reached  $3.67 \times 10^3$  cfu/mL,  $3.75 \times 10^3$  cfu/mL and  $3.80 \times 10^3$  cfu/mL for WMB, WPMB and WPCMB respectively. Faecal coliform showed a decreasing trend as the storage period increased, while non-faecal coliform count increased as the storage progressed (Table 3) and the same trend was reported by Ismail et al. [15] and Mahale et al. [16].

**Table 3.** Microbial counts of fresh and stored whey based mango beverage

Storage (Days)	Whey Beverage	Microbial Counts			
		Total Viable (cfu/ml)	Yeast & Mold (cfu/ml)	Faecal Coliform (cfu/ml)	Non-faecal Coliform (cfu/ml)
0	WMB	$2.38 \times 10^4$	$3.8 \times 10^3$	$4.6 \times 10^4$	$2.7 \times 10^2$
	WPMB	$2.40 \times 10^4$	$3.9 \times 10^3$	$4.65 \times 10^4$	$2.8 \times 10^2$
	WPCMB	$2.55 \times 10^4$	$3.95 \times 10^3$	$4.40 \times 10^4$	$2.9 \times 10^2$
10	WMB	$2.67 \times 10^4$	$3.75 \times 10^3$	$3.8 \times 10^4$	$2.8 \times 10^2$
	WPMB	$2.36 \times 10^4$	$3.85 \times 10^3$	$4.0 \times 10^4$	$2.88 \times 10^2$
	WPCMB	$2.50 \times 10^4$	$3.90 \times 10^3$	$3.4 \times 10^4$	$3.0 \times 10^2$
20	WMB	$2.65 \times 10^4$	$3.72 \times 10^3$	$3.3 \times 10^4$	$2.88 \times 10^2$
	WPMB	$2.33 \times 10^4$	$3.80 \times 10^3$	$3.6 \times 10^4$	$2.95 \times 10^2$
	WPCMB	$2.48 \times 10^4$	$3.85 \times 10^3$	$3.2 \times 10^4$	$3.1 \times 10^2$
30	WMB	$2.60 \times 10^4$	$3.67 \times 10^3$	$3.1 \times 10^4$	$2.75 \times 10^2$
	WPMB	$2.30 \times 10^4$	$3.75 \times 10^3$	$3.4 \times 10^4$	$2.84 \times 10^2$
	WPCMB	$2.45 \times 10^4$	$3.80 \times 10^3$	$3.1 \times 10^4$	$2.90 \times 10^2$

WMB: Whey based mango beverage; WPMB: Whey powder based mango beverage dry mix; WPCMB: Whey protein concentrate based mango beverage dry mix

### Sensory characteristics of beverages

The sensory evaluations of prepared beverages were performed by a panel of 5 judges using 9-point hedonic scale to know the overall acceptability of the product. The overall acceptability of the beverages was found to be good at the end of 30 days of storage period. The score of prepared beverage in fresh condition was 8.5 and at the end of 30 days of storage period the scores of corresponding samples were found to be 8.4. Gradual decrease was observed in overall acceptability for whey based mango beverage (WMB), while it was affected significantly for whey powder based mango beverage dry mix (WPMB) and whey protein concentrate based mango beverage dry mix (WPCMB) (Table 4). This was due to increase in viscosity and darkening of the colour and pungency in taste in case of WMB, while the WPMB and WPCMB were still good in colour without any objectionable flavour and may be attributed to the changes occurring during storage of beverage as reported by Shekilango et al. [17].

**Table 4.** Sensory characteristics of fresh and stored whey based mango beverage.

Parameters	Storage (Days)											
	0			10			20			30		
	WMB	WPMB	WPCMB	WMB	WPMB	WPCMB	WMB	WPMB	WPCMB	WMB	WPMB	WPCMB
Colour & Appearance	8.5	8.4	8.5	8.5	8.5	8.5	8.5	8.4	8.4	8.5	8.4	8.5
Flavour	8.5	8.4	8.5	8.5	8.5	8.5	8.0	8.4	8.5	8.0	8.2	8.4
Mouth-Feel	8.5	8.4	8.5	8.5	8.4	8.4	8.5	8.5	8.2	8.0	8.3	8.5
Overall Acceptability	8.5	8.4	8.5	8.4	8.5	8.5	8.2	8.4	8.4	8.0	8.5	8.5

WMB: Whey based mango beverage;  
WPMB: Whey powder based mango beverage dry mix;  
WPCMB: Whey protein concentrate based mango beverage dry mix

## **CONCLUSION**

The results of the study showed that whey in the form of acid whey, whey powder and whey protein concentrate could be successfully incorporated in beverages. The Storage of whey-based mango juice significantly resulted in increasing the acidity, and decreasing in the pH in all the three samples. However, the overall acceptability of the whey protein concentrate based mango beverage dry mix (WPCMB) was good after 30 days of storage at refrigeration temperature.

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