International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 2147-2151

Received: 28-05-2019
Accepted: 30-06-2019

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Technological development and quality evaluation of beverages by incorporation of aonla and beet root juice in paneer whey

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Abstract
Whey is the valuable by-product obtained during the manufacture of cheese, paneer, chhana, casein in dairy industries. Whey contains significant amounts of proteins and lactose, which have high nutritional value. Aonla fruit is the richest source of vitamin C. Pectin and minerals like iron, calcium and phosphorus are also found abundantly in aonla fruit. The beet roots are also high in protein content. The use of whey, aonla juice and beet root juice blends of whey beverages was studied. In the present investigation treatment T_0, T_1, T_2 and T_3 were formulated in which whey beverage was prepared by using whey, beet root juice and aonla juice was in the ratio of (100:00, 93:3:4, 92:4:4 and 91:5:4) respectively. Various analysis parameters were analyzed by two way ANOVA to obtained a predicted optimum result prepared whey beverages was subjected to physico-chemical and microbiological analysis to evaluate the higher percentage in the sample of fat T_0 (0.37), protein T_3 (4.74), ash T_3(1.30%), Total Solid T_3(8.66), acidity T_1(1.50), moisture T_0 (91.94) and pH value was higher in T_3(4.06), ascorbic acid (mg/100ml) T_1(0.67) and T.S.S. (^{0}Brix) value T_3(1.05) of whey beverages whereas SPC (x10^3cfu/ml) was recorded higher in T_3 (11.80) and coliform was nil in all treatment samples. Based on the result it was indicated that beneficial component of high protein in green whey and made them more favorable choice for dairy technologist to develop whey beverages.

Keywords: Paneer whey, Aonla, beet root, honey, fat, protein

Introduction
Whey is the valuable by-product obtained during the manufacture of cheese, paneer, chhana, casein in dairy industries. Milk whey is the liquid that remains from casein precipitation during cheese manufacturing (Magalhaes *et al*., 2010) [20]. It is a by-product from cheese industry (Baldissera *et al*., 2011; Khurana and Kanawjia, 2007) [6, 17], which corresponds to between 70 and 90 % of total milk entering the process and it contains around 50 % of the nutrients from the raw material, including soluble protein, lactose, vitamins and minerals (Bylund 2003) [7]. Whey contains significant amounts of proteins and lactose, which have high nutritional value (Antunes *et al*., 2007) [4]. Milk whey composition depends on several factors like type of cheese being processed, the method of casein precipitation, milk thermal treatment, storage after milking, among others (Johansen *et al.*, 2002; Lucas *et al.*, 2006) [14, 19]. Whey proteins have an excellent biological value and It is easily digestible, so that sufficient numbers of these amino acids reach the body's cells to permit them to make the proteins they need.

Aonla is the fruit of deciduous tree mainly found in India. Aonla belongs to the family *Euphorbiaceae.* The aonla fruit is fibrous in nature. Aonla is a fruit and are the richest source of natural vitamin C. Pectin and minerals like iron, calcium and phosphorus are also found abundantly in aonla fruit. Aonla primarily contains tannins, alkaloids, phenolic compounds, amino acids and carbohydrates. Tannins in aonla include Phyllaemblicin B, emblicanin A, emblicanin, punigluconin and pedunculagin (Ghosal *et al*., 1996) [13]. Due to high vitamin C content of Aonla has anti oxidative properties. It is a very powerful anti-inflammatory herb. Fresh fruit of aonla is rich source of ascorbic acid and appreciable source of total sugar, calcium, iron, phosphorus and also has great potential for processing (Khan 2009) [16]. Aonla also has medicinal and therapeutic properties. Aonla has been considered the best of the Ayurvedic rejuvenated herbs. Uniquely, Aonla has a natural balance of sweet, sour, pungent, bitter and astringent tastes all in one fruit, it stimulates the brain to rebalance the three main components of all physiological functions like water, fire and air elements within the body (Bajracharya 1979) [5].

