



A Study on Physico-chemical and Sensory Characteristics of Kokum Whey Beverage using Response Surface Methodology

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ABSTRACT

Background: The study aimed to explore the potential of kokum (*Garcinia indica*) as an ingredient to enhance the nutritional and sensory properties of whey beverages. This investigation focused on developing a kokum whey beverage (KWB) using reconstituted whey, intending to create a value-added product with appealing sensory attributes.

Methods: KWB was prepared using reconstituted whey made from DM 40 whey powder. Response Surface Methodology (RSM) was employed to optimize the formulation. The optimized parameters included a total solid (TS) content of reconstituted whey at 10.27%, sugar level at 10.92% (w/w of whey) and kokum syrup (prepared using the direct heat method) level at 6.94% (w/w of whey). Physicochemical properties such as total solids, fat, protein, carbohydrate, ash, free fatty acids (FFA), acidity, pH and viscosity were analysed to characterize the beverage.

Result: The final KWB formulation had total solids of 20%, fat 0.44%, protein 0.52%, carbohydrate 18.49%, ash 0.55% and FFA 0.011% (expressed as oleic acid). The acidity, pH and viscosity of KWB were recorded at 0.39% (citric acid), 4.07 and 6.01 cP, respectively. Sensory analysis revealed a significant ($P < 0.05$) decline in scores for flavour, colour and appearance, acidity, sweetness, consistency and overall acceptability.

Key words: Demineralised whey powder, *Garcinia indica*, Kokum, Whey beverage.

INTRODUCTION

During the conversion of milk into heat acid coagulated product (*i.e.* chhana, paneer *etc.*) milk solids are lost into whey (Sahu *et al.*, 2017). Whey, the liquid by product of cheese, casein and paneer manufacture, is one of the most abundant sources of protein in the modern diet. One of the most promising ways to use whey is to convert it into whey powder, use it in the form of reconstituted whey for manufacture of whey beverages. Whey proteins have unique nutritional and functional properties which can be explored to deliver high protein products to consumers. Dairy proteins are generally having a neutral - pH, therefore they can be used in manufacturing of beverages which are having different nutritional and functional attributes (Chavan *et al.*, 2015). Whey beverages are fermented or non-fermented products in which whey is used as an ingredient (Gomes *et al.*, 2013). A variety of whey based beverages consisting of plain, alcoholic, carbonated and fruit flavoured have been successfully developed and marketed all over the world. Benefits of the whey proteins can easily be enhanced by the beverages manufactures into different products *i.e.* highly soluble in a pH range of 2 to 10, produces stable and clear beverages even in the pH range of 3.0 to 3.2, *etc.*

Whey powder includes all of the components found in fresh whey and can be used to replace milk solids. In baking and confectionery, whey powder is act as an excellent browning additive (Dattatreya *et al.*, 2007). Whey powder, on the other hand, has a restricted applicability due to its low protein and high ash content. Whey powder is a complex ingredient made up of protein, lactose, fat and

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minerals (Matouq, 2008). Demineralised whey is made by removing minerals in part using ion exchange, diafiltration, or electrodialysis (Houldsworth, 1980). Demineralization levels are typically 25%, 50% and 90%.

Kokum (*Garcinia Indica Choisy*) is a tree native to India that belongs to the *Guttiferae (Clusiaceae)* family (Padhye *et al.*, 2009). It is an ancient fruit which is widely consumed in the form of sarbat in a western ghat of India (Chate *et al.*, 2019). It is prescribed in Ayurveda for ailments as varied as rheumatism, rickets and enlargement of spleen, uterine complaints and in animal disorders. Kokum fruit includes a variety of bioactive chemicals and probable compounds with antioxidant, antibacterial and antifungal activities

(Ranveer and Sahoo, 2017). Its activity against numerous cancer cell lines, including breast cancer, liver cancer and leukemia, has been established in scientific studies. Furthermore, Kokum exerts anti-histamine and anti-inflammatory effects (Swami *et al.*, 2014). In spite of its many health benefits there are very few products made with *Garcinia* available in the market, only a few research publications exist in the literature on the production of food products from Kokum, such as the use of Kokum juice in the making of paneer whey beverage (Rupnar *et al.*, 2008). Kokum fruit is used in RTS beverages and fruit bars (Bafna, 2014). Sowmya *et al.* (2019) reported that the formulations and sensory properties of a variety of value-added goods made with Kokum fruit as a value-added ingredient. Similarly, Alane *et al.* (2017) prepared a whey-based mango herbal beverage was prepared with addition of ginger extract ranging from 0.5-5 mL (v/v). In another study, Janiaski *et al.* (2016) and Souza *et al.* (2019) prepared fruit flavoured whey beverages utilising strawberry. Bhalekar *et al.* (2022) developed whey beverage using jackfruit pulp and concluded that jackfruit pulp could be successfully utilized for the preparation of whey beverages.

