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Enrichment of whey drink with vitamin C and calcium

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Abstract: Whey is one of the dairy by-products which are generally disposed into sewage, thus creating major problem of pollution besides loss of valuable nutrients. The process to bring back whey for human consumption involves higher processing costs. Therefore, the aim of the present work was to develop nutritious product by incorporation of gooseberry juice and any of calcium salts as sources of vitamin C and calcium respectively. Whey was subjected to pasteurization at 80°C and blended with gooseberry juice at 15% (w/v) and calcium salts at 5% (w/v) of whey. The product was also added with paste of spices (ginger, curry leaves and green chilly) and salt as required. After processing, the product was cooled, packaged in LDPE sachets and kept for storage at refrigeration temperature. Final product was evaluated for sensory attributes, physico-chemical and microbiological parameters. Comparison of the developed product was made with control (plain spiced whey drink) sample. Observations were made for the enrichment of vitamin C and calcium content. The data obtained was subjected to statistical analysis. The developed product, enriched with vitamin C and calcium can meet the deficiencies in adequate daily intake (ADI) of the same in human beings.
Keywords: Gooseberry, Calcium lactate, Calcium gluconate, Vitamin C, Enrichment

INTRODUCTION:

Whey is the yellow-green serum that is separated from the curd during manufacture of cheese, paneer, chana and casein. Generally whey is unutilized effectively because of its unacceptable taste and high processing costs though rich in valuable nutritional components [1]. Moreover there is growing concern over pollution and environmental control has renewed the pressure on cheese manufacturers to stop dumping whey into streams and municipal sewage systems. Consequently, search has begun again for new methods for utilization of whey. In the light of growing global food shortages, the most logical use would be to return whey to the human food chain in a palatable form [2]. So, whey is enriched with calcium salt and Vitamin C for its better utilization with minimum cost of processing and also to give its benefits to consumers with value addition. Calcium is required for vascular contraction and vasodilatation, muscle function, nerve transmission, intracellular signaling and hormonal secretion, though less than 1% of total body calcium is needed to support these critical metabolic functions. The remaining 99% of the body's calcium supply is stored in the bones and teeth where it supports their structure and function. Daily Values (DVs) were developed by the U.S. Food and Drug Administration to help consumers to compare the nutrient contents among products within the context of a total daily diet. The DV for calcium is 1,000 mg for adults and children aged 4 years and above. Ascorbic acid is another essential nutrient required for collagen synthesis, bone and teeth calcification, healing of wounds, hemoglobin formation, growth and other metabolic functions.

MATERIALS AND METHODS:

Cow milk was procured from University Dairy Plant, Kerala Veterinary and Animal Science University, Mannuthy. Milk was heated in a stainless steel vessel to 95°C followed by cooling to 70°C. The hot milk was acidified by adding two per cent citric acid solution followed by continuous stirring which resulted in the complete coagulation of the milk protein (casein). The liquid (whey) was filtered using muslin cloth [3].

Gooseberries, procured from a local market in Thrissur were cut into small pieces and had the seeds removed. Pieces were added in a mixing jar to obtain paste. The paste was squeezed by wrapping it in a clean cloth manually to separate out the juice. Ginger, chillies and curry leaves were similarly made into paste. Calcium lactate and calcium gluconate salts were used as sources of calcium.

