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Preparation of functional beverage from whey-based mango juice

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Abstract
Aiming for the utilization of whey, the project was undertaken involving blends of mango juice, *Asparagus racemosus* powder and paneer whey. The purpose of the study was to develop a novel functional beverage using *Paneer* whey and mango juice. The 1% *Asparagus racemosus* powder was used as an antioxidant. Whey contains about half of the solids present in the original whole milk, which include whey proteins, lactose, vitamins, minerals and some fat. Therefore, whey blended with 30, 40 and 50% of mango juice along with control (100% whey) was studied to explore the potency of these mango and *Asparagus racemosus* on antioxidant activity and storage quality of whey on 0, 3rd , 6th and 9th day in refrigerated (4±1^{0}C) condition. The 40:60 blends of mango and whey were adjudged to the best among all, based on sensory attribute. The shelf-life of the different blend was examined using physiochemical, microbiological analysis as well as sensory evaluation. The results suggested that functional beverages can be preserved for 9 days in refrigerated condition (4 ºC). It could be concluded that the whey based mango beverage enabled by-product utilization with excellent nutritional and functional value.

Keywords: Beverage, paneer whey, functional, antioxidant, shelf-life, mango

1. Introduction
In modern times, there has been a great concern in the production of functional beverages for their beneficial effects on human health and nutritional wellbeing. This has directed to a surge in the production of food items which are renowned as a functional food. Whey, the largest by-product of the dairy sector in India, is generated during the manufacturing of cheese, paneer, chhana, chakka and casein. In India, the major source of whey is from the production of chhana and paneer (Macwan *et al*. 2016) [14], resulting in an increased accessibility of whey. Whey is a serious pollutant as it imposes a very high biological oxygen demand (BOD > 35,000) and Chemical Oxygen Demand (COD > 60,000 ppm) (Smithers, 2015) [27], it is disposed by dairies only after treatment. Whey disposal is a serious problem for dairy industry from both an economical and an environmental point of view. This not only causes the loss of valuable nutrients but also incurs cost for the treatment of whey before disposal. Therefore, utilization of whey has been felt a necessity in view of the current requirements for alleviating environmental pollution as well as recovering available nutrients.
Whey contains about half of the solids present in the original whole milk, which include whey proteins, lactose, vitamins, minerals and some fat (De Jesus *et al*. 2015) [7]. Whey proteins are nutritionally the most valuable components, composed of β- lactoglobulin, α-lactalbumin, blood serum albumin and immunoglobulin as well as proteose-peptone (Božanić *et al*. 2014) [4]. Presence of several nutritionally important constituents having excellent functional properties enhances opportunities for wide range application of whey and its constituents in the food industry. Whey is a popular dietary protein supplement, which provides antimicrobial activity, immune modulation, and prevents cardiovascular disease and osteoporosis. In addition, it act as an antioxidant, anti-inflammatory, antihypertensive, antitumoral, hypolipidemic, antiviral, antibacterial, and antidiabetic (Patel, 2015) [17]. Considering the nutritional and functional virtues of whey, several attempts have been made earlier to utilize whey solids, which include production of beverages (Chavan *et al*. 2015) [5], Ice cream, yoghurt, bakery products (Wani *et al*. 2015) [31], infant food formulations, processed cheese and processed cheese analogues (Solowiej *et al*. 2015) [29] and also used as an edible coating for foods. However, keeping in view the quantum of whey production and the problems

associated with its disposal, many more efforts should be made to utilize this important by-product.

Antioxidant potential of mango and *Asparagus racemosus* (*Shatavari*) its utilization in beverages

India is the largest producer of fruits. These are mainly used as functional food ingredients for the preparation of several food products. Fruits are also rich source of vitamin c, carbohydrates and dietary fibers. Fruits helps in reduction of risk of various disease such as cardio vascular such as cardiovascular, Alzheimer etc. Fruits are known for their antioxidant potential and very useful in the defence mechanism against pathogen. Hydrophilic compound such as vitamin C, thiols and flavinoid, as well as lipophilic compounds such as Vitamin E, Vitamin A, carotenoids and ubiquinols are the best known natural antioxidants.