Hence, this study was planned and conducted to optimize a whey based beverage through incorporation with *Garcinia indica* (Kokum) to enhance the utilization of fruit to the best possible extent, along with availing the health benefits of the fruit and to evaluate proximate composition, physico-chemical and sensory properties of optimized product.

MATERIALS AND METHODS

The research work was carried out at SMC College of Dairy Science, Anand, Gujarat, from July 2019 to June 2021. Demineralised Whey Powder (DM-40) of 'Amul' brand, marketed by Gujarat Cooperative Milk Marketing Federation (GCMMF), Anand was used in the preparation of whey beverage. Organic Kokum rinds were purchased from Kokum grower's society of Sirsi, Uttara Kannada district of Karnataka. Cane sugar (Madhur Brand, M/s Shree Renuka Sugars Ltd., Karnataka, refined non-sulphited) of commercial grade was obtained from the local market of Anand.

Preparation of kokum syrup

In a stainless-steel vessel, 30 g kokum rinds were taken and 30 g sugar and 400 mL potable water was added to it. The contents were heated for 30 min at 70°C. To this 60 g of sugar syrup was added and heating continued for 15 min for complete dissolution of sugar (70° Brix). The contents were cooled and filtered through a fine muslin cloth.

Method for manufacturing of kokum whey beverage

For manufacturing Kokum whey beverage, reconstituted whey (9 to 11% TS) was prepared using DM 40 demineralised whey powder at 50°C. Contents were heated to 85°C for 5 min mixed and kept 2 h undisturbed for hydration, followed by filtering the whey through double layer muslin cloth, to obtain the clear whey. In the clear

whey, 6 to 8% (w/w) of kokum syrup was added and sugar was added at 9 to 12% (w/w of reconstituted whey). The contents were mixed and heated at 85°C for 5 min followed by hot filling in 200 mL capacity sterile glass bottles. The bottles were cooled and stored at 7±2°C. The TS of reconstituted whey (A) (9.0 to 11%), level of sugar (B) (9 to 12% w/w of whey) and level of kokum syrup (C) (6 to 8% w/w of whey) were optimized by adopting a Central composite rotatable design consisting of 20 experiments. The photograph of ingredients and finished product i.e. Kokum Whey Beverage was shown in the Fig 1.

Analysis of whey based beverage

The fat content of whey and whey beverage were estimated by Gerber method (BIS, 1977). The total solids (TS) and ash content of whey and whey beverages were determined by the standard procedure (BIS, 1989). The titratable acidity of whey was determined by the standard method (BIS, 1961). Titratable acidity and Free Fatty Acid (FFA) of whey beverage was determined by titration method as suggested by Ranganna (2018). The pH values of whey beverage samples were measured using electronic digital pH meter (M/s. Mettler Toledo AG, Schwerzenbach, Model CH-8603). The total nitrogen was determined using semi-micro Kjeldahl method (Jayaraman, 1981). The carbohydrate content of whey beverages were estimated by difference (Bemiller, 2010). The viscosity of whey beverage was determined by the method of Lowenstein and Haddad (1972) using a 'Brookfield' viscometer (DV II + Pro Viscometer, Model- LVDV- II + P, USA) at 20°C. All the samples of whey beverage were analyzed for aerobic plate count, coliform count, yeast and mold count using the method described in FSSAI (2012).

Sensory analysis of whey based beverage

The whey beverages subjected to sensory evaluation by a panel of 10 members (i.e. judges) comprised of faculty members from the College. The sensory attributes



Fig 1: Kokum whey beverage with ingredients used.

evaluated were flavour, colour and appearance, consistency, acidity, sweetness, overall acceptability score, based on 9-point hedonic scale. The whey beverage samples were served in 30 mL glass beakers. The containers were labelled with random digit codes. The order of presentation of samples to the judges was randomized. Sensory evaluation of the product was conducted in isolated booths, illuminated with incandescent light in sensory evaluation lab. The product temperature was maintained at $15 \pm 2^\circ\text{C}$ during the judging (Lawless and Heymann, 2010).

