



P-ISSN: 2349-8528

E-ISSN: 2321-4902

IJCS 2018; 6(6): 725-730

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Received: 09-09-2018

Accepted: 13-10-2018

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Development of whey incorporated with orange juice and appraisal of their sensory and nutritional qualities

Manju Jakhar and Monika Jain

Abstract

The experiment was conducted at department of food science and nutrition, Banasthali Vidyapith, Newai, Tonk in 2006. Studied that the dairy by products can be used to enrich fruit juices to enhance their therapeutic and nutritional value. This study was carried out with the objective of developing beverages using orange juice and incorporating whey at various percentage levels and to conduct sensory and nutritional analysis of the same. The change in sensory characteristics of beverages on storage was also observed. The results of sensory evaluation revealed that the overall acceptability of orange whey 10% beverages was very good and its aroma, color, appearance was appropriate. Protein value of beverages varied between 0.63-1.83%. Fat content was 0.60-1.20%. Ascorbic acid level ranged between 4.28-1.14%, and it was found to be decreasing with increasing amount of whey. The storage of the juices was also carried out for 15 days, acceptability declined on storage. Orange juice with whey 10% was highly in acceptable and had a fair content of protein too. Therefore, it could be considered the best category of beverage.

Keywords: orange, whey, juices, beverages, sensory

Introduction

It is important that a balanced diet is eaten, with foods from each of the major for groups. Choosing a variety of foods within each group also helps to make our meals more interesting from day to day. Eating a mixture of foods can help prevent disease such as diabetes, cancer and cardiovascular diseases. Fruits are important because they contain large amount of certain vitamins and minerals. A diet in fruits can decrease the chances of having a heart attack or stroke, protect from a variety of cancers, lower blood pressure. Oranges constitute a significant source of antioxidants (mainly vitamin c), and sufficient amount of folacin, thiamin, niacin, calcium, potassium and magnesium (Angew, 2007) [1]. There has been a considerable increase in the consumption of fruit juices in the world. They contribute significantly to the vitamin and electrolyte content of the diet, but these are generally a poor source of protein. This inherent lack of protein can be made up by addition of an ingredient which provides protein and does not negatively affect the color and flavor. The vehicles for fortification must be such that are highly consumed and preferred by the consumers and there is a great demand in the market. Hence, fortification of fruit juices with whey can be an excellent way to make them reach the society. Whey is obtained as a by-product in the preparation of chhanna, paneer and to a lesser extent from cheese. Disposal of whey poses a serious problem to dairy industry all over the world because of high organic matter in it (Kar and Mishra 1998) [7]. Nutritionally, the most valuable whey component is the whey protein. Whey proteins are one of the highest quality natural proteins available for utilization. Whey also contains minerals and water soluble vitamins. Over the years, numerous approaches have been taken in an effort to transform a large volume of whey into products suitable for use as food (Djuari *et al* 2004) [4]. Long term use of whey clearly depicts its therapeutic value in aging, cancer, and AIDS, helps in the proper functioning of liver, kidney and also reduces stress. In India both dairy and fruit sectors face problems of lack of basic infrastructure for handling peaks in production. Whey, a dairy by product has a great therapeutic value owing to its unique proteins. Whey based fruit beverages are more suitable for health as compared to other drinks (Sarvana and Manimegalai, 2005) [9]. Therefore, in order to make the use of dairy by product, present study was proposed to supplement them with fruit juices to prepare a delicious, drink and full of nutrients.

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Hence, the major objectives of the study were:

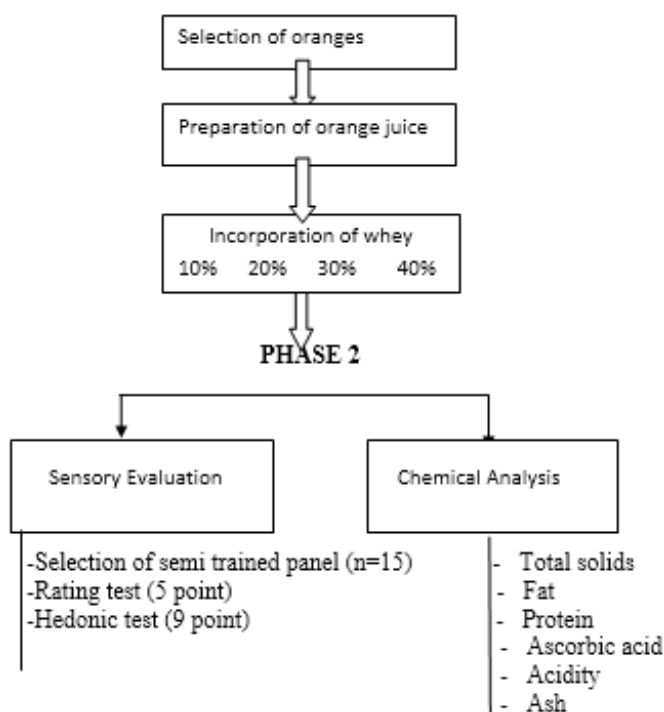
- To develop beverages using orange fruit and incorporating whey at various percentage levels.
- To evaluate these beverages for sensory qualities.
- To conduct nutritional analysis of all the beverages.
- To observe the change in sensory characteristics of beverages on storage.