Mango (*Mangifera indica* L.) is one of the most popular edible fruit. Mangoes are a potential source of flavonoids and carotenoids, which makes them a food with good bioactive potential. The main bioactive compounds found in mangoes are polyphenols mangiferin, catechins, quercetin, kaempferol, gallic acid, and benzoic acid, which are compounds associated with the prevention of degenerative diseases, including cancer, cardiovascular diseases, and diabetes.

Asparagus racemosus (*Shatavari*) is known as the 'Queen of herbs' and is regarded as curer of a hundred diseases (*Shat* means 'Hundred' and *Vari* means 'Cure'). The plant grows throughout the tropical and subtropical parts of India and is widely used in traditional Indian medicine (Ayurveda). The plant is a spinous under-shrub, with tuberous, short rootstock bearing numerous succulent tuberous roots that finds use in various medicinal preparations. The stem is woody, climbing, whitish grey or brown colored with small spines. The plant has been shown to aid in the treatment of neurodegenerative disorders. The plant also has potent antioxidant, antimicrobial, antibiotic, immune-stimulant, antidyspepsia and antitussive effects. Primary chemical constituents of *Asparagus racemosus* are essential oils, asparagine, arginine, tyrosine, flavonoids (kaempferol, quercetin, and rutin), resin, and tannin. This plant also contains vitamins A, B_1, B_2, C, E, Mg, P, Ca, Fe, and folic acid. *Asparagus racemosus* possess strong antioxidant properties and has been reported to decrease lipid peroxidation significantly. The antioxidant properties have been associated to presence of Isoflavons especially racemofuran, asparagamine A and racemosol (Sharma and Sharma, 2013) [25].

2. Procurement of raw materials

2.1 Paneer whey

Paneer samples were prepared by the method given by Aneja *et al*. (2002) [1] and whey was separated from coagulum by filtration using a clean muslin cloth. The whey was held for another 2 min at 85 °C before drawing it into a container for further processing.

2.2 Mango juice

Fresh Alphanso mango were collected from the local market and sliced followed by cutting into small pieces. The fruit pieces were grinded in a mixer (Siemens, Germany) and the resulting pulp was passed through a muslin cloth to extract the juice. The juice was heated up to 72°C for 30 seconds in a hot air oven to destroy the microbes. (Mirza *et al.* 2021)

2.3 Antioxidants

Asparagus racemosus was procured from "The Himalaya Drug Company".

2.4 Packaging material

Paneer whey beverage was packed in glass bottles and stored at refrigeration temperature during storage for its further evaluation.

3. Physio-chemical analysis

3.1 pH

pH of whey beverage was determined using digital pH at 20 °C. The pH meter was first calibrated using standard buffers of pH 4.0 and 9.2 and standardized using pH buffer of 7.0 at 20.0±0.10 °C. For pH reading, electrode was dipped into distilled water each and wiped off.

3.2 Titratable acidity

The titratable acidity of the prepared product was estimated by adopting the method as described by (Sadler & Murphy, 2010). About 10mL of sample was taken in beaker. This was followed by addition of 2-3 drops of 0.5% phenolphthalein indicator. The mixture was titrated with 0.1 N sodium hydroxide continuous stirring till the pink colours disappeared completely. Then acidity was calculated as % of citric acid.

$$\% \text{ TA} = \frac{0.064 \text{ NV}}{\text{W}} \text{ x } 100$$

Where,

V = Volume of titrate in mL

N = Normality of the alkali solution

W = Volume of sample in mL

3.3 Total Sugars

Phenol-Sulfuric Acid Method (DuBois *et al*., 1956) [9] is the most widely used colorimetric method to date for determination of carbohydrate concentration in aqueous solutions. The basic principle of this method is that carbohydrates, when dehydrated by reaction with concentrated sulfuric acid, produce furfural derivatives. Further reaction between furfural derivative and phenol develops detectible color. The standard procedure of this method is as follows. A 1ml aliquot of sample solution is mixed with 1mL of 5% aqueous solution of phenol in a test tube. Subsequently, 5 mL of concentrate sulfuric acid is added rapidly to the mixture. After allowing the test tubes to stand for 10 min, and was vortexed for 30 s and placed for 20 min in a water bath at room temperature for color development. Then, light absorption at 490 nm is recorded on a spectrophotometer. Reference solutions are prepared in identical manner as above, except that the 2ml aliquot of carbohydrate is replaced by distilled water. The phenol used in this procedure was redistilled and 5% phenol in water (w/w) was prepared immediately before the measurements.

