Original Research Article

Physical and Sensory Properties of Ice Cream as Influenced by Pulse Protein Concentrates

ABSTRACT

Pulses are one of the cheapest sources for the extraction of protein concentrates which can be gainfully utilized for meeting protein needs of specific groups. Techniques for maximum extraction of Pulse protein concentrates were developed for red gram and Bengal gram by standardisation of process parameters involving alkaline extraction followed by isoelectric precipitation. Extraction conditions viz., flour: water ratio – 1:10, pH 9 and stirring time- 4 hours were employed for isolation of the pulse protein concentrates. The protein concentrates extracted from red gram and chickpea were incorporated in ice cream formulations at concentrations of 5 and 10%. The pulse protein concentrate incorporated ice cream at 5% level had a higher sensory score of 8.7 and 8.8 on the nine-point hedonic scale compared to ice cream enriched with 10% pulse protein concentrate (8.4 and 8.5/9.0). The pulse protein enriched ice cream had a high protein content of 11.76 g/100g compared to 4.90 g/100g in control. Pulse protein concentrates have a wide food application in designing speciality foods for different age groups and disease conditions. The PPC incorporated protein enriched ice cream would provide for nutritious ice cream having desirable sensory properties with commercialisation prospects.

Keywords: Pulses, alkaline extraction, protein concentrates, ice cream

1. INTRODUCTION

Pulses are low cost and a rich source of nutrients such as carbohydrate, protein, bioactive compounds, vitamins and minerals etc., Pulses are processed into flours and used as food ingredients to improve the functional and nutritional characteristics of a wide range of food products. At present, use of pulse fraction in innovative food product development has encouraged pulse fractionation into their component parts of protein, starch and fibre which are being used as functional food ingredients in a variety of food applications (Boye et al., 2010).

Pulses contain anti-nutritional factors which interfere with the absorption of nutrients like proteins and minerals. These antinutritional factors are inactivated during processing leading to improved nutrient bioavailability. The protein fractions from the pulses have low or no anti-nutritional factors and are bland in taste and hence could be successfully incorporated in a range of food products for improved nutrition.

The competitive food industries are now concentrating on the development of innovative products conferring functional benefits to suit individual consumer needs. Consumers are

more aware of healthier foods, which provide both enhanced nutritional and functional benefits to the body. Hence, there is a challenge for the industry to develop novel food products which innovative and not similar to the existing products in the market (Dias et al., 2015).

Ice cream is one of the delicious dairy frozen foods which are liked by people of all age groups around the world. Psychologically, the consumption of ice cream evokes an enjoyable state of mind in an individual (Choo et al., 2014). In India, the annual escalation rate of ice cream is 12-15% with the market value of nearly 2500 crores per year. Hence the study was focused on developing pulse protein concentrate to be incorporated on ice cream and study its functional physicochemical and organoleptic properties.

2. MATERIAL AND METHODS

2.1. Extraction of pulse protein concentrates (PPC)

Pulses- Bengal gram and red gram (which was purchased from the local market at Madurai) were cleaned, ground into flour in an electric blender (KenStar Excellence, India) and sieved through BS 60 Mesh. The pulse flour was suspended in water in the ratio of 1:5 (flour: water) and the suspension was stirred for uniform mixing in magnetic stirrer. The pH of the suspension was adjusted to 9.0 using 1 N NaOH and stirred it for 60 minutes at room temperature. The alkaline suspension was decanted at 4 °C for 4 hours and the suspension was centrifuged at 5200 rpm for 30 minutes. The supernatant (protein solution) was collected and adjusted the pH to 4.5 using 50% citric acid for isoelectric precipitation of proteins. The precipitated protein solution was allowed for the decanting process for 30 minutes. The decanted solution was centrifuged at 5200 rpm for 30 minutes and the protein pellets were collected and neutralized to pH 7.0. The neutralized protein solution was spray dried using spray drier (Milk Tech Engineers, Bangalore, India) and the spray dried powder (moisture content 5.05%) was stored for further use.