Statistical analysis

The mean values generated from the analysis of duplicate samples of Kokum whey beverage were subjected to statistical analysis using the software developed by Anand Agricultural University, Anand. To carry out their optimization of selected parameters, an advanced statistical software program named Design Expert (Version 13.0.1.0.) was employed.

RESULTS AND DISCUSSION

KWB was prepared with varying TS level of reconstituted whey (%), sugar (% w/w of whey) and Kokum syrup (% w/w of whey) as suggested by Response Surface Methodology to choose the best combination for manufacture of an acceptable product.

Optimization of kokum whey beverage

Process optimization for the development of KWB was carried out with the objective of determining the best possible combination(s) of different levels of factors viz. TS level of reconstituted whey (%), level of Kokum syrup (% w/w of whey) and level of sugar (% w/w of whey), that would lead to the most acceptable product in terms of sensory scores. The goals that were set for obtaining the best possible combination are illustrated in Table 1. The data were analyzed in Design Expert Package 13.0.1.0. Considering the constraints and their limits, the RSM suggested the one most suitable solution.

A larger R^2 value suggests a better fit of the quadratic model. The adequate precision measures the signal to noise ratio, a ratio greater than 4 is desirable. The adequate precision value for flavour score, consistency score, acidity score, sweetness score, colour and appearance and overall acceptability were 0.85, 0.65, 0.79, 0.88, 0.76 and 0.85 respectively, which were greater than 4, hence, it is considered to be supporting the suitability of the model to navigate the design.

Effect of TS level of reconstituted whey, level of sugar and kokum syrup on sensory scores of kokum whey beverage

The experimental design matrix as per their run order is shown in Table 1 while P values and partial coefficients of regression equation of suggested depicted in Table 2. The scores of flavour, consistency, acidity, colour and

appearance, sweetness and overall acceptability were well fixed in quadratic model. The quadratic model for sensory parameters were obtained through successive regression analysis. Furthermore, the coefficient of determination (R^2) shown in Table 3 which reflects the proportion of variability in data explained or accounted by the model for flavour, consistency, acidity, sweetness score, colour and appearance and overall acceptability were respectively.

As seen in Table 1, the flavor score of KWB ranged from 6.0 to 8.5. The coefficient of determination (R^2) is the proportion of variability in the data explained or accounted for the model and 0.85 value of R^2 (Table 3) indicate a better fit of the model to the data. Also the adequate precision value (APV) of 8.29 recommends the use of this response to navigate the design. At linear level of sugar (B) showed its significant ($P < 0.05$) positive effect on flavour score. However, TS level of reconstituted whey (A^2) and level of sugar (B^2) and level of Kokum syrup (C^2) had significant ($P < 0.05$) negative effect on flavor score at quadratic level. The higher TS level of reconstituted whey (A^2), level of Kokum syrup (C^2) and level of sugar (B^2) showed significant ($P < 0.05$) negative effect on acidity score of KWB at quadratic level.

Also at higher TS level of reconstituted whey (A^2), level of sugar (B^2), Kokum syrup (C^2), showed significant ($P < 0.05$) negative effect on sweetness score at quadratic level. The level of sugar (B) showed significant ($P < 0.05$) positive effect on colour and appearance score in linear terms. At extremely higher TS level of reconstituted whey (A^2) and level of Kokum syrup (C^2) showed significant ($P < 0.05$) negative effect on colour and appearance score of KWB at quadratic level. In similar studies, the interaction effect of level of lemon juice and sugar ($L \times S$) was found non-significant on colour and appearance score of lemon flavoured whey beverage (Patel, 2015). The interaction of various treatment combinations of Kokum juice and sugar had non-significant effect on colour and appearance of Kokum whey beverage (Rupnar *et al.*, 2008); who reported that flavor of paneer whey beverage was influenced by level of Kokum juice significantly ($P < 0.05$). Patel (2015) also observed the consistency score of lemon flavored whey beverage was non-significantly affected by addition sugar in whey beverage. In another study conducted by Begum *et al.* (2019), 30% watermelon juice is recommended for whey beverage drink.