3.4 Total Soluble Solids (TSS)

The total soluble solid of the optimized beverage was calculated in terms of Brix using a hand refractometer. Refractometer is an analog instrument for measuring substances dissolved in liquid by noting the refractive index of the respective liquid. It works on the principle that the light travelling through the sample is either passed through to the particle or totally internally reflected. The net effect is that a shadow line forms between the illuminated area and the dark area. It is where this shadow line crosses the scale a reading is taken. Because refractive index is very temperature

dependent, it is important to use a Refractometer with automatic temperature compensation. Compensation is accomplished through the use of a small bi-metallic strip that moves a lens or prism in response to temperature changes. Further, the refracted angle is then viewed by the user through a magnifying eyepiece. The scale most commonly used is referred to as the Brix scale.
Firstly, the 0-32^{0}B range Refractometer was calibrated using distilled water. Then a sample of whey beverage was placed between a measuring prism and a small cover plate, and reading was noted according.

3.5 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity

The ability to scavenge 1,1diphenyl-2picrylhydrazyl (DPPH) radical by added antioxidants in samples was estimated following the method of Kato *et al*. (1998) [12] with slight modification. DPPH can make stable free radicals in aqueous or ethanol solution; however, fresh DPPH solution was prepared before every measurement. In this method, 5ml of the sample was mix with 20 ml of methanol and ethanol (1:1) for 2 min. The content was quantitatively transferred into a beaker and filtered through Whatman filter paper No. 42. Then, 3.9 ml of DPPH reagent (250 µM) was mixed with 1ml of 0.1M Tris-HCl buffer (pH 7.4) and 0.1 ml of sample extract in test tubes. The content was gently mixed and then incubated in dark for 20 min. The absorbency in time t=0 min. (t_0) was measured at 517 nm using a UV-VIS Spectrophotometer (SL-159 Elico India Limited, Mumbai). The sample tubes were also incubated at room temperature under dark for measurement of absorbency in time t=20 min. (t_{20}). Ethanol was used as a blank. The free radical scavenging activity was calculated as the decrease in absorbance from the equation:

Scavenging activity (% inhibition) = $100 - (At_{20}/At_0) \times 100$.

3.6 Total Phenolic content

One ml of fresh juice from samples was diluted up to the volume of 25ml. Part of solution was centrifuged at 15000 rpm for 20 minutes at 4 ºC. Supernatural solution was used for analysis. The total phenolic content was determined by spctrophotometry, using gallic acid as a standard, described by (Singleton & Rossi, 1965) [26] For this, 0.2 ml of the diluted of Folin-Ciocalteu's reagent in water. After waiting for 10 minutes, 0.8 ml of a sodium carbonate solution (7.5% w/v) was added to the sample. The tubes were then allowed to stand at room temperature for 30 min before absorbance at 743 nm was measured. The TPC was expressed as gallic acid equivalents (GAE) in mg/100ml of fruit juice. The concentration of polyphenols in sample was derived from a standard curve of gallic acid ranging from 0.2 to 4 mg/L.

4. Sensory evaluation of whey beverage

The whey beverage samples were evaluated for their acceptability in terms of sensory scores. Sensory evaluation was carried out by presenting approximately 50 ml of whey beverage sample to seven semi-trained panelists, selected from the faculty of Livestock products Technology Division. Nine-point hedonic scale was followed to carry out the evaluation of samples for sensory attributes such as colour and appearance, consistency, sweetness, flavor and overall acceptability. The nine-point hedonic scales includes various scales of grading i.e. liked extremely (9), liked very much (8), liked moderately (7), liked slightly (6), neither liked nor disliked (5), disliked slightly (4), disliked moderately (3), disliked very much (2), disliked extremely (1) (Lawless & Heymann, 2010).

5. Microbiological Quality

Total Plate Count, Yeast and Mold Count and Coliforms Count in the samples were enumerated following the methods as described by American Public Health Association (APHA 1984) [2].

6. Statistical Analysis

Data were analyzed statistically on IBM SPSS Statistics-20.0 software, USA packages as per standard methods. Duplicate samples were drawn for each parameter and replicated thrice (n=6). Sensory evaluation was performed by a panel of seven judges, total observations were 21 (n=21). Means between the periods of storage, between treatments, and within treatments were compared by two-way analysis of variance (ANOVA) and critical difference test as per Snedecor and Cochran (1982) [28]. The statistical significance was estimated at 5% level ($P<0.05$) and evaluated with Duncan's multiple range test. The results were presented in the form of Mean±S.E.