Research methodology

This endeavour was an attempt to develop beverages based on fruit juices with nutritive ingredients like whey incorporated in them. These had to be processed to enhance shelf life and evaluated for nutrient composition and sensory qualities. In this we design fruit based beverages with enhanced nutritive value as well as to come up with beverage using whey in which taste is not compromised.

The methodological aspects of the study have been discussed as Product development, Sensory evaluation, Chemical analysis, statistical analysis.

Flow Chart Elucidating the Experimental Plan
Phase 1



In primary processing the orange juice, whey and sugar syrup was prepared. Household method were used for preparation of juices, whey and sugar syrup.

Preparation of Orange Juice

- Fresh oranges were procured from the local greengrocer.
- These were divided into two equal halves.
- The juice was extracted using the citrus fruit juice extractor attachment of a food processor.
- Yield: 3kg orange= 1.3 liter juice

Preparation of Whey

- Milk (1 Lt) was brought to a boil.
- A pinch of citric acid was added to it.
- It was allowed to simmer for five minutes.
- The whey was collected by straining and was immediately cooled.

Preparation of butter milk

- Curd was measured and water was added to it (curd: water: 2:1)
- It was churned well in a mixie.
- A few cubes of ice were added and churned, to chill the mixture.
- Butter that lumped on the top was separated.
- Remaining liquid was passed through a strainer to collect the buttermilk.

Preparation of sugar syrup

- 400g of sugar was taken.
- 250ml of water was added to it and the mixture was put on a flame.
- It was heated with continuous stirring for 15 minutes.

In totality four recipes were standardized which has been mentioned below:

Orange juice with whey

S. No	Ingredients	Amount (ml)			
		10%	20%	30%	40%
1	Orange juice	80	70	60	50
2	Whey	10	20	30	40
3	Sugar syrup	10	10	10	10

In secondary processing the premeasured ingredients were mixed in the ratios given in table. These were blenderized in a semi-automated food processor.

Processing for Preservation

The beverages thus obtained were heated to 80 C for 2-3 seconds. These were immediately cooled and bottled in pre sterilized bottles. These bottles were placed in a water bath and subjected to the heat of boiling water for 30 minutes. The bottles were cooled immediately and stored.

Storage and Use of Beverages

Fresh beverages were subjected to sensory evaluation. One bottle of each beverage was refrigerated while another one was stored at room temperature for 24 hours. Both of these were subjected to sensory analysis on first day and the refrigerated ones were evaluated for sensory attributes on 5th, 10th, and 15th day of storage. The beverages were analyzed for total solids, fat, protein, ascorbic acid, acidity, ash content.

Sensory Evaluation

The sensory testing requires human judges who were selected by using triangle difference test. Triangle difference test was conducted to screen 35 PG students of home science faculty for their testing and discriminating ability. The 15 judges selected by triangle test evaluated the test product. Sensory evaluation was done using two kinds of test-(1) Hedonic Test (2) Rating Test In hedonic test the panelists were asked to measure the degree of pleasurable and unpleasurable experience of the food product on a nine point scale ranging from "like extremely" to "dislike extremely". The former carried a score of nine while the latter was scored as one.

In rating test the judges were presented with a score sheet which contained a rating scale of 1-5 against the various attributes (appearance, color, aroma, mouth feel, after taste) of the product were to be measured.

Chemical Analysis

Chemical analysis was done for total solids (Sharma 1993)^[10], fat content was estimated by blorr method. Biuret method was used for protein estimation. Ascorbic acid by titrametric method, titrable acidity and mineral ash content (NIN, 2003)^[8] were also done.

