

RESEARCH ARTICLE

Optimization and quality characterization of *Aloe vera* enriched flavored whey beverage

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Abstract: Whey is a by-product from cheese, channa and paneer industries containing valuable nutrients such as, proteins, vitamins, phosphorus and calcium etc. *Aloe vera* is often called “miracle” plant due to its antiseptic, antibacterial, antiviral, anti-diabetic, anti-carcinogenic, anti-inflammatory, natural healer, improves human immune system and digestive system. So the present study was undertaken to develop functional beverage blend using whey and *Aloe vera* juice. In the present investigation, paneer whey has been used as a base material to prepare flavoured whey beverage by incorporating *Aloe vera* juice. Different concentrations 0, 5, 10, 15 and 20 per cent of *Aloe vera* juice were optimized to prepare whey beverage. The effect of *Aloe vera* juice incorporation on sensory, proximate composition and physicochemical characteristics of control and whey samples were studied. The treatment samples were observed significant different and comparable to control samples on “9 point Hedonic sensory evaluation score card. The overall acceptability of experimental samples was between 7.12-7.40 which was on par with control. From organoleptic scores and colour data, it was observed that no significant difference in colour and taste were perceived in experimental products. Total solids, fat, protein and carbohydrate constituents were reduced marginally due to dilution effect. Titratable acidity and viscosity increased in treatment samples, whereas pH was decreased slightly. However, the incorporation of 15% *Aloe vera* juice showed organoleptically most liked *Aloe vera* enriched flavored whey beverage in terms of sensory quality without adversely affecting the physicochemical properties.

Keywords: *Aloe vera* juice, Whey beverage, Sensory, Viscosity, Acidity and pH

Introduction

Whey is a nutritious by-product from *cheese, channa and paneer* industries containing a range of nutrients, such as protein (serum albumin, immunoglobulins, β -lactoglobulin, α -lactoalbumin), vitamins (thiamine, and riboflavin), phosphorus, magnesium, and calcium. Additionally, whey proteins are fast proteins because of their ability to quickly deliver nourishment to muscles (Bindu Naik et al. 2023). Around 80% of whey comes from *Channa* and *Paneer*; out of which only 2-3 per cent is utilised and rest is drained. Whey constitutes 45-50% of total milk solids, 70% of milk sugar (lactose), 20% of milk proteins and 70-90% of milk minerals and most importantly, almost all the water soluble vitamins originally present in milk (Alane et al. 2017). The conversion of whey in to beverages through fermentation or without fermentation is one of the common methods for the utilisation of whey and can be used for consumption of baby, geriatric and athletic drink. By adding some simple ingredients like sugar, colour, flavours to whey, we can improve the nutritive value, taste and acceptability. Whey contains a diverse range of components, some with high nutritional value and biological activity, which has intensified interest in its utilization (Miloradovic et al. 2025).

The *Aloe barbadensis* miller is botanical name of *Aloe vera* and it belongs to *Asphodelus* (Liliaceae) family. *Aloe barbadensis* Miller is reported to the most biologically active species. *Aloe vera* is well known as a miracle plant. *Aloevera* juice consists of about $97 \pm 0.17\%$ water (Kamble et al. 2022). AV is available in different forms including fresh whole leaf, fresh gel (pulp), juice (sap and extract), and dried gel. It contains over 200 biologically active substances, such as anthraquinones (barbaloin, isobarbaloin, anthranols, aloetic acid), hydrosoluble and liposoluble vitamins, minerals, enzymes, polysaccharides, phenolic compounds, and organic acids (kaur S and Bains K. 2024). *Aloe vera* works as antiseptic, antibacterial, antiviral, anti-diabetic, anti-carcinogenic, anti-inflammatory and natural healer, improves human immune and digestive system (Asif et al. 2022). *Aloe vera* has been used as a functional and therapeutic food, especially for the preparation

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of health food drinks and other beverages. Nitesh et al (2022) formulated the different types of whey beverages and estimate the sensory quality of whey beverages which prepared from camel and goat milk (70%, 30%). The formation of whey beverages blended in various combinations of whey, alovera juice (5%, 10% and 15%), coconut water (5%, 10% and 15%), honey (5%) and black salt (1%).