7. Experimental Design

Three (03) different types of whey based mango beverages were prepared by mixing of different blends of whey and mango juice. In each blend, 10% sugar level was used as constant. The control was marked as 100% whey. The proportion of mango juice blended with paneer whey was 30%, 40% and 50%. The 1% *Asparagus racemosus* powder was used as an antioxidant, added into different blends of whey based mango beverage. The products were evaluated based on physio-chemical, antioxidant activity, sensory and microbiological profile on 0, 3rd, 6th, and 9th day during refrigeration storage at (4±1°C).

Table 1: Preparation of whey-based mango juice beverage

Treatment	Mango juice (%)	Whey (%)	Sugar (%)	*A. racemosus* (%)
Control*	0	100	10	1
Mango juice (30%)	30	70	10	1
Mango juice (40%)	40	60	10	1
Mango juice (50%)	50	50	10	1

Control*= 100% whey

8. Result and discussion

8.1 Physico-chemical parameters

8.1.1 pH

The pH of paneer whey blended with mango juice was recorded to be lower with increased in level of mango juice. It may be due to the fact that it contains polyphenols mangiferin, gallic acid, benzoic acid and other phenol and flavonoids which are acidic in nature. This was supported by the finding of Coelho *et al.* (2019) [6]. The pH was decreased significantly on successive storage till 9th days irrespective of levels of incorporation of mango juice in paneer whey including control may be attributed to degradation of some fibrous component available in added juice in whey beverage. Similar declined in pH was observed by Divya kumari (2009) [8] in whey beverage. (Table 2)

8.1.2 Acidity

The acidity of whey based mango beverage was recorded to be higher with increased in level of mango juice. This may be attributed to the fact that it contains polyphenols mangiferin, gallic acid, benzoic acid and other phenol and flavonoids which are acidic in nature. The acidity was increased significantly on successive storage till 9th days irrespective of levels of incorporation of mango juice in paneer whey. This may be due to bacterial spoilage by lactose fermentating organism. Sachdeva and Singh (1990) [19] also observed increase in acidity of paneer samples during storage.

8.1.3 Total sugar

The total sugar of whey blended with mango juice was recorded to be higher with increased in level of mango juice. The reason behind this case may be attributed to the sugar content of the fruit juices. The significantly highest total sugars were observed at the 9th day of research work followed by 3th day of storage period. The significantly lowest total sugars were found at the zero day of storage period. The data reveals that total sugars in all juices increases by the increase in storage duration. The increase in total sugars may be due to hydrolytic changes and conversion of polysaccharides like starch and pectin etc. into sugars. These findings agreed with the values as reported by Purthi *et al*. (1984) [18] who reported that reducing sugars increased in clarified apple juice concentrate at a rate determined by the inversion of sucrose during storage period of 111 days at 37 °C.

8.1.4 Total solid

The significantly highest total solids were observed at the 50% mango juice blended with paneer whey followed by 30 and 40%. The total solid values increases comparatively throughout the storage study period. The interaction between storage time and treatment showed significantly the higher total soluble solids. The present result are in close agreement with the finding of Sattar *et al*. (1998) [24], who also reported that the total soluble solids increased during 32 days of storage period of pasteurized drink due to formation of water soluble pectin fractions.

Table 2: Effect of refrigerated storage on physio-chemical characteristics of *Paneer* whey based mango beverage (Mean±SE)*