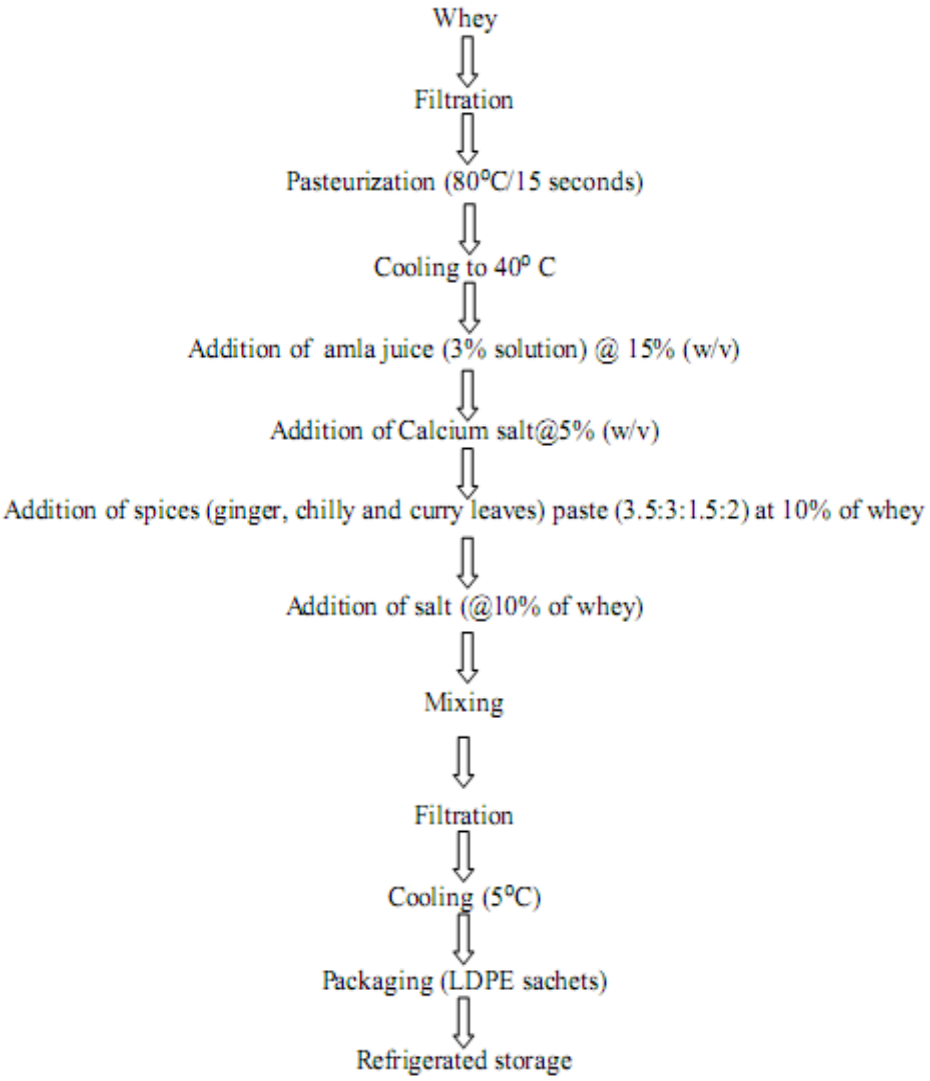

Fig-1: Flow chart for preparation of spiced whey drink with enriched vitamin C and calcium (optimized product)

Whey was filtered through muslin cloth and pasteurized at 80ºC for 15 seconds to destroy spoilage and pathogenic microbes. Then it was cooled to 40ºC and calcium lactate @5% (w/v), diluted amla juice (3% solution) @15% (w/v) were added. The paste of spices and salt were also added directly into whey which was then filtered to remove settled particles. The final product was then packaged in LDPE sachets and was stored at refrigeration temperature.

Physico-chemical, microbiological and sensory analysis:

Analysis of Total soluble solids (TSS) was done as described in Rangana [4]. pH of the developed product was determined by using digital pH meter (Hannah make pH/ORP meter). Titrable acidity of samples was determined by Samee *et al.;* method [5].

The microbiological analysis was carried out through total bacterial count, yeast and mould count and coliform count whose procedures were defined in Harrigan [6].

Vitamin C content was analysed as per redox titration method using Iodine Solution. Pipette out 20 mL of the sample solution into a 250 mL conical flask and add about 150 mL of distilled water and 1 mL of starch indicator solution. Titration was carried with 0.005 mol L^{-1} iodine solution. Endpoint of the titration is identified as the first permanent trace of a dark blue-black colour due to the formation of starch-iodine complex [7].

Calcium content was determined by flame photometer according to procedure given in AOAC (1990). The knob of flame photometer was adjusted to sodium (Na), potassium (K) and calcium (Ca) respectively and reading was set to zero using deionized water. Blank solution was run and reading was again set to zero. Standard solution of calcium was run and reading of flame photometer was recorded. The reading for calcium in developed product was taken by running the samples one by one.

Statistical Analysis:

Data obtained throughout the experiment was analyzed using one way ANOVA as per procedure described by Snedecor and Cochran [8].

RESULTS AND DISCUSSION:

Chemical analysis:

The prepared vitamin C and calcium enriched spiced whey drink was analyzed for chemical parameters like pH, acidity, TSS, calcium and vitamin C contents and were compared with plain spiced whey drink, Vit.C and Calcium enriched spiced whey drink(Calcium gluconate) and plain whey.