2.2. Preparation of ice cream

Cow's Milk (Arokya 6.5% fat and 8.5% SNF) was heated to 100°C in a thick-bottomed saucepan on medium heat and sugar (60g) was added and blended it well. Corn flour, Glycerol Mono Stearate and Carboxy Methyl Cellulose (purchased from Shree Mahalakshmi Chemicals, Mumbai, India) were taken in a separate bowl, to which was added 50 ml of hot milk and made to a fine paste. The mixed paste was added to hot boiled milk and stirred well to avoid the formation of lumps. The mixture was cooled (under normal condition) added 2 drops of vanilla extract and filtered to get the clear mixture. Fresh cream was added to the clear mixture containing 5% and 10% of the pulse protein concentrates and stored overnight at refrigeration condition (4° C). The refrigerated ice cream mixture was homogenized in ice cream maker (Kitchenif) for 30 minutes. The homogenized ice cream was frozen (-18° C) and stored (Plate 1).

Plate 1. Pulse Protein Concentrate incorporated ice cream

T_0 - Control T_1 – 5% red gram PPC T_2 – 5% Bengal gram PPC

2.3. Chemical constituents

The proximate composition of PPC incorporated ice cream such as moisture, carbohydrate, fat, protein and ash was estimated by AOAC, (2000) methods.

2.4. pH and acidity

Five gram of the sample was mixed well by stirring with 50 ml of distilled water and the pH of the suspension was determined in the pH meter (EUTECH Instruments, Mumbai, India). The acidity of the sample was determined by AOAC, (2000) method.

2.5. Overrun

The overrun of the ice cream was estimated by using a standard 100 ml cup, according to the equation as follows:

$$\text{Overrun (\%)} = \frac{\text{The volume of ice cream – the volume of the mix}}{\text{Volume of mix}} \times 100$$

2.6. Melting property

Melting property of the ice cream was analyzed at room temperature (25±2°C). The hardened ice cream (25g), held at frozen temperature (-18°C) was placed on a sieve which had 2 mm wide and square openings. The volume of the melted ice cream during the first ten minutes was recorded and further measured at every 5 min interval until the time of 40 min was reached.

2.7. Colourimetric analysis

A Hunter Lab digital colourimeter (Chromometer, M/s Lovibond, England) was used to measure the L*a*b* values of the PPC incorporated to the ice cream.

2.8. Sensory evaluation

Sensory evaluation was conducted by a semi-trained panel (ten judges) at Community Science College and Research Institute, Tamil Nadu Agricultural University, Madurai. Frozen ice cream samples (30g) were filled in 45-mL polystyrene cups with lids, labelled with three-digit codes. All testing sessions were held in a sensory evaluation laboratory with a partitioned booth at Department of Food Science and Nutrition, CSC&RI, TNAU, Madurai. RO (Reverse Osmosis) water was provided to rinse their palates between each sample.

2.9. Statistical Analysis

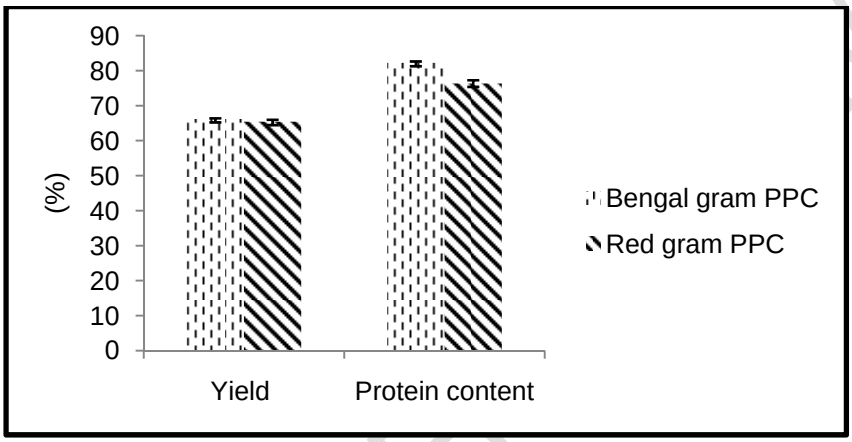
The statistical design for physical properties of PPC incorporated ice cream was a completely randomized design (CRD). Data were analyzed statistically by analysis of variance (ANOVA) using AGRES for Window version 10.0. Means with a significant difference ($P<0.05$) were compared by Least Significant Difference.