Statistical analysis

The statistical methods used for analysis of data regarding the present investigation were: Mean, Standard Deviation.

Results and Discussion

This work was an attempt to develop fruit based beverages which had been enhanced in nutritive value by the addition of whey. All these beverages were tested for sensory characteristics and chemical analysis.

Sensory Evaluation

Sensory evaluation was done by a semi trained panel of 15 judges. The score of two tests (5 point rating, 9 point hedonic) have been averaged for the whole panel. The drinks were subjected to rating test when freshly prepared, on 24 hours of storage, both refrigerated and room, temperature, and on 5th, 10th, and 15th day of storage (refrigerated).

5 Point Rating Test

The rating test scores of four beverages varying in the percentage of whey incorporated is being discussed here:

Orange juice with 10%

The means for various attributes on different days of evaluation have been presented in table 1.1.1.

Sensory Evaluation

Table 1.1- Rating Test

The means for various attributes on different days of evaluation have been presented in table-

Table 1.1.1: Orange juice with whey 10%

	Fresh	24 hrs refrigerated	24 hrs non-refrigerated	5 days refrigerated	10 days refrigerated	15 days refrigerated
Appearance	4.46±0.51	4.53±0.51	4.40±0.50	3.93±0.79	3.33±0.66	2.13±0.63
Color	4.33±0.61	4.33±0.66	4.33±0.61	4.06±0.59	3.73±0.70	3.06±0.70
Aroma	4.26±0.59	4.53±0.51	4.26±0.59	3.80±0.56	3.40±0.50	2.53±0.51
Mouth feel	4.13±0.63	4.60±0.50	4.40±0.63	3.73±0.88	3.00±0.65	2.40±0.50
After taste	3.93±0.79	4.46±0.51	4.33±0.61	3.93±1.03	3.20±0.56	2.46±0.51

(MEAN±SD)

Appearance-The product appeared orange in color and was translucent. 24 hrs refrigerated sample scored 4.53 amounting to 'good' acceptability which was even better than the fresh one. On storage, there was slight decrease in the mean value. On 15th day mean were 2.13, suggesting deterioration in appearance.

Color- This beverage had an orange color. The highest mean was 4.33 for freshly prepared, 24hr refrigerated and 24hr without refrigerated sample. On storage a change in color was observed.

Aroma-The aroma was pleasant and the scores were such that it was interpreted to be 'good' initially. Highest mean was 4.53 for 24hr refrigerated beverages. Similar mean value (4.26) was observed for freshly prepared beverages and 24hrs without refrigerated sample. Lowest mean was 2.53 for 15 day refrigerated beverage.

Mouth feel- Highest mean was 4.60 for 24 hrs refrigerated beverage. On storage a change in mouth feel was observed which was also reflected in gradually declining scores.

After taste- 24 hrs refrigerated stored beverage had highest mean value. The mean value 3.93 was obtained for freshly prepared beverage and 5 days refrigerated beverage. Lowest mean was 2.46 for 15 days refrigerated beverage.

This beverage had good appearance, color, and aroma. After 15 days most of the attributes just managed to be graded as 'fair', except color which remained 'good'.

Orange juice with whey 20%

The mean value for different attributes on different days of evaluation has been presented in table 1.1.2.

Table 1.1.2: Orange juice with whey 20%

	Fresh	24 hrs refrigerated	24 hrs non- refrigerated	5 days refrigerated	10 days refrigerated	15 days refrigerated
Appearance	3.93±0.70	4.60±0.50	4.40±0.50	3.60±0.73	2.93±0.59	2.33±0.48
Color	3.73±0.59	4.46±0.83	4.00±0.65	3.66±0.72	3.33±0.61	2.53±0.51
Aroma	3.46±0.63	4.00±0.75	3.86±0.74	3.60±0.63	3.20±0.56	2.66±0.61
Mouth feel	3.60±0.50	4.13±0.63	3.53±0.51	3.06±0.88	2.66±0.61	2.26±0.59
After taste	3.46±0.63	3.66±0.48	3.53±0.51	3.13±1.12	2.66±0.72	2.53±0.63

(MEAN±SD)

Appearance – Highest mean value was 4.60 for 24 hr refrigerated beverage. On storage gradual decline in the mean value was observed.

Color – This beverage had orange color. Highest value was 4.46 for 24 hr refrigerated beverage. There was decline in the mean values till 15 days.

Aroma – Much variation was not observed in the mean.