Materials and methods

Dairy and non-dairy ingredients

Fresh Buffalo milk was procured from Dairy farm at Serikhedi, National Highway -6, Raipur, (C.G). Fresh *Aloe vera* leaves were procured from Centre of Excellence on Medicinal & Aromatic plants and NTFP's of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G). Good quality cane sugar, orange flavour, orange colour and black salt were purchased from the local market of Raipur.

The samples were analyzed for various physicochemical parameters. The pH of beverage samples was determined by using "Digital pH analyzer" as per the procedure. Specific gravity was determined by finding out the weights of a certain volume of sample and of the same volume of distilled water at the same temperature taken in a specific Gravity bottle. The viscosity of the whey, *Aloe vera* and beverage sample was determined by Ostwald viscometer. The fat content of whey, *Aloe vera* juice and beverage sample was estimated by Gerber method. Titratable acidity was titrated against the standard 0.1 N NaOH solution using phenolphthalein as an indicator and the acidity was calculated by using following formula and expressed in terms of per cent lactic acid. Total solids measured by Gravimetric method, protein contents estimated as per the procedure SP: 18, Part XI (BIS, 1961) using the Pelican Kel plus nitrogen estimation system. The A.O.A.C (2005) procedure was adopted for estimating the ash content and was calculated using follows:

$$\% \text{ of ash} = \frac{\text{Weight of crucible dish after ashing} - \text{Weight of empty crucible dish}}{\text{Weight of the sample}} \times 100$$

Preparation of *Aloe vera* juice and paneer

First, the fresh *Aloe vera* leaves were washed and then peeled. After that, its gel was completely homogenized by a mixer. The gel was pasteurized with a water bath at temperature of 70°C for 30 minutes. (Fig. 1) (Nooshi Manjili et al. 2024).

Paneer was prepared by standardizing buffalo milk to 6.0 per cent fat and 9.0 % SNF using the procedure (Kumar S et al. 2014). The whey (Fig.2) obtained during paneer process was used for preparation of control whey beverage (T₀) and *Aloe vera* based whey beverage (Fig.3).

The treatment combinations used for preparation of Whey based *Aloe vera* beverage as depicted in Table 1. The *Aloe vera* juice (AVJ) was incorporated at different levels (0%, 5%, 10%, 15%, 20%), sugar incorporated at constant level @ 10 % (based on preliminary trials, the amount of *Aloe vera* juice incorporation was restricted to a maximum of 20% for final study).

Results and Discussion

Effect of *Aloe vera* juice incorporation on sensory attributes of whey beverage

The sensory characteristic of whey beverage prepared with incorporation of *Aloe vera* is presented in Table 2. The sensory attributes for different treatment samples were evaluated following the 9-point hedonic scale rating. On this scale, 'like extremely' was given the highest score of '9' and 'dislike extremely' is given the lowest score of '1'. A judgment panel of 25 participants comprised of postgraduate students and faculty of 20-60 age group people those who are expertise in judging and grading of food & dairy products of the College of dairy and food technology raipur.

It is evident that *Aloe vera* incorporation did not have any significant influence on colour and appearance (Fig 4) and taste of the product. However, the incorporation had significant (P<0.05) effect on flavour, consistency and overall acceptability of the product. The control had the highest score of 7.54 and differed significantly from T2 and T4 samples but was on par with T1 and T3. Among experimental samples, T3 had the highest

Table 1. Treatment Details and proportions of ingredients

Treatments/ingredients	Per cent				
	T0	T1	T2	T3	T4
Whey	89.3	84.3	79.3	74.3	69.3
<i>Aloe vera</i>	0	5	10	15	20
Sugar	10	10	10	10	10
Black salt	0.5	0.5	0.5	0.5	0.5
Colour	0.1	0.1	0.1	0.1	0.1
Flavour	0.1	0.1	0.1	0.1	0.1
Total	100	100	100	100	100



