International Journal of Food Science and Nutrition
www.foodsciencejournal.com
ISSN: 2455-4898
Received: 05-12-2024, Accepted: 05-01-2025, Published: 20-01-2025
Volume 10, Issue 1, 2025, Page No. 80-83

Development of β-carotene enriched whey frozen dessert

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Abstract
Whey is a major by product from milk products manufacturing industry, which is a liquid fraction that remains during production of cheese, chhana, paneer and casein. The portion of whey contains important whey protein fractions and it is left as waste on the ground. This study is attempted to utilize the whey and to develop a commercially valuable frozen dessert. An acceptable whey frozen dessert could be prepared by incorporating carrot puree @ 15% in whey. The amount of β-Carotene present in enriched whey protein desert was 1.35mg/100g and 0.052mg/100g in control. The whey based β-carotene frozen desert was stored at -18°C. The cost economics of the frozen desert was calculated as per the standard method.

Keywords: Whey, carrot, β-carotene, frozen dessert, proximate composition

Introduction

In India, the major source of whey is from production of chhana, paneer and chakka. Approximate 5 MT whey is produced in India annually. In that channa and paneer whey contribute around 80 per cent of total whey. Whey protein is not only easy to digest, but also has a high biological value and high protein efficiency ratio (Rajarajan (2019) [13]. Khumari (1998) [10]. prepared paneer whey beverage (PWB) with different proportions of whey *viz*., (whey: water) 100:00, 75:25, 50:50 and 25:75 and different levels of sugar 10, 14, 18, 22 per cent used to prepare paneer whey beverage. Samea *et al* (2015) manufactured functional ice cream containing natural antioxidants by adding vegetables like carrots and tomatoes. Shereprerana, (2019) [16]. studied the influence of carrot puree incorporation on quality characteristics of instant noodles and found that the total carotenoids were increased. The objective of the research work was to develop whey frozen dessert with β-Carotene enrichment using carrot.

Materials and Methods

1. Separation of whey

Milk was boiled up to 80°C and 0.3% citric acid was added. Milk protein casein coagulates and whey gets separated. The suspension was filtered through muslin cloth. The retained whey liquid was used for further processing.

2. Optimization of carrot puree in dessert mix

For preparation of whey frozen dessert incorporated with β-Carotene, three different percentage (10, 15 and 20 %) of carrot puree was added with dessert mix. From the result of sensory analysis percentage of carrot puree to be added for preparation of whey frozen dessert was optimized.

Table 1: Optimization of carrot puree concentration in whey frozen dessert

S. No	Treatments	Concentration (%) of Carrot Puree
1.	Control	--
2.	WFD_1	10
3.	WFD_2	15
4.	WFD_3	20

WFD- Whey Frozen Dessert

3. Preparation of dessert mix

Farm fresh milk was heated up to 90°C and then citric acid was added to it. The whey was separated from curdled milk. The suspension was filtered through muslin cloth. Three carrots weighing 200g were washed peeled, diced and steam cooked. The carrot puree was made by following steps. The cooked carrots were then ground into to fine paste with 5g of butter. 500 mL of whey was measured and taken in a pan heated to a temperature of approximately 80°C and then 50g of khoa, 20g of skim milk powder, chosen amount of carrot puree, 75g of sugar (powdered), 4g of stabilizer were added and mixed well. The mix was allowed to cool. Then it was kept in the refrigerator at 4°C overnight for aging.

Table 2: Formulation of dessert mix

Ingredients	Control	WFD_1	WFD_2	WFD_3
Milk (%)	100.0	-	-	-
Whey (%)	-	100	100	100
Carrot puree (%)	-	10.0	15.0	20.0
Sugar (%)	15.0	15.0	15.0	15.0
Khoa (%)	50.0	50.0	50.0	50.0
Butter (%)	10.0	10.0	10.0	10.0
Stabilizer (%)	0.8	0.8	0.8	0.8
Skim milk powder (%)	4.0	4.0	4.0	4.0

4. Deep freezing and storage
The prepared frozen dessert mix was poured into suitable moulds and it was kept in deep freezer at -18℃ for hardening for 4 to 6 h. The frozen dessert was then packed into suitable packaging material.

5. Proximate analysis
Determination of Protein, Total fat, Carbohydrates, Energy, Total fibre, Moisture content, Ash content, Beta carotene, pH of the sample and control were determined as per the method outlined by AOAC, (2005) [2]. Total sugar was determined as per the FSSAI, (2006) [4]. The Melting rate of the sample was determined as per BIS, (1981) [7].

6. Sensory evaluation
The sensory panelists (20 semi trained) were academic staff and students of the college of food and dairy Technology, Koduveli. The panellists were instructed to assess the quality of whey frozen dessert on the basis of sensory attributes such as appearance, flavour, texture, melting quality and overall acceptability using 8 point descriptive scale where 8 = like extremely, 7 = like very much, 6= like moderately, 5=like slightly, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much and 1 = dislike extremely.