Treatments	0-day	3rd day	6th day	9th day
pH				
Control*	5.20±0.04^{Aa}	5.10±0.04^{Ab}	4.95±0.02^{Ac}	4.85±0.03^{Ad}
Mango juice (30%)	4.62±0.01^{Ba}	4.47±0.04^{Bb}	4.30±0.02^{Bc}	4.11±0.05^{Bd}
Mango juice (40%)	4.55±0.03^{Ca}	4.30±0.02^{Cb}	4.12±0.05^{Cc}	6.30±0.01^{Cd}
Mango juice (50%)	4.48±0.04^{Da}	4.22±0.01^{Db}	4.05±0.03^{Dc}	3.95±0.02^{Dd}
Titratable acidity (%)				
Control*	0.23± 0.04^{Dd}	0.34±0.04^{Dc}	0.42±0.02^{Db}	0.49±0.03^{Da}
Mango juice (30%)	0.32± 0.01^{Cd}	0.39±0.04^{Cc}	0.49±0.02^{Cb}	0.56±0.05^{Ca}
Mango juice (40%)	0.39± 0.03^{Bd}	0.47±0.02^{Bc}	0.58±0.05^{Bb}	0.65±0.01^{Ba}
Mango juice (50%)	0.48±0.03^{Ad}	0.58±0.01^{Ac}	0.67±0.03^{Ab}	0.73±0.02^{Aa}
Total sugar				
Control*	7.49±0.04^{Dc}	7.54±0.04^{Db}	7.58±0.02^{Da}	7.62±0.03^{Da}
Mango juice (30%)	10.15±0.01^{Cd}	10.40±0.04^{Cc}	10.85±0.02^{Cb}	11.45±0.05^{Ca}
Mango juice (40%)	13.25±0.03^{Bd}	13.55±0.02^{Bc}	13.91±0.05^{Bb}	14.50±0.01^{Ba}
Mango juice (50%)	15.90±0.03^{Ad}	16.20±0.01^{Ac}	16.65±0.03^{Ab}	17.20±0.02^{Aa}
Total solid				
Control*	9.01±0.04^{Db}	9.05±0.04^{Dab}	9.09±0.02^{Da}	9.11±0.03^{Aa}
Mango juice (30%)	13.26±0.01^{Cb}	13.29±0.04^{Cab}	13.33±0.02^{Ca}	13.36±0.05^{Ba}
Mango juice (40%)	16.67±0.03^{Bc}	16.73±0.02^{Bb}	16.77±0.05^{Bab}	16.81±0.01^{Ca}
Mango juice (50%)	19.61±0.03^{Ac}	19.66±0.01^{Ab}	19.71±0.03^{Aab}	19.76±0.02^{Da}

Mean± SE with different superscripts in a row wise (lower case alphabet) and column wise (upper case alphabet) differ significantly (P<0.05). n=6 for each treatment. Control*= 100% whey.

8.2. Antioxidant activity

8.2.1 DPPH scavenging activity

DPPH scavenging activity was significantly (P<0.05) increased with increased in the level of incorporation of mango juice in whey. The probable reason could be higher phenolic content. Antioxidant activity was significantly decreased on successive storage days in whey based mango beverage including control. Similar trend of decline in value was reported by Shady *et al*. (2013) in organic acid whey beverage.

8.2.2 Total phenolic content (TPC)

The TPC value increased significantly (P<0.05) with increased in the level mango juice in whey based beverages. The TPC value has decreased comparatively on successive refrigeration storage days in all preparation including control. Similar fall of TPC activity was observed in case whey-based pineapple beverage prepared by Baba *et al*. (2016) [3]. It is postulated that during storage some phenol like monomeric anthocyanins have been distorted into polymeric compounds that led to reduction in total polyphenols (George *et al*. 2007) [11].

Table 3: Effect of refrigerated storage on antioxidant activity of *Paneer* whey based mango beverage (Mean±SE)*

Treatments	0-day	3rd day	6th day	9th day
DPPH scavenging activity				
Control*	10.15 ±0.04^{Da}	10.11±0.04^{Dab}	10.08±0.02^{Dbc}	10.02±0.03^{Dc}
Mango juice (30%)	27.52 ±0.01^{Ca}	27.47±0.04^{Cab}	27.44±0.02^{Cbc}	27.40±0.05^{Cc}
Mango juice (40%)	33.14 ±0.03^{Ba}	33.11±0.02^{Bab}	33.08±0.05^{Bbc}	33.03±0.01^{Bc}
Mango juice (50%)	39.25 ±0.03^{Aa}	39.21±0.01^{Aab}	39.18±0.03^{Abc}	39.15±0.02^{Ac}
Total Phenolic count				
Control*	11.56±0.04^{Da}	11.50±0.04^{Dab}	11.44±0.02^{Dbc}	11.38±0.03^{Dc}
Mango juice (30%)	33.66±0.01^{Ca}	32.45±0.04^{Cab}	31.05±0.02^{Cbc}	30.45±0.05^{Cc}
Mango juice (40%)	38.78±0.03^{Ba}	37.45±0.02^{Bab}	36.84±0.05^{Bbc}	35.75±0.01^{Bc}
Mango juice (50%)	43.48±0.03^{Aa}	42.85±0.01^{Aab}	42.67±0.03^{Abc}	41.95±0.02^{Ac}