3. RESULTS AND DISCUSSION

3.1. Protein content and yield of PPC

The protein content and yield of protein concentrates were illustrated in Figure 1. The protein yield of the pulse protein concentrates, was high in Bengal gram (66.26%) followed by red gram (65.47%). On comparing protein content of pulse protein concentrates, the highest purity was present in Bengal gram protein concentrates (82.3%) followed by red gram protein concentrates (76.4%).

Figure 1. Protein content and yield of pulse protein concentrates



3.2. Proximal composition

No significant difference in terms of moisture, fat, ash and carbohydrate was noticed among the different pulse protein concentrate incorporated ice cream samples (table.1). However, the protein content among the PPC incorporated ice cream was significantly higher than control. The addition of PPC significantly increased the protein content of all the samples. Among the two different pulse protein concentrate incorporated ice cream samples, the Bengal gram protein concentrate incorporated ice cream had 9.54 and 11.76 g/100g protein corresponding to 5 and 10% of PPC incorporation which was higher than the red gram protein concentrate incorporated ice cream (8.10 and 10.58 at 5 and 10% level of incorporation respectively).

Table 1. Proximal composition (g/100g) of protein isolate incorporated to ice cream

S. No.	Ice cream		Carbohydrate	Protein	Fat	Ash
1.	Control		25.50±0.3	4.90±0.2	11.50±0.5	1.15±0.05
2.	Bengal gram protein concentrates	5%	26.25±0.2	9.54±0.3	11.85±0.2	1.35±0.04
3.		10%	25.82±0.8	11.76±0.4	11.60±0.4	1.42±0.03
4.	Red gram protein concentrates	5%	26.05±0.3	8.10±0.3	11.75±0.4	1.20±0.01
5.		10%	25.70±0.1	10.58±0.1	11.62±0.2	1.45±0.005
SED			0.3618	0.2467	0.3217	0.0272
CD (0.01)			1.147^{NS}	0.782^{**}	1.019^{NS}	0.0864^{NS}

Values are means ± SDs of triplicate determinations.

3.3. pH and acidity

The acidity and pH values of PPC incorporated ice cream is illustrated in Table 2. There was no significant difference in acidity values between the treatments. The substitution of 5 per cent protein concentrates did not bring about much change in pH values of ice cream samples with respect to control. At 10 per cent pulse protein concentrate incorporation, a slight increase in pH was noticed compared to 5 per cent pulse protein concentrate incorporated samples. The results indicate that the increase in protein substitution by way of PPC increased the pH values. These results are comparable to the results obtained by Atallah and Barakat, (2017) and Gracas Pereira et al., (2011) for the pH of ice cream.

Table 2.Physico chemical properties of PPC incorporated to ice cream

Ice cream		Acidity (%)	pH	Overrun (%)
Control		0.96±0.04	6.65±0.2	5.26±0.1
Bengal gram protein concentrates	5%	1.02±0.04	6.70±0.3	4.71±0.1
	10%	1.08±0.03	6.95±0.2	4.17±0.1
Red gram protein concentrates	5%	1.02±0.006	6.67±0.1	3.09±0.1
	10%	1.05±0.04	6.80±0.09	2.86±0.06
SED		0.0304	0.1807	0.1021
CD (0.01)		0.0964*	0.5728NS	0.3236**

Values are means ± SDs of triplicate determinations.

3.4. Overrun

The values of the overrun of PPC incorporated ice cream (Table 2) revealed that 5 per cent pulse protein concentrate incorporated ice cream had the highest overrun, which was probably due to better foaming capacity of pulse proteins leading to enhanced air bubbles, resulting in a better volume of the frozen sample. However, when the pulse protein concentrate incorporation was increased to 10 per cent level, it caused a more viscous gel matrix, which may have affected air incorporation during the freezing process, providing ice cream samples with decreased overrun. There were significant differences ($P<0.01$) in overrunning among ice cream samples. The results showed that the increased addition of PPC leads to decreased over the run of the frozen samples. Pinto et al., (2006), Marzieh and Mazaheri (2008), Gracas Pereira et al., (2011) also reported that the increased level of incorporation of protein isolates decreased the overrun of ice cream.