Fig 1. Aloe vera gel and Aloe vera juice



Fig 2. Buffalo milk, *Paneer* coagulum and whey



Fig. 3 Preparation of *Aloe vera* enriched flavored whey beverage

flavor score of 7.50, while the T4 had the lowest score of 7.19. As compared to control, the lower flavour score in experimental sample might be due to carry over of residual Aloin and Aloe-emod in content from *Aloe vera* juice in to the samples, which might have reduced the flavour score as the level of incorporation of *Aloe vera* juice increased. Similar results found that control beverage had highest score in flavour in whey based ready-to-serve therapeutic beverage from *Aloe debrana* juice developed by Mohammed et al (2021).

Incorporation of *Aloe vera* juice had a significant influence on the consistency score of whey beverage and the values are given in Table 2. It could be seen that T0 (Control) had significantly ($P<0.05$) lowest value of 7.23 for consistency, while the T4 had the highest value of 7.49 for consistency. Among the experimental samples the consistency value ranged from 7.27(T1) to 7.49 (T4). The T1 was on par with the control (T0) in its consistency and differed from the rest of the samples. A significant increase in the consistency score was recorded by addition of above 10 % *Aloe*

vera juice incorporation in the beverage and was found significant from their onwards.

The observed difference in the consistency value of experimental beverage could be accounted to increase in viscosity as AVJ had higher viscosity (3.21 cp) as compared to whey (1.80 cp) which was very well reflected in the mouth feel as recognized by panel of judges. The increase in consistency score might also be due to presence of polysaccharides which has the tendency to increase the viscosity and thereby the consistency of the product. The value on consistency attributes obtained in this study were similar to the Elbandy et al (2014), prepared mango nectar by incorporating *Aloe vera* juice showed increased consistency from 18.6 to 19.2 (out of 20) as the level of *Aloe vera* juice incorporation was increased.

The *Aloe vera* juice incorporation had significant ($P<0.05$) effect on the overall acceptability scores. The control had the highest overall acceptability score of 7.40 and was par with T1, while T4 had lowest overall acceptability score of 7.12. Among the

experimental samples, the T1 overall acceptability score was on par with T2, T3. Though the level of *Aloe vera* juice incorporation increased, the overall acceptability was not statistically significant up to 15 % incorporation. The lowest score in T4 is very well corroborated to its lower score in its colour and appearance, flavor and taste. Sharma Chand Nitesh et al (2022) developed whey beverages with a composition of 79% whey and 15% aloe vera juice (T₁A₃) had obtained maximum overall acceptability (7.54±0.050).

Effect of *Aloe vera* juice incorporation on the Physico-chemical composition of whey beverage:

The observations on effect of *Aloe vera* juice incorporation on the physico-chemical properties of whey beverage are displayed in Table 3. From the Table, it is evident that *Aloe vera* juice incorporation had significant effect on specific gravity, viscosity, ash, total solids (TS), total carbohydrate (TCH), acidity and pH of the experimental whey beverage samples.

It can be observed that specific gravity of the beverage decreased with increase in *Aloe vera* juice incorporation. The control had the highest specific gravity of 1.035 and was on par with T1 and T2. The lowest specific gravity was recorded in T4 beverage (1.024) and significantly ($P<0.05$) differed from T1, T2 and T3.

The decrease in specific gravity value in beverages might be associated to lower total solids in *Aloe vera* juice, that resulted in dilution of whey beverage as the level of AVJ incorporation increased at and above 15 %.

A significant contribution by incorporation of *Aloe vera* juice on viscosity was also observed. The control (T0) had the lowest viscosity of 2.86 cp, while samples T4 had the highest viscosity of 4.11 cp. As the level of *Aloe vera* juice incorporation increased, the viscosity of the beverage samples also increased. The increase in viscosity might be due to the presence of mucilaginous substances and polysaccharides present in *Aloe vera* juice. The addition of *Aloe vera* juice increased the viscosity in yoghurt samples (Ahmed S et al. 2023).