Mean± SE with different superscripts in a row wise (lower case alphabet) and column wise (upper case alphabet) differ significantly (P<0.05). n=6 for each treatment. Control*= 100% whey

8.3) Microbiological Characters

A total plate count was significantly (P<0.05) decreased as level of mango juice increases from 30% to 50% in whey beverages. The total plate count has increased significantly (P<0.05) on successive refrigeration storage days from 0 to 9th day in whey based mango beverage including control (Table-3). The yeast and molds were not detected till 7th day of storage but it appeared in all product from 9th day onward. This finding is in agreement with the research work of Mendoza *et al*. (2007) [15] who reported that decline in the TVC in whey-based probiotic beverage during storage at 4±1°C. Coliforms count were found to be absent in all the samples during storage. Coliforms count in any dairy product represents the extent of hygienic conditions maintained during production, packaging and storage.

Table 4: Effect of refrigerated storage on microbiological characteristics of *Paneer* whey based mango beverage (Mean±SE)*

Treatments	0-day	3rd day	6th day	9th day
Total Plate Count (logcfu/g)				
Control*	2.25±0.03^{Ad}	2.52±0.09^{Ac}	2.77±0.02^{Ab}	2.98±0.05^{Aa}
Mango juice (30%)	1.77±0.05^{Bd}	2.04±0.05^{Bc}	2.35±0.02^{Bb}	2.54±0.02^{Ba}
Mango juice (40%)	1.65±0.05^{Cd}	1.82±0.00^{Cc}	2.05±0.01^{Cb}	2.32±0.05^{Ca}
Mango juice (50%)	1.59±0.02^{Cd}	1.77±0.01^{Cc}	2.01±0.09^{Cb}	2.28±0.05^{Ca}
Yeast and Molds Count (logcfu/g)				
Control*	ND	ND	ND	2.50±0.02^{A}
Mango juice (30%)	ND	ND	ND	2.05±0.07^{B}
Mango juice (40%)	ND	ND	ND	1.85±0.05^{C}
Mango juice (50%)	ND	ND	ND	1.78±0.07^{C}

Mean± SE with different superscripts in a row wise (lower case alphabet) and column wise (upper case alphabet) differ significantly (P<0.05). n=6 for each treatment. Control*= 100% whey.

8.4 Sensory Parameters

The storage study is essential aspect to determine the shelf life of the product throughout storage time. The objective of the storage study is to evaluate whether the product would be safe, acceptable and stable throughout storage time.

The colour and appearance, flavour, consistency, sweetness and overall acceptability scores of 40% whey based mango beverages were found to be significantly higher than 30 and 50% whey based mango beverages and control.

All the sensory parameters viz. colour and appearance, flavour, consistency, sweetness and overall acceptability were found to be significantly (P<0.05) lower on successive refrigeration storage in whey based mango beverage including control.

Authors postulated that degradation in colour and appearance could be due to change in colouring compounds during storage and is primarily because of maillard reaction and possibly also due to hydrolysis of sucrose present in pulp and added sugar during storage, envisaging the degradation of product. Similar trend of decreasing colour values was seen in case of whey mango beverage reported by Sakhale *et al*. (2012) [22] in whey based mango and kesar RTS beverage.

On storage, decrease in flavour and consistency could be due to volatile component and settling of heavy particle which causes thinning of the upper layers of the beverages, respectively. Similar flavour loss was observed by Sameen *et al*. (2013) [23], in carbonated flavour whey drink during storage.

Decreasing trend was observed for sweetness during storage. On day 3rd slightly increase in sweetness but on successive days it decreases. This could be due to hydrolysis of sugar at low pH. Similar trend was recorded by Divya kumari (2009) [8] in whey guava beverage.

The mean sum of all sensory attributes in terms of overall acceptability showed the declining trend in control and prepared beverages. Results obtained are in concordance with the findings obtained by Gad *et al*. (2013) [10] in whey mango beverage. Tariq *et al*. (2020) [30] also reported decline in OA in blend of antioxidant rich beverage in a span of 90 days during storage period.