Beetroot (*Beta vulgaris*) is belongs to *Chenopodiaceae* family and has several varieties with bulb colors ranging from yellow to red. Deep red-colored beet roots are the most popular for human consumption for both cooked and raw as salad or juice. Beetroot is growing as natural food colors. The root of the beet plant is used as a cooked vegetable, is manufactured into sugar, or is processed into pharmaceuticals, while the tops are used as a leafy green vegetable. It is important in the sugar industry and providing more than 40 percent of the raw materials used in the world for the manufacture of raw sugar (Koljajic, *et al.,* 2003) [18]. 20 percent of the world's sugar production comes from beets (FAO, 2009) [12]. Beet leaves contains high protein, good digestive aids and contain mineral compounds that help complete deficiencies of both micro and macro elements (Dzida, *et al.,* 2011) [10]. The beet roots are also containing high in carbohydrate (Ahmad *et. al*, 2012) [2]. Beetroot is also contributed to consumers' health because it is known to have antioxidants properties. It contains nitrogen pigments called betalains, mainly comprise of red–violet colored betacyanins and yellow–orange-colored betaxanthyns (Alard *et al.* 1985; Kaur and Kapoor 2002) [3, 15]. Betalains are particularly suitable for use colouring food products (Cai *et al*., 2001; Roy *et al*., 2004) [8, 21]. Betalain pigment mixtures can be used as a natural additive for food, drugs and cosmetic products in the form of beet juice concentrate or beet powder (Dornenburg and Knorr, 1996) [9]. The beet is well adapted to many environmental conditions, is very resistant to cold and is fairly tolerant of heat and saline conditions (Abdel-Mawly and Zanouny, 2004; Ahmad *et al*., 2012) [2]. The sugar beet is considered as important alternative to sugarcane, particularly in the temperate zones where sugarcane is not grown.

Materials and Methods

The present study was carried out in the research lab of "Cyto Gene Research and Development" B – Block Chauraha, Indra Nagar, Lucknow, India – 226016 and in the Research lab of Dairy Technology, Warner College of Dairy Technology, SHUATS, Prayagraj, U.P.

Procurement and collection of ingredients: Paneer Whey**,** Aonla Juice and Beet root were collected from the local market Bhoothnath, Indra Nagar, Lucknow and Allahabad.

Treatment combination

T_0 -Control prepared from whey (100%)
T_1 –Experimental sample prepared from whey, beet root juice and aonla juice (93:3:4)
T_2 –Experimental sample prepared from whey, beet root juice and aonla juice (92:4:4)
T_3 –Experimental sample prepared from whey, beet root juice and aonla juice (91:5:4)
The product were made by using different combinations as T_1, T_2 and T_3 and follow as per the flow diagram mentioned hereunder. (As per procedure Srivastava *et al*., 2018 with slightly modification)

Preparation of Paneer whey

Buffalo milk standardized (6% fat and 9% SNF) and heated at 90 ^{0}C, cooled at 72 ^{0}C then addition of coagulant citric acid @1%, draining and hooping and pressing to obtained whey.

Preparation of Beetroot Juice

Beetroot sorted and peeled, rewashed and sliced (2-3mm thick) then juice extracted, filtration by using muslin cloth and obtained beetroot juice.

Preparation of Aonla Juice

Mixing with strained syrup solution and heated, homogenization and sterilization and filled in tetra pack and cooling and storage.