The standardized product has shown significant ($p<0.05$) difference in pH compared to plain spiced whey drink and vitamin C and calcium enriched spiced whey drink (Calcium gluconate). But there was no significant difference between optimized product and plain whey. This may be due to higher neutralizing capacity of calcium lactate compared to calcium gluconate. The titrable acidity (TA) of the optimized product significantly ($p<0.05$) differ from all the drinks. The total soluble solids (TSS) of all drinks were significantly higher than plain whey because of addition of spices, amla juice and calcium salt.

Table 1: Chemical composition of various drinks

Drinks	pH	Vitamin C (mg/100ml)	Acidity (%LA)	Total soluble solids	Calcium (ppm)
Plain spiced whey drink	4.98 ± 0.05^{b}	1.27 ± 0.02^{b}	0.35 ± 0.00^{b}	9.47 ± 0.96^{b}	217.625 ± 2.30^{b}
Vit.C and Calcium enriched spiced whey drink (Calcium lactate)	5 ± 0.00^{c}	2.65 ± 0.03^{c}	0.31 ± 0.07^{a}	12.52 ± 0.18^{d}	368.62 ± 0.51^{c}
Vit.C and Calcium enriched spiced whey drink(Calcium gluconate)	4.85 ± 0.03^{a}	2.625 ± 0.5^{c}	0.42 ± 0.00^{c}	12.1 ± 0.07^{c}	500 ± 1.94^{d}
Plain whey	5 ± 0.00^{c}	1.12 ± 0.0^{a}	0.36 ± 0.05^{b}	7.55 ± 0.028^{a}	75 ± 2.04^{a}

*values (mean± SE; n=4) * Superscripts are to be read column wise for mean comparison
*Means with similar superscripts in column do not differ significantly ($p<0.05$).

The calcium and vitamin C contents of optimized product significantly differ from plain spiced whey, obliviously because of addition of calcium lactate and amla juice respectively. Controversially calcium content in optimized product was significantly lower than that of Vit.C and calcium enriched spiced whey drink (Calcium gluconate). There is no significant difference between optimized product and Vit.C and calcium enriched spiced whey drink (Calcium gluconate) in terms of vitamin C content because of equal amount of addition of amla juice in both.

Sensory analysis:

The colour, flavour and mouth feel of the developed product were found to be non significant in all drinks but overall acceptability was significantly higher for optimized product.

Table 2: Sensory evaluation of various spiced whey drinks

Drinks	**Color**	**Flavour**	**Mouth feel**	**Overall acceptability**
Plain spiced whey drink	6.78 ± 0.28^{a}	7.22 ± 0.33^{a}	7.22 ± 0.15^{a}	6.88 ± 0.23^{a}
Vit.C and Calcium enriched spiced whey drink (Calcium lactate)	7.22 ± 0.28^{a}	6.78 ± 0.28^{a}	7.22 ± 0.28^{a}	7.67 ± 0.29^{b}
Vit.C and Calcium enriched spiced whey drink(Calcium gluconate)	7.67 ± 0.29^{a}	7.78 ± 0.36^{a}	8 ± 0.33^{a}	8.22 ± 0.22^{c}

*values (mean± SE; n=9) * Superscripts are to be read column wise for mean comparison
*Means with similar superscripts in column do not differ significantly ($p<0.05$).

Microbiological analysis:

Yeast and mould count in plain spiced, optimized whey drinks and Vit.C and Calcium enriched spiced whey drink (Calcium gluconate) were found to be absent at zero days period storage. The total bacterial count of all drinks varied significantly because of addition of unpasteurized amla juice and spices mix to the pasteurized whey.

Table 3: Microbiological evaluation of various whey drinks

Parameters (cfu/ml)	Plain spiced whey drink	Vit.C and Calcium enriched spiced whey drink (Calcium lactate)	Vit.C and Calcium enriched spiced whey drink (Calcium gluconate)
Total bacterial count	2250 ±28.868[a]	2675±47.87[b]	2750±64.55[c]
Yeast & Mould	Nil	Nil	Nil
Coliforms	Nil	Nil	Nil

*values (mean± SE; n=4) * Superscripts are to be read column wise for mean comparison
*Means with similar superscripts in column do not differ significantly ($p<0.05$).

CONCLUSION:

Above study has revealed that a satisfactorily good quality spiced whey drink can be produced with enriched vitamin C and calcium content. The vitamin C content in whey was found to rise from 1.125 mg/100ml to 2.65mg/100ml when diluted amla juice (3%) solution was added @15% w/v. Similarly, the calcium content increased significantly from 75 ppm to 368 ppm when calcium salt i.e. calcium lactate was added @5% w/v.

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