At higher TS level of reconstituted whey (A^2), level of sugar (B^2) and Kokum syrup (C^2) showed significant ($P < 0.05$) negative effect on overall acceptability score at quadratic level. From Fig 2, Fig 3 and Fig 4 it can be observed that with increase in the level of sugar and level of Kokum syrup, TS of reconstituted whey there was increase in overall acceptability score to certain level then there was decrease in score at higher level. Thus, this study indicated a definite influence of TS level of reconstituted whey (%), level of sugar (% w/w of whey) and level of Kokum syrup (% w/w of whey) on the colour and

Table 1: Experimental design matrix for sensory score of Kokum whey beverage.

Std run	Parameters				Sensory score*				
	TS of reconstituted whey (%)	Sugar (% w/w of whey)	Kokum syrup (% w/w of whey)	Flavour	Consistency	Acidity	Sweetness	C and A#	OA##
1	10	10.5	7	8.5	8.5	9	9	8.6	8.5
2	10	7.97	7	6.3	8	6.4	6.1	8.1	6.4
3	9	9	6	6	7	6	6	8	6
4	9	12	6	7.13	7.5	6.11	6.88	8.23	7.11
5	9	12	8	7.4	7.5	6.8	7.2	8.5	7.6
6	11.68	10.5	7	7.3	6.4	7.4	7.5	7.2	7.4
7	11	9	6	6.2	7.1	6.3	6.4	7.6	6.3
8	10	10.5	8.68	6.8	7.3	6.7	6.6	7.8	6.7
9	9	9	8	6.33	7	6	6	8	6.33
10	8.32	10.5	7	8.3	8.4	8.8	8.8	8.2	8.3
11	10	10.5	5.31	8	8.5	8.1	8	7.6	7.9
12	10	10.5	7	8.5	8.5	9	9	8.7	8.5
13	11	12	8	7.5	8	7.5	7	8.5	7.5
14	10	10.5	7	8.5	8.5	9	9	8	8.5
15	11	9	8	6.4	7.1	6.3	6.5	7.6	6.4
16	10	10.5	7	8.5	8.5	8.5	9	8.6	8.5
17	10	10.5	7	8.5	8.5	9	8.5	8.5	8.5
18	10	10.5	7	8.5	8.5	9	9	8.6	8.75
19	11	12	6	7	8	7.5	7	8.5	7
20	10	13.02	7	6.5	8	7.5	6.5	8.5	6.75

* based on 9-point hedonic scale, # - C and A=color and appearance, ##-OA =Over all acceptability score.

Table 2: P values and partial coefficients of regression equation of suggested.

Parameter	Flavour score		Consistency score		Acidity score		Sweetness score		Colour and appearance score		Overall acceptability score	
	Partial coefficient	P value	Partial coefficient	P value	Partial coefficient	P value	Partial coefficient	P value	Partial coefficient	P value	Partial coefficient	P value
Linear level												
A	-0.1055	0.4440	-0.1584	0.3100	0.0245	0.9025	-0.1000	0.5075	-0.1619	0.0660	-0.0991	0.4652
B	0.3248*	0.0341	0.2050	0.1964	0.3778	0.0821	0.2821	0.0813	0.2345*	0.0136	0.3491*	0.0233
C	-0.0525	0.6997	-0.1477	0.3420	-0.1218	0.5470	-0.1416	0.3534	0.0444	0.5840	-0.0438	0.7442
Interactive effect												
AB	-0.0375	0.8328	0.1	0.6166	0.1862	0.4826	-0.1225	0.5339	0.1337	0.2213	-0.0725	0.6798
AC	0.0125	0.9439	-8.3792	1.0000	-0.08625	0.7426	-0.0275	0.8879	-0.0337	0.7488	-0.0275	0.8751
BC	0.03	0.8659	8.2099	1.0000	0.0862	0.7426	0.0275	0.8879	0.03375	0.7488	0.07	0.6902
A ²	-0.3268*	0.0296	-0.4568*	0.0100	-0.4644*	0.0348	-0.3821*	0.0224	-0.2295*	0.0132	-0.3253*	0.0284
B ²	-0.8218**	< 0.0001	-0.2447	0.1205	-0.8710**	0.0010	-1.0362**	< 0.0001	-0.01739	0.8245	-0.7761**	0.0001
C ²	-0.4682**	0.0046	-0.2801	0.0807	-0.7119**	0.0038	-0.6826**	0.0007	-0.2295*	0.0132	-0.5197**	0.0022

**Significant 1% level (P<0.01); *Significant at 5% level (P<0.05).

Note: A, B and C refer to the level of TS level of reconstituted whey (%), level of sugar (% w/w of whey) and level of Kokum syrup (% w/w of whey).

appearance score of KWB. Addition of Kokum in the form of syrup gave a light pinkish colour to the Kokum whey beverage, which was liked by panelists.