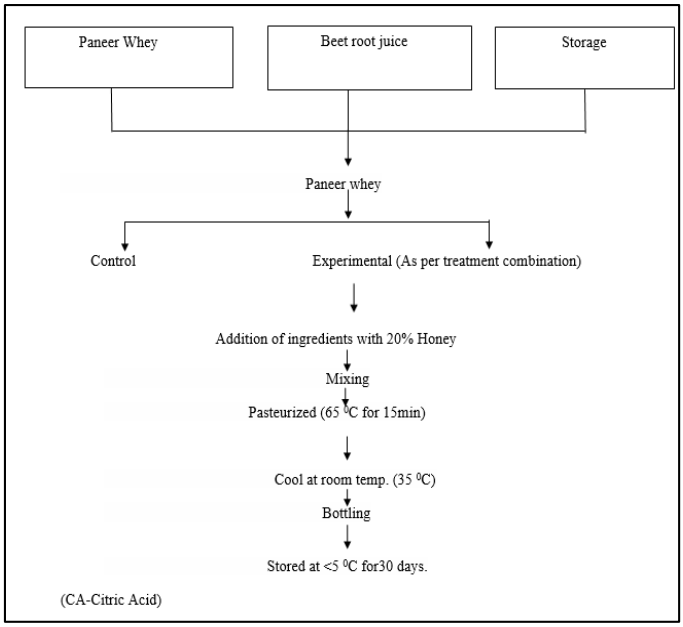

Fig 1: Flow diagram for preparation of whey beverage

Chemical analysis-: Protein: was determined by Lowry's method (AOAC, 1990)**.** Ascorbic acid was determined by DCPIP method (AOAC, 1990)**.** Fat was determined by hydrolysis method (AOAC, 2000**).** Total solid was determined by difference method (FSSAI Laboratory Manual1). Ash was determined by cheering method according to AOAC (1990)**.** Total soluble solids was determined by the hand refractometer Official method 138.15 (1993). Acidity was determined by the titration method mentioned in AOAC 17th edn,2000, Official method 942.15. pH was determined by digital pH meter.

Microbiological analysis-: Standard plate count: (Nutrient agar): Bacterial count was determined as per procedure laid down in IS:1947 Part 3 and manual in food bacteriology, ICAR Publications (1972) and Coliform count: (MacConkey agar) was determined as per procedure laid down in IS: 1947 Part 3 and manual in food bacteriology, ICAR Publications (1972).

Statistical Analysis-: The Data was analyzed using Analysis of Variance (ANOVA) technique and Critical difference (C.D.) in WASP software and excel software.

Results and Discussion

The data collected on the different aspects were tabulated and analyzed statistically using the method of analysis of variance and critical difference technique. The significant and non-significant differences observed have been analyzed critically within and between the treatment combinations. The analyzed data is presented under the Physico-chemical, Microbial and Statistical analysis.

Table 1: Average data for different parameters of control and experiments (in percent) of whey beverage

Parameters	Treatment			
	T_0	T_1	T_2	T_3
1. Physico-chemical analysis				
Fat (%)	0.37±0.04	0.32±0.03	0.31±0.02	0.28±0.03
Protein (%)	4.65±0.02	4.70±0.04	4.73±0.04	4.74±0.14
Ash (%)	1.22±0.03	1.26±0.02	1.28±0.01	1.30±0.02
Total solids (%)	7.77±0.42	8.38±0.07	8.53±0.02	8.66±0.03
Acidity (%) LA	1.35±0.02	1.50±0.07	1.34±0.23	1.15±0.03
Moisture (%)	91.9±0.23	91.6±0.09	91.4±0.02	91.3±0.03
pH	3.97±0.02	4.05±0.03	4.04±0.02	4.06±0.03
Ascorbic acid (mg/100ml)	0.00±0.00	0.67±0.02	0.67±0.02	0.66±0.02
Total soluble solids (^{0}Brix)	0.21±0.21	0.65±0.03	0.86±0.02	1.05±0.02
2. Microbiological analysis				
SPC (x10^{3}cfu/ml)	10.0±1.58	9.2±0.83	10.2±1.30	11.8±0.83
Coliform	Nil	Nil	Nil	Nil

Chemical characteristics of control and experimental value of whey beverages by incorporation of Aonla and Beet root juice in Paneer whey.

Fat percentage in sample of different treatments of whey beverage

The data regarding fat percent in control and experimental of whey beverage of different treatments are presented in table 1. It was statistically analyzed that mean value of whey beverage of T_0, T_1, T_2 and T_3 was found to be 0.37, 0.32, 0.31 and 0.28 respectively. Fat percentage in samples of different treatments and control, the highest mean was recorded in the sample of T_0 (0.37) followed by T_1 (0.32), T_2 (0.31) and T_3 (0.28). Earlier, Dyanchenko (2006) [11] observed that whey based herbal mango pulp beverages was richer in fat. Whey beverage indicates that increased in proportion of aonla and beet root juice in the blend decreased the fat percentage of whey beverage with significant differences ($P < 0.05$).