Cost Economics
The cost was estimated for Whey Frozen Dessert mix and the control.

Results and Discussion
1. Optimization of carrot puree concentration for whey frozen desert
The ground carrot puree was incorporated in different concentrations *viz*., 10, 15 and 20% respectively in different treatments WFD_1, WFD_2 and WFD_3 of whey frozen desserts. The Sensory analysis scores showed that the level of 15% addition had higher overall acceptability as compared to other treatments.

Table 3: Sensory scores of control and samples (Mean ± SE)

Sample	Appearance	Taste/Flavour	Body and texture	Melting quality	Overall Acceptability
Control	7.70±0.40 ^{b}	7.50±0.30 ^{b}	7.30±0.20 ^{b}	8.20±0.50 ^{a}	7.60±0.30 ^{b}
WFD_1	7.50±0.40 ^{b}	7.90±0.20 ^{ab}	8.30±0.50 ^{a}	7.50±0.30 ^{b}	7.80±0.40 ^{ab}
WFD_2	8.90±0.30 ^{a}	8.50±0.4 ^{0a}	8.20±0.20 ^{a}	8.40±0.50 ^{a}	8.50±0.20 ^{a}
WFD_3	9.20±0.50 ^{a}	8.20±0.30 ^{ab}	7.10±0.40 ^{b}	7.30±0.20 ^{b}	7.90±0.50 ^{ab}
F-value	18.92**	5.64**	6.18**	7.33**	4.97*

** Highly significant ($p \leq 0.01$), *Significant ($0.01<p\leq 0.05$), NS No significant differences,

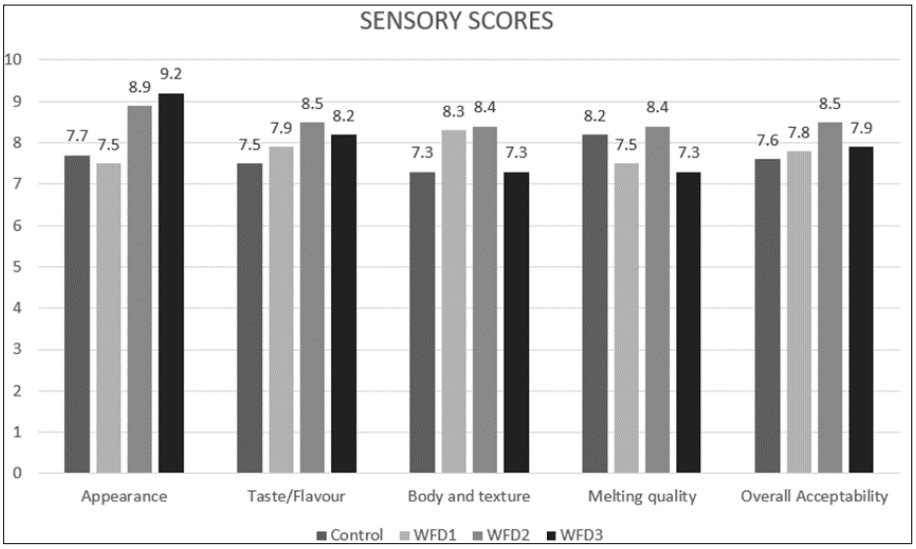

Fig 1: Sensory values of Control and Treatments

It is clear from the data given in the table that WFD_2 has recorded the highest values for appearance, taste/flavour, body and texture, melting quality and overall acceptability. It could be observed also that control has the lowest scores of all sensory properties. The infusion of ß- Carotene gave a rich yellow to orange colour in the whey frozen dessert. These findings were in accordance with the results of Ateteallah *et al*. (2019) [3]. in carrot and pumpkin pulps

added ice cream. Improvement in flavour and colour of WFD_2 fortified with carrot puree were confirmed according to Denzil, (2014) [6].

2. Chemical composition of frozen dessert

2.1 Total Fat

From table 4.2 it is shown that the total fat percent (%) of control and WFD_2were 3.9 and 1.86 respectively. The fat content in WFD_2 was lower compared control and is attributed with replacement of whey with milk; whey contains only the maximum fat content of 0.13 to 0.9 percentage. Shankar and Bansal (2013) [14]. reported that addition of Carrot puree to ice cream mix decreased the fat and protein content significantly.

2.2 Total Protein

The protein percentage (%) of WFD_2 was 3.13 and the control was 4.7. The protein in WFD_2 was slightly less than the control since, the control contained milk while the sample did not have. Hence it resulted in lesser the protein content. In general, milk has 80% of casein protein and 20% of whey protein. (Giri *et al.*,2014) [8]. observed similar results with respective to protein content of whey kulfi prepared from different ratios of cow milk and whey.

2.3 Total sugar

The sugar content (%) of control and WFD_2 was 13.4 and 25.69 respectively. This rise in total sugar may be due to the addition of carrots in WFD_2. The sugar content of carrot varies from 5.1% to 13.6% (Kumar *et al*., 2001) [11].