Table 2. Effect of *Aloe vera* juice incorporation on the sensory quality of fresh beverage

Treatments	Colour and appearance (C&A)	Flavour	Taste	Consistency	Overall acceptability(OA)
T0	7.44	7.54 ^A	7.38	7.23 ^A	7.40 ^A
T1	7.35	7.44 ^{AB}	7.36	7.27 ^A	7.34 ^{AB}
T2	7.34	7.41 ^B	7.33	7.38 ^B	7.26 ^B
T3	7.51	7.50 ^{AB}	7.36	7.44 ^C	7.24 ^B
T4	7.39	7.19 ^C	7.31	7.49 ^D	7.12 ^C
F-values	1.38	14.17	0.145	6.88	9.97
SE(m)	0.020	0.074	0.003	0.041	0.045
CD ^s	NS	0.11	NS	0.05	0.10

^s indicates significant at 5 per cent level

The superscript A, B, C indicate the comparison of variables with respect to *Aloe vera* juice incorporation levels based on the CD values.

Table 3. Effect of *Aloe vera* juice incorporation on the physico-chemical quality of fresh beverage

Samples	Per cent								
	Specific gravity	Viscosity (cp)	Fat	Protein	Total solids	Carbohydrates	Ash	Acidity	pH
T0	1.035 ^A	2.86 ^A	0.11	0.41	15.52 ^A	14.40 ^A	0.59 ^A	0.22 ^A	5.08 ^A
T1	1.035 ^A	3.12 ^B	0.09	0.40	15.20 ^B	14.16 ^{AB}	0.53 ^B	0.24 ^B	4.98 ^{AB}
T2	1.033 ^A	3.37 ^C	0.08	0.37	14.93 ^C	13.96 ^{BC}	0.52 ^B	0.26 ^C	4.96 ^B
T3	1.028 ^B	3.62 ^D	0.08	0.35	14.65 ^D	13.69 ^{CD}	0.51 ^{BC}	0.27 ^D	4.84 ^C
T4	1.024 ^C	4.11 ^E	0.07	0.34	14.41 ^D	13.43 ^D	0.48 ^C	0.29 ^E	4.73 ^D
F-Values	22.826	42.865	0.766	14.603	28.629	15.812	9.272	53.597	16.291
SE(m)	0.00	0.922	0.001	0.002	0.765	0.586	0.006	0.003	0.072
CD ^s	0.003	0.226	NS	NS	0.252	0.297	0.040	0.019	0.103

^s indicates significant at 5 per cent level

Values are average of four replications

Table 4.Cost analysis of *Aloe vera* enriched flavored whey beverage

Ingredients	Quantity required(g) for 1000 g of beverage					Rate in Rs./kg	Cost in Rs				
	T0	T1	T2	T3	T4		T0	T1	T2	T3	T4
Paneer whey	893.0	843.0	793.0	749.0	693.0	2.0	1.79	1.69	1.59	1.49	1.39
<i>Aloe vera</i> Juice @ 0, 5, 10, 15,20	0	50.0	100.0	150.0	200.0	25.0	0.0	1.25	2.50	3.75	5.0
Sugar @ 10%	100.0	100.0	100.0	100.0	100.0	40.0	4.0	4.0	4.0	4.0	4.0
Black salt @ 0.5%	5.0	5.0	5.0	5.0	5.0	30.0	0.15	0.15	0.15	0.15	0.15
Color @ 0.1%	1.0	1.0	1.0	1.0	1.0	400.0	0.40	0.40	0.40	0.40	0.40
Flavour @ 0.1%	1.0	1.0	1.0	1.0	1.0	400.0	0.40	0.40	0.40	0.40	0.40
Total weight (g)	1000.0	1000.0	1000.0	1000.0	1000.0	Cost Rs./lit	6.74	7.89	9.04	10.19	11.34

It could be seen from Table 3, the control whey beverage (T0) showed higher values of carbohydrate and pH of 14.40 and 5.08% respectively on par with T1 sample whereas, the total solids (TS) and ash of control differed significantly ($p < 0.05$) when compared with fortified whey samples. Among experimental samples T1 had the highest TS, carbohydrate, ash and pH than other treatments. The significant decrease ($p < 0.05$) of constituents in *Aloe vera* incorporated whey beverage might be due to the dilution effect by addition of *Aloe vera* juice which had lower values in its chemical constituents.