Comparison of predicted v/s actual values of responses selected

The final product was manufactured employing this suggested formulation and the actual results obtained were compared with these predicted values of the criteria/responses selected for process optimization. The calculated values of 't' for all the parameters are reported in Table 4.

Comparing the predicted values of the responses being studied with the actual values of the selected responses when the product was practically produced using the suggested process parameters, it is confirmed that the selected combination is the best in terms of the sensory score responses defined at the beginning of the study. The results are also validated statistically by t- test. The values for 't' test being less than the table values, it is inferred that there was non-significant difference between the predicted and actual values of responses as shown below.

Based on the results obtained in this study the standardized procedure for Kokum whey beverage involved preparing reconstituted whey using (10.27% from DM-40 whey powder) at 50°C, then the pH of whey adjusted to 4.5, then the contents were mixed and allowed for hydration till 2 h, after 2 h sediments were settled at the bottom, these sediments were removed by passing through double layer muslin cloth, for the obtained clear whey, addition of Kokum syrup at 6.72 % w/w of reconstituted whey, sugar @ 10.92 (% w/w of reconstituted whey) and a blend of stabilizer (MCC:Pectin 0.05:0.05 @ 0.1 %) and mixed, finally heating to 85°C for 5 min, filtered through single layer muslin cloth to remove any hydrated particles and hot filling the beverage into sterile glass bottles and crown capping. Then the bottles were sterilized at 100°C for 5 min and finally bottles were cooled and stored at 7±2°C. The physico-chemical properties and composition values of optimized Kokum whey beverage was given in Table 5.

Proximate composition and physico-chemical properties of optimized product

The proximate composition and physico-chemical properties of Kokum Whey Beverage (KWB) are depicted in Table 5. These parameters provide essential insights into the quality, stability and nutritional attributes of the beverage.

pH and acidity

The pH of the KWB was recorded as 4.07±0.15, indicating a mildly acidic nature. This is in line with the expected acidity levels of fruit-based whey beverages, contributing to its refreshing taste and stability. The corresponding acidity, expressed as % citric acid, was found to be 0.39±0.01. The moderate acidity level ensures the preservation of the

beverage while contributing to the tartness imparted by the kokum fruit. The acidic environment also helps in maintaining microbiological stability and enhances the shelf life of the beverage.

Compared to the study conducted by Bafna (2014), who reported a pH of 3.8 and acidity of 0.98% citric acid for a kokum RTS beverage, the pH of KWB was slightly higher, while the acidity was lower, making it less tart. This milder acidity could enhance consumer preference for a more balanced flavour profile. On the other hand, when compared to Rupnar (2008), who reported a pH of 4.68 and acidity of 0.42% in a Kokum paneer whey beverage, KWB exhibited a lower pH and acidity, suggesting that it may have a more pronounced tangy flavour.

Viscosity

The viscosity of the KWB was measured at 20°C and obtained as 6.01 ± 0.01 cP. This relatively low viscosity reflects a thin, liquid consistency, which is typical of fruit-based beverages with whey. The consistency of the drink is essential for consumer acceptance, as overly thick beverages can be unappealing in the context of whey-based drinks.

Brix and total solids

The total soluble solids (TSS) of the beverage, measured in Brix, was found to be 19.50 ± 0.1 , indicating a moderate

sweetness that likely results from the combination of whey and kokum extract. The total solids content was slightly higher, recorded at $20.00 \pm 0.01\%$, which contributes to the body and mouthfeel of the beverage. The total solids value also indicates the concentration of the combined whey proteins, kokum constituents and added sweeteners or solids in the beverage. In contrast, Rupnar (2008) reported a total solids content of 16.44%, which was lower than the TS found in KWB, suggesting that KWB contains more solids, likely enhancing its nutritional value and texture.