2.4 Total fibre

The total fibre (%) of WFD_2 and control was 0.52 and Nil respectively. This was because the fibre in milk was almost negligible (Sehamv *et al*, 2015) [14].and the fibre in sample was due to the carrot puree addition during preparation (SherePrerana, 2013) [16]. Sule *et al* (2019) observed that there was increase in fibre content (0.82 to 2.43%) while studying the effect of carrot powder incorporation on the quality of Pasta.

2.5 Carbohydrates

The carbohydrate percentage in control and WFD_2 was 24.4 and 29.52 respectively. Similar results were obtained by Sehamv *et al, (2015*) [14].

2.6 Energy

The energy in kilo calories of the control and WFD_2 was 137 and 126.83 Kcal respectively. Energy was calculated from the levels of carbohydrate, protein and fat. Since the protein and fat percentage of control was slightly higher than the sample, control has higher energy than the sample.

2.7 Moisture Content

The control had 65.13% moisture and WFD_2 had 62.52%. Highest moisture content moisture content is found in control. The addition of fruits and vegetables might decrease the moisture level. Similar trend was observed by Choudhari, (2010) [5]. while manufacturing of alcoholic beverage.

2.8 Ash

The percentage of ash present in control and WFD_2 was 0.52% and 0.93% respectively. WFD_2 had higher ash content due to addition of carrot puree. Moreover, Kumar *et al.*, (2012) [12]. reported that ash content of ice cream increased significantly by adding 50% carrot juice.

2.9 pH

The pH of the control and sample was 6.62 and 6.34 respectively. Similar results were reported by Anjum *et al* (2004) [1]. while preparing functional ice cream with vegetables extract and stated that pH decreased gradually with decreasing fat contents by fig addition on ice cream.

Table 4: Proximate analysis of control and Whey Frozen Dessert

Composition	Control	WFD_2
Moisture (%)	65.13	62.52
Total protein (%)	4.7	3.13
Total fat (%)	3.90	1.86
Carbohydrate (%)	24.4	29.52
Total fibre (%)	0.0	0.52
β-Carotene (mg/100g)	0.052	1.35
Ash (%)	0.52	0.93
Total sugar (%)	13.4	25.69
pH	6.62	6.34
Energy (Kcal/100g)	137	126.83

3. Melting rate

The melting rate of the sample was 14ml/ 15min and the melting rate of control was 20ml/15min. A compact structure may have formed in the sample due to the addition of vegetable purees such as carrot and beetroot that showed high melting resistance preventing ambient air across into the dessert matrixas stated by Ateteallah *et al.* (2019) [3].

4. β- Carotene

The amount of β-Carotene present in WFD_2 was 1.35mg/100g and 0.052mg/100g in control. The recommended β-Carotene intake is 2-4mg/day. Absorption of carotenoids from raw carrots is about 3 to 4 percent, cooking and mashing the carrot releases 27% of beta carotene when consumed (Hedren *et al*, 2002) [9].

5. Cost Economics

The total production cost of 1Llitre of control frozen dessert mix is Rs.131.00 and the total production cost of 1 litre of whey frozen dessert mix is Rs.173.00. One Litre of mix yields about 20 frozen desserts. Hence the cost of one control frozen dessert is Rs. 10.00 and the cost of one whey frozen dessert is Rs. 9.00

Table 5: Cost estimation of control and whey frozen dessert

S. No.	Ingredients	Quantity	Cost incurred for Control (Rs)	Cost incurred for Whey frozen dessert (Rs)
1	Milk & Whey	1.0 L	50.00	56.00
2	Carrot	200.0g	-	17.00
3	Khoa	100.0g	45.00	45.00
4	Butter	10.0g	4.50	4.50
5	Sugar	150.0g	6.00	6.00
6	Skim milk Powder	40.0g	16.00	16.00
7	Stabilizer	6.0g	1.5	1.5
8	EB charges (1 unit / day preparation)		7.00	7.00
	Storage (7 units/day)		2.00	2.00
9	Stick and packing material	10 No's	3.00	3.00
10	Labour (Rs 371.00/day)	-	15.00	15.00
11	Sale of Paneer (yield)	180g	-	-60
	Total Production Cost		131.00	113.00

The Coagulation of 1 litre of milk yielded 180g of Paneer, which was sold for Rs. S60. Hence a sum of Rs.60 is excluded from the total production cost of whey frozen dessert.

Conclusion

From this study, it can be concluded that an acceptable whey frozen dessert can be prepared by incorporating carrot puree @15% in whey. The product adds goodness of carrot and whey in the diet of people who likes afresh vegetable flavour in afrozen dessert. Whey, a by-product of paneer / cheese manufacturing industries can be converted into a product that prevents environmental pollution, enhances whey (water) utilization without recycling and benefits small scale industries in gaining profit.

Acknowledgement

Part of the project work was submitted to College of food and Dairy Technology, Tamil Nadu Veterinary and Animal Sciences University, Chennai - 52 by the project student in partial fulfilment for the award of B. Tech degree.

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