Protein percentage in sample of different treatments of whey beverage

The mean value of protein for whey beverage of T_0, T_1, T_2 and T_3 was found to be 4.65, 4.70, 4.73 and 4.74 respectively. Protein percentage in samples of different treatments and control, the highest mean protein percentage was recorded in the sample of T_3 (4.74) followed by T_2 (4.73), T_1 (4.70) and T_0 (4.65). The finding are slightly lower in protein to those observed by Verma *et al*., (2010) [22] that utilization of paneer whey for the preparation of whey corn flour soup. It was observed that mean treatment values was increased from T_0 to T_3 experimental samples after increased in proportion of aonla and beet root juice in the blend of whey beverage.

Ash percentage in sample of different treatments of whey beverage

The mean value of ash for whey beverage of T_0, T_1, T_2 and T_3 was found to be 1.22, 1.26, 1.28 and 1.30 respectively. Ash in samples of different treatments and control, the highest mean Ash percentage was recorded in the sample of T_3 (1.30) followed by T_2 (1.28), T_1 (1.26) and T_0 (1.22). Whey beverage indicates that increased in proportion of aonla and beet root juice in the blend, increased the ash percentage of whey beverage with significant differences ($P < 0.05$). The significant difference was further analyzed statistically to find out the C.D. between and within the different treatment combinations. The difference between the mean values of T_0-T_1 (0.03), T_0-T_2 (0.05), T_0-T_3 (0.07), T_1-T_2 (0.04), T_1-T_3 (0.04) and T_2-T_3 (0.02) was greater than the C.D. value, 0.01 Therefore, the difference was significant.

Total Solids percentage in sample of different treatments of whey beverage

The mean value of total solid percentage for whey beverage of T_0, T_1, T_2 and T_3 was found to be 7.77, 8.38, 8.53 and 8.66 respectively. Total Solids percentage in samples of different treatments and control, the highest mean Total Solids percentage was recorded in the sample of T_3(8.66) followed by T_2(8.53), T_1(8.38) and T_0(7.77). The finding are similar to those observed by Verma *et al*., (2010) [22] that utilization of paneer whey for the preparation of whey corn flour soup. Whey beverage indicates that increased in proportion of aonla and beet root juice in the blend, increased the total solid percentage of whey beverage with significant differences ($P < 0.05$).

Acidity percentage in sample of different treatments of whey beverage

The mean value of acidity percentage for whey beverage of T_0, T_1, T_2 and T_3 was found to be 1.35, 1.50, 1.34 and 1.15 respectively. Acidity percentage in samples of different treatments and control, the highest mean acidity percentage was recorded in the sample of T_1 (1.50) followed by T_0 (1.35), T_2 (1.34) and T_3 (1.15). The ANOVA result shows that the F (Cal) value (5.25) was greater than the table value of F (3.49) at 5% level of significance. Therefore, the difference was significant, indicating significant effect of treatments on acidity percent. The significant difference was further analyzed statistically to find out the C.D. between and within the different treatment combinations. The difference between the mean values of T_0-T_3 (0.19) and T_1-T_3 (0.34) was greater than the C.D. value, 0.19 Therefore, the difference was significant. The difference between the mean values of T_0-T_1 (0.14), T_0-T_2 (0.01), T_1-T_2 (0.16) and T_2-T_3 (0.18) was lower than the C.D. value, 0.19 Therefore, the difference was non significant.

Moisture percentage in sample of different treatments of whey beverage

The mean value of whey beverage of T_0, T_1, T_2 and T_3 was found to be 91.94, 91.61, 91.47 and 91.34 respectively. Moisture percentage in samples of different treatments and control, the highest mean moisture percentage was recorded in the sample of T_0 (91.94) followed by T_1 (91.61), T_2 (91.47), T_3 (91.34). Whey beverage indicates that increased in proportion of aonla and beet root juice in the blend decreased the moisture percentage of whey beverage with significant differences ($P < 0.05$). The significant difference was further analyzed statistically to find out the C.D. between and within the different treatment combinations. The difference between the mean values of T_0-T_1 (0.33), T_0-T_2 (0.47), T_0-T_3 (0.60), T_1-T_3 (0.27) and T_2-T_3 (0.17) was greater than the C.D. value, 0.17 Therefore, the difference was significant. The difference between the mean values of T_1-T_2 (0.14) was lower than the C.D. value, 0.17 Therefore, the difference was non significant.