Mouth feel- Highest value was 4.13 for 24 hr refrigerated sample and lowest value was observed in 15 days stored beverage.

After taste – Highest mean was 3.66 for 24 hr refrigerated sample, and there was slight **feel** – Highest value was 4.13 for 24 hr refrigerated sample and lowest was in 15 days stored beverage difference in the score between 10 days and 15 days stored beverages.

The beverage was good in all attributes and highest mean value was observed for 24 hrs refrigerated beverages.

Orange juice with whey 30%

The mean values of different attributes of developed beverages which were kept for specified days for evaluation, have been tabulated in 1.1.3.

Table 1.1.3: Orange juice with whey 30%

	Fresh	24 hrs refrigerated	24 hrs non-refrigerated	5 days refrigerated	10 days refrigerated	15 days refrigerated
Appearance	4.13±0.35	4.33±0.61	4.06±0.59	3.46±0.74	2.93±0.70	2.26±0.45
Color	3.73±0.59	4.13±0.51	3.93±0.70	3.40±0.98	2.86±0.74	2.20±0.67
Aroma	4.06±0.45	3.60±0.50	3.53±0.51	3.60±0.73	3.13±0.63	1.73±0.59
Mouth feel	4.00±0.65	3.73±0.45	4.13±0.51	2.73±0.96	2.53±0.63	1.93±0.59
After taste	3.46±0.63	3.66±0.81	3.46±0.51	2.66±0.89	2.40±0.63	2.06±0.70

(MEAN±SD)

Appearance – Highest mean was 4.33 for 24 hrs refrigerated beverages indicating its good appearance.

Color – This beverage had light orange color. The mean score of freshly prepared beverage was similar to 24 hrs without refrigerated beverages.

Aroma – The highest mean value was 4.06 for freshly prepared beverages and this was followed by a mean value for 24 hr refrigerated and 5 days refrigerated beverages.

Mouth feel – Variation was observed in the mean values till 15 days. Lowest mean value was 1.93 for 15 days refrigerated

beverage and highest was 4.13 for 24 hrs without refrigerated sample. This being better than its refrigerated counterpart.

After taste – The after taste was interpreted to be fair. The mean score of freshly prepared beverage and 24 hr non-refrigerated beverage was same.

This beverage had many variations in the mean values. After 5 days the scores were lower as compared to fresh beverage and the lowering continued till 15th day.

Orange juice with whey 40%

The mean values for various attributes and results of evaluation on specified days have been presented in table 1.1.4.

Table 1.1.4: Orange juice with whey 40%

	Fresh	24hrs refrigerated	24hrs non- refrigerated	5 days refrigerated	10 days refrigerated	15 days refrigerated
Appearance	2.93±0.70	3.13±0.63	2.93±0.59	3.26±0.59	2.53±0.51	1.73±0.59
Color	2.73±0.59	2.66±0.61	2.73±0.59	2.73±0.45	2.53±0.51	1.66±0.48
Aroma	2.80±0.41	2.53±0.51	2.86±0.51	3.20±0.56	2.73±0.59	1.60±0.63
Mouth feel	2.80±0.67	2.93±0.59	2.93±0.70	3.40±0.73	2.93±0.59	2.00±0.65
After taste	2.33±0.48	2.46±0.51	2.46±0.51	3.20±0.56	2.60±0.63	1.93±0.70

(MEAN±SD)

Appearance – The appearance was not good. Same value was seen in (2.93) freshly prepared beverage and 24 hr without refrigerated beverage.

Color – This beverage had a light orange color. Highest mean value was (2.73) similar for fresh, 24hr without refrigerated and 5 days refrigerated beverages.

Aroma – The aroma was not good. The fresh and 24hr stored beverages had lower scores than the ones obtained on 5th day of storage.

Mouth feel – Mouth feel was fair. Mean was same (2.93) in 24 hr refrigerated and 24hr without refrigerated sample.

After taste – Two means were same, observed in 24 hr refrigerated beverage and 24hr non-refrigerated beverages (2.46).

Among all whey added orange juices this one had lowest acceptability.

Hedonic Test

The overall acceptability depends on the concentration or amount of particular component, the nutritional and other hidden attributes of a food and its palatability or sensory quality. Nine point hedonic scales were used by the panelists to assess and evaluate the overall acceptability of all

beverages. The 9 point hedonic test scores (means) of beverages have been presented in table 1.2.