The fat and protein was shown no significant affect by the incorporation of *Aloe vera* juice. *Aloe vera* juice contain tiny amount of 0.02 %fat and 0.12 % protein (Kamble et al. 2022). Acidity increased with increase in *Aloe vera* juice incorporation in whey beverage. Control had the lowest acidity of 0.22 per cent LA, while T4 had the highest acidity of 0.29 % LA. The highest acidity in *Aloe vera* incorporated samples could be attributed to the fact that initially the *Aloe vera* juice itself had higher acid. Mudgil et al (2016) reported that titratable acidity of cultured buttermilk showed an increasing trend with increase in level of *Aloe vera* juice fortification. Sasikumar and Deka (2015) developed Low calorie therapeutic *Aloe vera* RTS beverage and reported that there was an increase in titratable acidity from 0.30 to 0.38 per cent LA and pH values decreased as the increase in *Aloe vera* juice incorporation increased.

As the level of *Aloe vera* juice incorporation increased the pH of the beverage samples decreased 5.08, 4.98, 4.96, 4.84 and 4.73 for T0, T1, T2, T3, and T4 respectively. The control had the highest pH score of 5.08 and was on par with T1, while the lowest pH value was observed in T4 sample. The significant decrease in the above constituent might be due to the addition of *Aloe vera* juice which had lower side in pH value. Kamble et al (2022) reported *Aloe vera* juice had pH 4.47 % which is lower than whey pH. Similar observations were recorded by Biswas S et al (2016) who Development and Quality Evaluation of *Aloe Vera* and Pineapple Juice Blended Beverage.

Cost analysis of *Aloe vera* enriched flavored whey beverage

The Table 4 shows the various ingredients used and their cost in the manufacture of beverage.

Cost of Whey based *Aloe vera* herbal beverage was estimated simply by considering the price of each ingredient. The cost estimates include only the raw materials cost incurred in the preparation of 1000 gm of final beverage. *Aloe vera* was procured at Rs 10.0 per Kg and was converted in to juice as per the procedure. The yield of AVJ was about 40 %. The cost of AVJ was calculated as Rs 25.0 per kg. This AVJ was used for manufacture of beverage by incorporating at different levels. The cost per kg of whey based *Aloe vera* herbal beverage was calculated to be Rs 6.74 (T0), 7.89 (T1), 9.04 (T2), 10.19 (T3) and 11.34 (T4). The higher difference in the cost of experimental samples was attributed to the fact that the raw material *Aloe vera* juice itself had higher cost per liter (Rs 25/-). Though the costs of AVJ incorporated beverages are higher than control, the health benefits derived in terms of therapeutic value from *Aloe vera* juice can be offset.

Conclusions

It can be concluded that *Aloe vera* juice can be utilized for incorporation in whey based beverages. *Aloe vera* juice can be incorporated @ 15 per cent to produce organoleptically good quality *Aloe vera* enriched flavored whey beverage without adversely affecting the sensory and physico-chemical properties of the product. The technologies generated may be explored for value addition to paneer for preparing a product from the by product whey. Though the cost of AVJ incorporated beverages are higher than control, the health benefits derived in terms of therapeutic value from *Aloe vera* juice can be offset. Due to the continuous growth of the dairy industry, large quantities of by-products are produced, mainly whey. Lactose, fat, and proteins constitute the main fraction of the organic load. In the absence of sustainable practices, whey is considered the most important environmental pollutant of the dairy industry because a large amount of whey is disposed of as wastewater and is associated

with serious environmental hazards. The disposal of whey also represents a significant loss of potential nutrients and energy, so in order to utilize the nutritional value of whey and at the same time mitigate the harmful effects of disposal in the environment, it is important to direct whey management towards a cost-effective and sustainable way of utilization and directing it into the production of novel valuable products at the same time.

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