pH in sample of different treatments of whey beverage

The mean value of pH for whey beverage of T_0, T_1, T_2 and T_3 was found to be 3.97, 4.05, 4.04 and 4.06 respectively. pH in samples of different treatments and control, the highest mean pH was recorded in the sample of T_3 (4.06) followed by T_1 (4.05), T_2 (4.04) and T_0 (3.97). The finding are lower

observed by Verma *et al*., (2010) [22] that utilization of paneer whey for the preparation of whey corn flour soup.

Ascorbic acid in sample of different treatments of whey beverage

The mean value of ascorbic acid value for whey beverage of T_0, T_1, T_2 and T_3 was found to be 0.00, 0.67, 0.67 and 0.66 respectively. Ascorbic acid value in samples of different treatments and control, the highest mean Ascorbic acid value was recorded in the sample of T_1 (0.67) followed by T_2 (0.67), T_3 (0.66) and T_0 (0.00). The result of ANOVA shows that the F (Cal) value (1743.19) was greater than the table value of F (3.49) at 5% level of significance. Therefore, the difference was significant, indicating significant effect of treatments on ascorbic acid percent.

T.S.S. in sample of different treatments of whey beverage

The mean value of T.S.S. (^{0}Brix) value for whey beverage of T_0, T_1, T_2 and T_3 was found to be 0.21, 0.65, 0.86 and 1.05 respectively. T.S.S. value in samples of different treatments and control, the highest mean T.S.S. value was recorded in the sample of T_3 (1.05) followed by T_2 (0.86), T_1 (0.65), T_0 (0.21). Whey beverage indicates that increased in proportion of aonla and beet root juice in the blend increased the pH content of whey beverage with significant differences ($P < 0.05$).

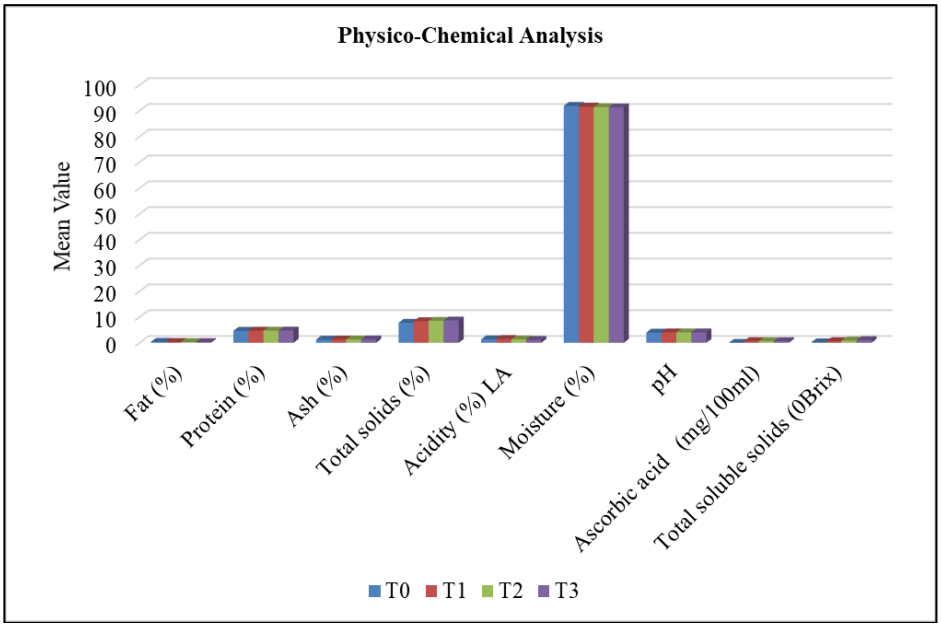

Fig 2: Average data of Physico-Chemical analysis in the samples of control and experimental samples of whey beverage.