3.5. Melting property

When considering the melting property of the ice cream samples, the increase in viscosity appeared to be related to meltdown properties of ice cream samples containing pulse protein concentrates (Table 3). The control ice cream was observed to have the fastest melting ice cream while the 10 per cent pulse protein concentrates substitution ice cream had the lowest melting property. Among the different pulse protein concentrate incorporated ice cream samples, the slowest melting time was found in Bengal gram protein concentrate incorporated ice cream samples. The control ice cream had highest melting property which indicated that increased addition of pulse protein concentrates reduced melting rates of ice cream samples, which was probably due to the liquid binding property of pulse protein concentrates to form a stable gel network, which leads to immobilization of the water molecules to move freely among other molecules of the mix. Similar results were found in the work of El-Nagar et al., (2002) who stated that addition of inulin may act as a stabilizer and its water binding capacity it decreased the association of water molecules, which results

in the reduction of melting characteristics of the ice cream products and also Kaya and Tekin (2001) reported that the increase in viscosity decreased the melting time of ice cream.

Table 3. Melting (ml) property of pulse protein concentrate incorporated ice cream

Time (mins) / Samples	C	BP1	BP2	RG1	RG2
10	0	0	0	0	0
15	30	0	10	25	15
20	45	15	15	40	35
25	50	30	35	50	40
30	-	50	45	-	45
35	-	-	50	-	50
40	-	-	-	-	-

C – Control; BP1 – 5% Bengal gram protein concentrate incorporated ice cream; BP2 – 10% Bengal gram protein concentrate incorporated ice cream; RG1 – 5% Red gram protein concentrate incorporated ice cream and RG2 – 10% Red gram protein concentrate incorporated ice cream.

3.6. Colour value

Colour differences among ice cream samples with different levels of pulse protein concentrate substitution was observed by instrumental analysis and represented in Table 4. Colour values in terms of a* values red (+) and green (-) and b* values yellow (+) and blue (-) were increased with increasing levels of PPC substitution. The lighter colour value was found in control ice cream samples whereas the PPC incorporated ice cream samples had darker colour values which may be due to the presence of the PPC. This is in line with the results of Akewosan, 2009 who reported that substituting of PPC in ice cream formulations increased the a* and b* values.

Table 4. Colour value of PPC incorporated ice cream

Ice cream		L*	a*	b*
Control		86.67±0.2	1.24±0.01	1.39±0.03
Bengal gram protein concentrates	5%	89.21±0.04	1.70±0.01	1.71±0.07
	10%	85.02±0.3	1.77±0.007	1.67±0.02
Red gram protein concentrates	5%	82.04±0.3	1.80±0.07	2.54±0.08
	10%	79.45±0.08	2.04±0.08	2.59±0.1
SED		0.3501	0.0425	0.0605
CD (0.01)		1.1095**	0.1346**	0.1917**