Orange juice with whey 10%

The 9 point hedonic test scores (means) of orange juice + whey (10%) have been presented in table 1.2.1. The highest sensory quality was of the product stored in refrigerated and evaluated after 24 hrs of storage. Same mean was (8.53) observed in freshly prepared and 24 hrs non-refrigerated beverage. The decreasing mean with increasing storage time with the beverage still being 'liked slightly' after a storage period of 15 days.

Table - 1.2 - Hedonic test

Table 1.2.1: Orange juice with whey (10%)

Orange juice with whey	Mean ± SD
Fresh	8.53±0.51
24 hrs refrigerated	8.73±0.45
24 hrs non-refrigerated	8.53±0.51
5 days refrigerated	7.86±0.74
10 days refrigerated	6.93±0.59
15 days refrigerated	6.20±0.56

Orange juice with whey 20%

24 hrs refrigerated beverage was 'liked highly' by the panelists. Mean score was similar in freshly prepared

beverage and 24 hr non-refrigerated beverage. Table 1.2.2. Shows the decreasing means of the beverage acceptability after storage beyond 24 hrs.

Table 1.2.2: Orange juice with whey 20%

Orange juice with whey	Mean \pm SD
Fresh	7.80 \pm 0.56
24 hrs refrigerated	8.33 \pm 0.48
24 hrs non-refrigerated	7.86 \pm 0.83
5 days refrigerated	7.53 \pm 0.91
10 days refrigerated	6.93 \pm 0.70
15 days refrigerated	6.13 \pm 0.63

Orange juice with whey 30%

Mean was highest in the beverage analyzed after 24 hrs and stored at room temperature (7.80) suggesting that it was 'liked highly' by the majority of the panelists (table 1.2.3). The product deteriorated in sensory qualities which are indicated by a low mean of 5.26 on 15th day.

Table 1.2.3: orange juice with whey 30%

Orange juice with whey	Mean \pm SD
Fresh	7.66 \pm 0.48
24 hrs refrigerated	7.73 \pm 0.59
24 hrs non-refrigerated	7.80 \pm 0.56
5 days refrigerated	6.93 \pm 0.79
10 days refrigerated	6.33 \pm 0.61
15 days refrigerated	5.26 \pm 0.79

Orange juice with whey 40%

The mean value of 24 hrs non-refrigerated and 24 hrs refrigerated beverages were slightly higher than the freshly prepared beverages and the beverage evaluated after storage of 5 days obtained the highest score.(table 1.2.4). Further storage resulted in rapid deterioration of quality. The lowest mean value was 5.13 for 15 days refrigerated beverage.

Table 1.2.4: Orange juice with whey (40%)

Orange juice with whey	Mean \pm SD
Fresh	6.73 \pm 0.45
24 hrs refrigerated	6.86 \pm 0.63
24 hrs non-refrigerated	6.80 \pm 0.67
5 days refrigerated	6.93 \pm 0.70
10 days refrigerated	6.60 \pm 0.63
15 days refrigerated	5.13 \pm 0.99

Nutrient Analysis

The beverages made as a part of this study were analyzed fresh for total solids, fat, protein, ascorbic acid, acidity and ash. The result has been discussed below:

Table 2: Nutrient Analysis

	10%	20%	30%	40%
Total Solids (%)	16.15	15.00	15.00	12.94
Fat (g %)	0.60	0.70	1.20	1.70
Protein (g %)	0.63	0.90	1.51	1.83
Ascorbic acid (mg)	4.28	3.82	2.74	1.14
Acidity (%)	0.53	0.50	0.45	0.44
Ash (g %)	0.60	0.10	0.50	0.70

Total solids: The total solids of orange juice + whey beverages have been presented in table 2. In these beverages there was decrease in TS with increase in the concentration of whey. Highest value was 16.15 for 10% beverage. Same value

was observed for 20% and 30% beverage and lowest value was 12.9 obtained for the beverage containing 40% whey.

Fat: Fat content of orange juice rose with the increase in the concentration of whey. Difference was observed in 10% and 20% beverage. Highest fat content was 1.7 for 40% beverage. Table 2 shows that the lowest mean is 0.6 for 10% beverage. From the result it can be inferred that all the beverages are low fat drinks and are appropriate for weight conscious individuals.