Microbiological Analysis

Standard Plate Count in sample of different treatments of whey beverage

The mean value of SPC (x10^{3}cfu/ml) content for whey beverage of T_0, T_1, T_2 and T_3 was found to be 10.00, 9.20, 10.20 and 11.80 respectively. SPC in samples of different treatments and control, the highest mean SPC content was recorded in the sample of T_3 (11.80) followed by T_2 (10.20), T_0 (10.00), T_1 (9.20). The significant difference was further analyzed statistically to find out the C.D. between and within the different treatment combinations. The difference between the mean values of T_0-T_3 (1.80) T_1-T_3 (2.60) T_2-T_3 (1.60) was greater than the C.D. value, 1.42 Therefore, the difference was significant. The difference between the mean values of T_0-T_1 (0.80), T_0-T_2 (0.20) and T_1-T_2 (1.00) was lower than the C.D. value, 1.42 Therefore, the difference was non significant.

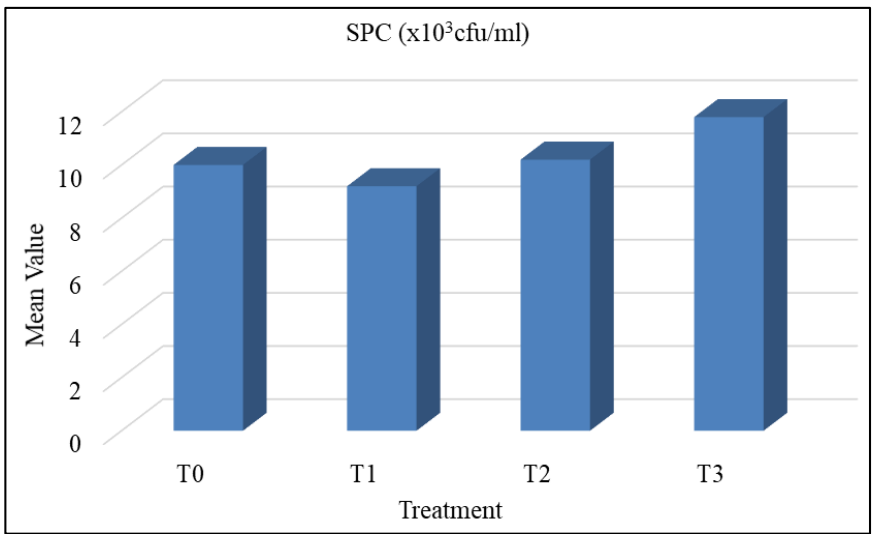

Fig 3: Average score of SPC in the samples of control and experimental samples of whey beverage.

Coliform count in sample of different treatments of whey beverage

Coliform count in control and experimental were found to be absent.

Conclusion

In view of the experimental result obtained during the present investigation, it may be concluded that whey beverages can be successfully prepared by using Aonla and Beet root juice with paneer whey. The moisture percentage highest mean percentage was in the sample of T_0 and lowest was recorded in T_3. Similarly, the ash percentage highest mean was recorded in the sample of T_3 and lowest in T_2. The Ascorbic acid value highest mean was recorded in the sample of T_1 and lowest was recorded T_0. Similarly, the highest mean fat percentage was recorded in the sample of T_0 and lowest in T_3. The highest mean protein, TSS and total solid percentage was recorded in the sample of T_3 and lowest was found in T_0. The Acidity percentage in samples of highest mean was recorded in the sample of T_1 and lowest was recorded in T_3. The pH in samples of different experimental treatments and control, the highest mean pH percentage was recorded in the sample of T_3 and lowest was recorded in sample of T_0. The standard plate count ($x10^3$cfu/ml) score was recorded highest in the sample of T_3 and lowest was recorded in sample of T_1 and the coliform count were found to be absent. This beverage contains significant amount of fat, protein, carbohydrate and ascorbic acid which may be acceptable to the maximum spectrum of consumers. Therefore, aonla and beet root juice can be easily incorporated in Beverage to utilize its nutritional properties and commercial manipulation in the market.

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