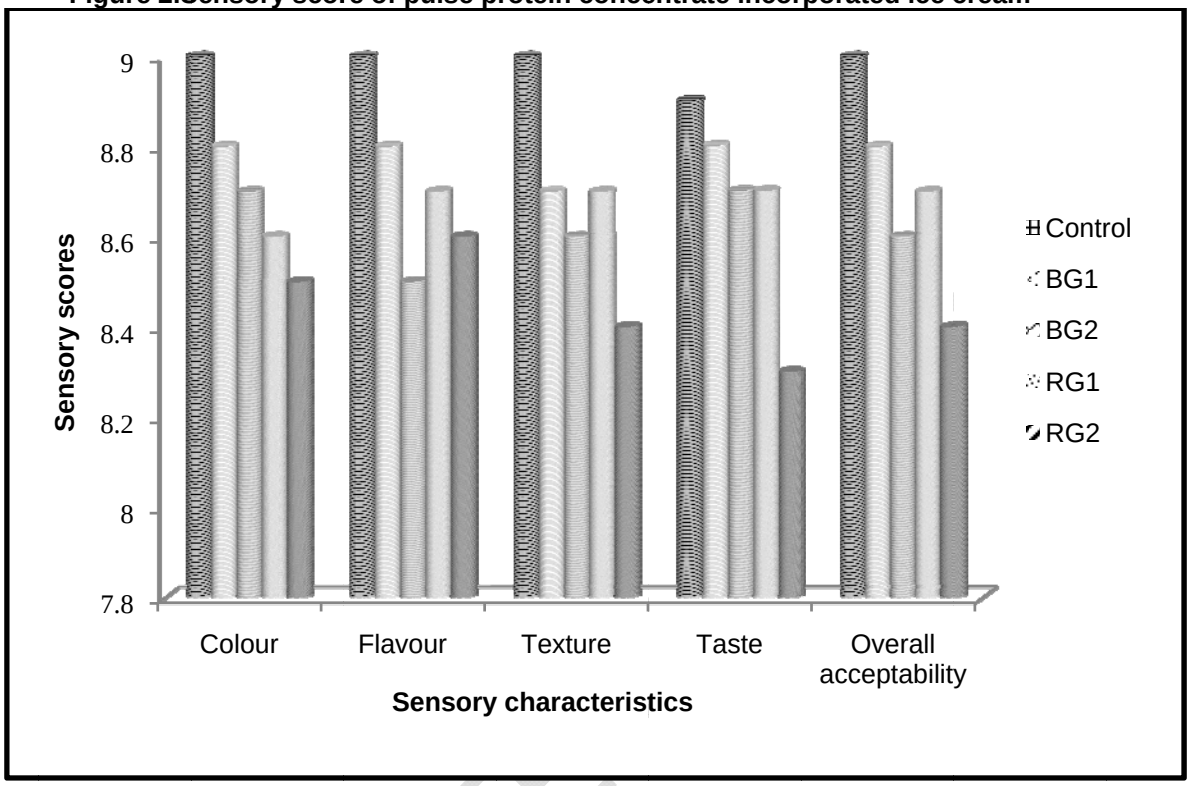
Values are means ± SDs of triplicate determinations.

L* = lightness (0 = black, 100 = white), a* = redness / greenness (+ = red, – = green), b* = yellowness / blueness (+ = yellow, – = blue).

3.7. Sensory characteristics

The ice cream was prepared by incorporating 5 and 10 per cent of pulse protein concentrates and was subjected to sensory evaluation on a nine-point hedonic scale and the results are illustrated in Figure 2. Among the two levels of substitution, 5 per cent level of PPC incorporation was highly acceptable compared to the 10 per cent level of PPC in the ice cream. The overall acceptability was higher in 5 per cent Bengal gram protein concentrate incorporated ice cream (8.8) followed by 5 per cent red gram protein concentrate incorporated ice cream (8.7).

Figure 2.Sensory score of pulse protein concentrate incorporated ice cream



4. CONCLUSION

The technology for extraction of pulse protein concentrates from the selected pulses can be used for gainful enrichment/fortification of protein as suitable for those in need of better nutrition such as the immuno-compromised individuals, convalescents, elderly, adolescents, sportspersons etc., The incorporation of PPC in ice cream will significantly increase the protein content and also confer functional benefits to the body. The addition of PPC in ice cream may provide an acceptable way to introduce additional protein in the diet of the consumers. The novel protein ingredients will help the consumer to have healthier food without compromising the taste and quality of the food products.

REFERENCES

1. Ahanian, B., Pourahmad, R. and Mirahmadi, F. Effect of substituting soy milk instead of skim milk on physico-chemical and sensory properties of sesame ice-cream. Indian Journal of Scientific Research. 2014; 7(1): 1134-1143.

2. Akesowan A. Influence of Soy Protein Isolate on Physical and Sensory Properties of Ice Cream. Thai Journal of Agricultural Science. 2009; 42(1): 1-6.