Fat and protein

The fat content of KWB was relatively low, at $0.44 \pm 0.01\%$, reflecting the low-fat nature of whey-based beverages, which makes them appealing to health-conscious consumers. The protein content was also low, measured at $0.52 \pm 0.00\%$. Whey is naturally a source of high-quality proteins and though the protein content in KWB is modest, it still contributes to the beverage's nutritional profile. However, compared to Bafna (2014), KWB exhibited higher protein levels, making it nutritionally superior in terms of protein contribution.

Ash

The ash content, which represents the total mineral content, was found to be $0.55 \pm 0.01\%$. This value indicates that the beverage contains a reasonable amount of

Table 3: Coefficients of selected models for sensory attributes of Kokum whey beverage.

Response	Suggested model	Intercept	Model F value	Adequate precision	R ²
Flavour score	QUADRATIC	8.51	6.59	8.29	0.85
Consistency score	QUADRATIC	8.51	2.07	4.11	0.65
Acidity score	QUADRATIC	8.94	4.41	6.06	0.79
Sweetness score	QUADRATIC	8.93	8.74	8.95	0.88
Colour and appearance score	QUADRATIC	8.49	3.55	6.70	0.76
Overall acceptability score	QUADRATIC	8.55	6.72	8.15	0.85

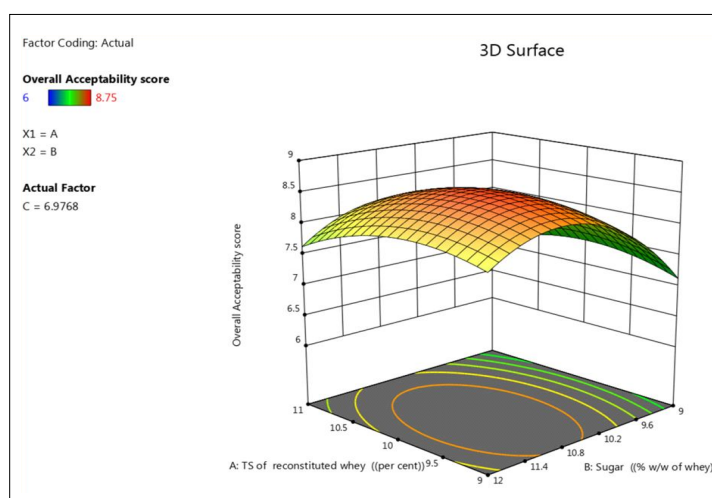


Fig 2: Response surfaces of overall acceptability as influenced by (A) TS of reconstituted whey (%) and (B) sugar (% w/w of whey).

minerals, which are primarily derived from whey, making the drink not only refreshing but also nutritionally valuable.

Carbohydrate

The carbohydrate content in KWB was $18.49 \pm 0.01\%$, which was lower than the 20.34% as reported by Bafna (2014) for

kokum RTS beverage. This slight reduction in carbohydrates may make KWB more appealing to health-conscious consumers looking to reduce sugar intake while still enjoying a flavourful drink.

In overall, the physico-chemical properties of the Kokum Whey Beverage suggest that it is a nutritious, low-

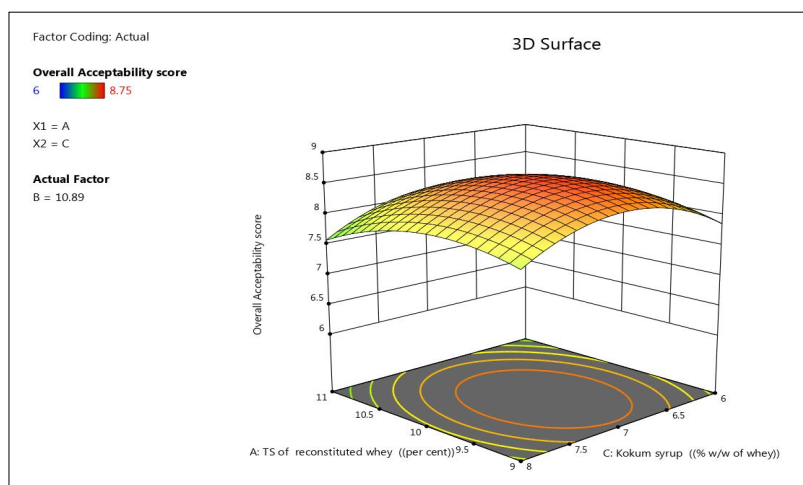


Fig 3: Response surfaces of overall acceptability score as influenced by (A)TS of reconstituted whey (%) and (C) Kokum syrup (% w/w of whey).