Table 5: Effect of refrigerated storage on sensory attributes of *Paneer* whey based mango beverage (Mean±SE)*

Treatments	Sensory Parameters			
	0 Day	3rd-Day	6th-Day	9th-Day
Colour and appearance				
Control*	5.50±0.07^{Da}	5.05±0.09^{Db}	4.45±0.07^{Dc}	4.09±0.07^{Ad}
Mango juice (30%)	7.69±0.07^{Ca}	7.20±0.06^{Cb}	6.78±0.05^{Cc}	6.44±0.06^{Cd}
Mango juice (40%)	8.45±0.08^{Aa}	8.05±0.08^{Ab}	7.62±0.08^{Ac}	6.91±0.08^{Ad}
Mango juice (50%)	8.02±0.08^{Ba}	7.58±0.06^{Bb}	7.12±0.08^{Bc}	6.40±0.06^{Bd}
Flavour				
Control*	5.45±0.07^{Da}	5.01±0.09^{Db}	4.41±0.07^{Dc}	4.04±0.03^{Dd}
Mango juice (30%)	7.64±0.06^{Ca}	7.13±0.06^{Cb}	6.74±0.02^{Cc}	6.40±0.03^{Cd}
Mango juice (40%)	8.50±0.08^{Aa}	7.99±0.08^{Ab}	7.47±0.06^{Ac}	6.94±0.05^{Ad}
Mango juice (50%)	8.11±0.06^{Ba}	7.61±0.06^{Bb}	7.12±0.08^{Bc}	6.46±0.03^{Bd}
Consistency				
Control*	5.25±0.06^{Da}	4.80±0.05^{Db}	4.21±0.07^{Dc}	3.84±0.03^{Dd}
Mango juice (30%)	7.44±0.07^{Ca}	7.05±0.06^{Cb}	6.65±0.02^{Cc}	6.30±0.04^{Cd}
Mango juice (40%)	8.20±0.08^{Aa}	7.78±0.03^{Ab}	7.17±0.05^{Ac}	6.68±0.05^{Ad}
Mango juice (50%)	8.01±0.06^{Ba}	7.41±0.06^{Bb}	6.91±0.04^{Bc}	6.26±0.03^{Bd}
Sweetness				
Control*	5.43±0.06^{Da}	5.51±0.09^{Da}	4.80±0.07^{Db}	4.40±0.06^{Dc}
Mango juice (30%)	7.65±0.07^{Ca}	7.72±0.06^{Ca}	7.05±0.02^{Cb}	6.25±0.07^{Cc}
Mango juice (40%)	8.52±0.08^{Aa}	8.56±0.08^{Aa}	7.87±0.06^{Ab}	7.57±0.08^{Ac}
Mango juice (50%)	8.10±0.06^{Ba}	8.61±0.06^{Ba}	7.59±0.08^{Bb}	6.70±0.03^{Bc}
Overall acceptability				
Control*	5.40±0.06^{Da}	4.95±0.07^{Db}	4.40±0.07^{Dc}	4.05±0.03^{Dd}
Mango juice (30%)	7.81±0.07^{Ca}	7.27±0.06^{Cb}	6.78±0.02^{Cc}	6.53±0.03^{Cd}
Mango juice (40%)	8.55±0.08^{Aa}	8.05±0.08^{Ab}	7.52±0.06^{Ac}	6.99±0.08^{Ad}
Mango juice (50%)	8.11±0.06^{Ba}	7.63±0.06^{Bb}	7.13±0.08^{Bc}	6.51±0.03^{Bd}

Mean± SE with different superscripts in a row wise (lower case alphabet) and column wise (upper case alphabet) differ significantly (P<0.05). n=6 for each treatment. Control*= 100% whey

9. Conclusion

It can be summarized that whey bids a good option for the development of functional whey-based mango beverages. Thus, the study was targeted to formulate an antioxidant rich whey-based mango beverages using different blends of mango juice and *paneer* whey with the addition of *Asparagus racemosus* (*Shatavari*) as an antioxidant. The study has revealed competently good quality antioxidant beverage by using a 40:60 blend of mango juice and paneer whey with a shelf life of 9 days at refrigerated condition (4 ± 1°C).

10. References

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