3. Akin, M.B. and Dasnik, F. Effects of Ascorbic Acid and Glucose Oxidase Levels on the Viability of Probiotic Bacteria and the Physical and Sensory Characteristics in Symbiotic Ice-Cream. Mljekarstvo. 2009; 65, 121-129.

4. Boye, J. I., Aksay, S., Roufik, S., Ribéreau, S., Mondor, M., Farnworth, E. Comparison of the functional properties of pea, chickpea and lentil protein concentrates processed using ultrafiltration and isoelectric precipitation techniques. Food Research International. 2010; 43(2): 537–546.

5. Choo S.Y., Leong S.K. and Henna Lu F.S. Physicochemical and Sensory Properties of Ice-cream Formulated with Virgin Coconut Oil.Food Science and technology International. 2010; 16(6):531–541. DOI: 10.1177/1082013210367546.

6. Dias, M. I., Ferreira, I. C. F. R., & Barreiro, M. F. Microencapsulation of bioactives for food applications. Food and Function.2015; 6(4). 1035-1052. PMid: 25710906. http://dx.doi.org/10.1039/C4FO01175A.

7. El-Nagar, G., Clowes, G, Tudorica, C.M., Kuri, V. and C.S. Brennan. Rheological quality and stability of yog-ice cream with added inulin. International Journal of Dairy Technology.2002; 55: 89-93.

8. Erkaya, T., Dagdemir, E. and Sengul, M. Influence of Cape Gooseberry (Physalisperuviana L.) Addition on the Chemical and Sensory Characteristics and Mineral Concentrations of Ice Cream.Food Research International. 2012; 45, 331-335.

9. Gracas-Pereira G.D., Resende J.V., Abreu L.R., Oliveira-Giarola T.M and Perrone I.T. Influence of the partial substitution of skim milk powder for soy extract on ice cream structure and quality. European Food Research and Technology.2011; 232: 1093-1102.

10. Kaya, S. and A.R. Tekin. The effect of salep content on the rheological characteristics of a typical ice cream mix.Journal of Food Engineering.2001; 47: 59-62.

11. Kumar S., Rai D. C. and Singh D. The functional, rheological and sensory attributes of tulsi (Holy Basil, Ocimum sanctum) extract based herbal ice-cream. The bioscan. 2012; 8 (1): 77-80.

12. Manoharan, A., Ramasamy, D., Naresh, K. C., Dhanalashmi, B. and Balakrishnan, V. Organoleptic evaluation of herbal ice creams prepared with different inclusion levels of aloe vera pulp. Indian Journal of Medicine and Healthcare. 2012; 1(2):25-28.

13. Marzieh, M. and Mazaheri, T. Effect of some stabilizers on the physic chemical and sensory properties of ice cream type frozen yogurt, American Eurasian Journal of Agriculture and Environmental Sciences. 2008; 4 (5): 584-589.

14. Pandiyan, C., Kumaresan, G., Annal, V. R. and Rajarajan, G. Incorporation of whey protein concentrate in ice cream. International Journal of Chemical Sciences.2010; 8: 563-567.

15. Pinto, S. V., Rathour, A. K. Jana A. H., Parjapati, J. P. and Solanky, M. J. Ginger shreds as flavoring in ice cream. Natural Product Radiance.2006; 5:15 18.

16. Ranadheera, C.S., Evans, C.A., Adams, M.C. and Baines, S.K. Production of Probiotic Ice Cream from Goat's Milk and Effect of Packaging Materials on Product Quality. Small Ruminant Research. 2013; 112, 174-180. https://doi.org/10.1016/j.smallrumres.2012.12.020

17. Shaviklo, G. R., Thorkelsson, G., Sveinsdottir, K. and Rafipour, F. Chemical properties and sensory quality of ice cream fortified with fish protein. Journal of the science of Food and Agriculture.2011; 91: 1199- 1204.

18. Sofijan, R. P. and Hartel, R. W. Effects of overrun on structural and physical characteristics of ice-cream. International Dairy Journal. 2004; 14(3): 255–262.