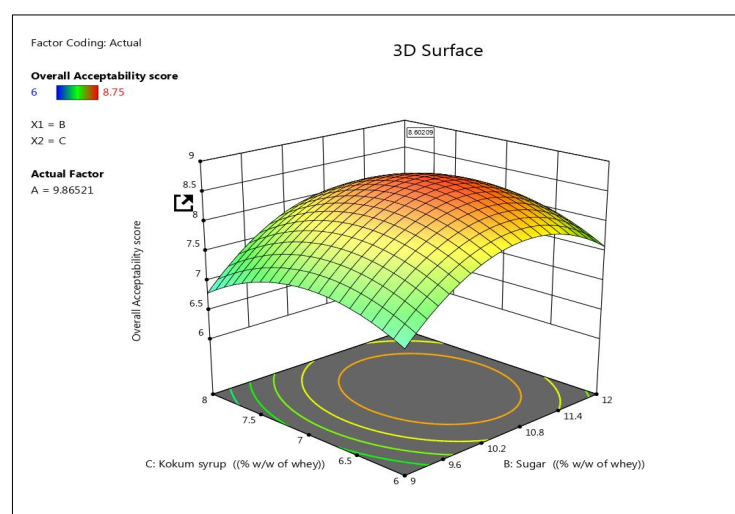


Fig 4: Response surfaces of overall acceptability score as influenced by (B) sugar (% w/w of whey) and (C) Kokum syrup (% w/w of whey).

Table 4: Comparison of predicted v/s actual values of responses selected.

Response	Predicted value *	Actual value @	Cal.t-value#	P value	Significance
Flavour	8.55	8.60	0.6549	0.0034	NS
Consistency	8.56	8.53	0.3882	0.1368	NS
Colour and appearance	8.57	8.57	0.4432	0.0305	NS
Sweetness	8.95	8.87	0.7352	0.0011	NS
Acidity	8.97	8.75	1.1556	0.0150	NS
Overall acceptability	8.60	8.65	0.4962	0.0032	NS

Sensory scores obtained on 9 point hedonic scale; * Predicted values of Design Expert 13.0.1.0 Package @ Actual values are average of seven trials of optimized product; # t-values found non-significant at 5 % level of significance; NS = Non-significant; Tabulated t-value = 2.447 (Cal. t-value less than tabulated value).

Table 5: Proximate composition and Physico-chemical properties of Kokum whey beverage.

Parameter	KWB
pH (at 20°C)	4.07±0.15
Acidity (% CA)	0.39±0.01
Viscosity (cP at 20°C)	6.01±0.01
Brix (TSS)	19.50±0.1
Total Solid (%)	20.00±0.01
Fat (%)	0.44±0.01
Protein (%)	0.52±0.00
Ash (%)	0.55±0.01
Carbohydrate (%)	18.49±0.01

Each observation is a mean±SD of 3 replicate experiments.

fat and refreshing drink with a balanced composition of acidity, sweetness and viscosity. The presence of carbohydrates and minerals enhances its energy and nutritional content, while its low fat and moderate protein levels cater to health-conscious consumers. The pH and acidity contribute to its stability and shelf life, making it a promising functional beverage in the dairy and fruit-based beverage market.

CONCLUSION

Acceptable quality of whey beverage incorporated with Kokum can be prepared by using reconstituted whey using DM 40 whey powder (10.27% TS), sugar (10.92%) and Kokum syrup (6.94%). The Kokum Whey Beverage (KWB) developed in this study showed a balanced composition, with a mildly acidic pH, moderate total solids and a satisfying sweetness, making it a nutritionally appealing functional beverage. The beverage's protein and carbohydrate content provided nutritional benefits, while its low viscosity ensured a smooth, drinkable consistency. Sensory evaluation revealed a favourable flavour score, with a light pinkish colour from the Kokum syrup that was well-received by panellists. Statistical analysis confirmed a strong model fit, indicating that sugar positively influenced flavour, while excessive levels of total solids, sugar and Kokum syrup negatively impacted the flavour, sweetness and overall acceptability. Optimizing these levels resulted in a refreshing and visually appealing beverage with high consumer potential.

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Conflict of interest

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