Protein: Addition of milk based product adds to protein content. The concentration of protein in orange juice whey beverage was found to be increasing due to incorporation of whey which is illustrated in table 2. Highest mean was 1.83 for 40% beverage. Much difference in 10% and 20% beverage. Lowest value was 0.68 for 10% beverage. Addition of whey increments the protein content of juices which is evident from a linear rise in protein with an increase in proportion of whey. On an average all these beverages have low protein but the protein of milk, particularly that of whey have tremendous health benefits. Even when consumed in small amounts on regular basis as a part of lifestyle these proteins assert their therapeutic value and render preventive effects on degenerative diseases and related disorders.

Ascorbic acid: The values have been presented in table 2. There was difference in the content of this vitamin in various orange juice whey beverages. The highest ascorbic acid value was 4.28 for 10% beverage and lowest was 1.14 for 40% beverage. With the increasing proportion of whey decreasing value was observed.

The result shows that the highest content was observed in 10% beverage. With the increasing proportion of whey a receding value was noticed. Fruits, particular the citrus ones are a rich source of vitamin c while milk product is not.

Acidity: In orange juice whey beverage there was not much different in acidity values. Value was similar in 10% and 20% beverage or 30% and 40% beverages. Highest mean value was 0.53 for 10% beverage. The value varied between 0.53-0.44(table 2).

Ash content: Highest value was 0.7 for 40% beverage. Lowest value was 0.1 for 20% beverage. There was a difference in 10%, 30% and 40% beverages (table 2). Ash signifies the mineral content of the food.

Summing up the results, it could be inferred that the orange juice with whey 10% and 20% has fair nutritional composition and good acceptability, therefore, this set of beverages are likely to be accepted by the consumers as a health drink.

Conclusions

The present study was designed and conducted to develop beverages using fruit juices and whey; and to appraise their sensory and nutritional quality.

The results of the analysis of the beverages were as follows:

Sensory Test

Rating test (5 point): Appearance was 'very good' in 20% whey beverage. Highest mean value was 4.60 (24hr refrigerated). The mean values varied between 4.60 to 1.73 and lowest value was observed for 40% (15 days) beverage.

- Color was 'good' in all beverages, the range of mean being 4.46-1.66. Highest value was obtained for 20% (24hrs refrigerated) whey beverage.
- Aroma was 'good' in 10% beverage and the highest mean was 4.53 in 24hr refrigerated product. The lowest value was computed for 40% (15 day storage) beverage (1.60).
- Mouth feel was 'good' in 10% product lowest value was seen in 30% whey added beverage that was 1.93.
- In after taste the highest value was seen (4.46) in 24hr refrigerated beverage. The mean value varied between 4.46 to 1.93. The lowest value was seen in 40% (15 day refrigerated) beverage.

Hedonic Test (9 Point): Over all acceptability was 'liked extremely' in 10% and 20% beverage and 30% and 40% products were 'liked moderately'. Highest value was 8.73 and lowest value was 5.13 in 40% (15 days refrigerated) beverage.

Chemical analysis

Total solids: Total solids content was in the range of 16.15 to 12.94. The highest value was seen in 10% beverage. The scores decreased with the increase in the concentration of whey.

Fat: All the beverages were low in fat. The content rose with an increment in the concentration of whey. Similar value was found in 30% and 40% beverage. The fat content was in the range of 0.60 to 1.20.

Protein content: Increased within increase in the concentration of whey. The range was 0.63 to 1.83g%. The lowest value was seen in 10% beverage and the highest value was 1.83 in 40% beverage.

Ascorbic acid: Content was highest in 10% beverage. With the increasing proportion of whey ascorbic acid content decreased. The ascorbic acid was in the range of 4.28 to 1.14mg%.

Acidity was higher (0.53) in 10% beverage. The lowest value was seen in 40% beverage. The content was decrease with an increase in the concentration of whey The range in between 0.53 to 0.44%.

Ash content – In beverages the score range varied between 0.10 to 0.70g%.The lowest range was seen in 20% beverage (0.10g%) and the highest was 0.70g% in 40% beverage.

Thus the following conclusions could be drawn from the results of the study.

1. Over all acceptability of the beverages is very good. Its color, aroma, appearance is appropriate.
2. Acceptability declined on storage.
3. Addition of whey resulted in increase in estimated protein value.
4. All the beverages were low in fat.
5. The ascorbic acid level was low and the content decreased as the amount of whey increased.
6. Orange juice with whey have good acceptability fair protein and low fat, therefore, these can be judged better.

It was interpreted that orange juice with whey was of good nutritional composition, which could be recommended to consumers as health and refreshing drink.

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