Quality and sensory evaluation of ice-cream fortified with calcium

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Abstract

Milk is an essential dietary calcium source, with estimates from 40% up to 74% of calcium coming from dairy foods. People who avoid dairy foods usually had an inadequate nutritional intake, unless they had an adequate intake of other high calcium dietary foods. A study was conducted to enrich calcium in ice cream to counteract the deficiency. Calcium in the form of calcium citrate was supplemented at three different levels viz. 500mg, 1000mg and 1500mg in one litre of ice cream mix. The enriched ice cream samples were subjected to sensory evaluation for its acceptance, using the 9-point hedonic scale.

Further, the sensory attributes of calcium-enriched ice cream were analyzed with the texture profile analyzer's help. The recovery percentage of calcium in the enriched ice cream was carried out by Atomic absorption spectrometry. The study concluded that calcium could be enriched in ice cream mix at a 500 mg per litre level since it had better acceptability and thereby counteract the calcium deficiency.

Keywords: Ice Cream -Calcium- Enrichment- Sensory evaluation- Texture analysis- Stability

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Introduction

Calcium is an essential nutrient required for critical biological functions such as nerve conduction, muscle contraction, mitosis, blood coagulation, and structural support of the skeleton. Calcium enriched foods are likely to play an increasingly important role in helping consumers achieve newer calcium requirements to reduce the risk of osteoporosis. The calcium source should be well absorbed and beneficial in building peak bone mass during growth and protecting against bone loss later in life. The calcium source must also be compatible with the enriched food, which relates to the salt's solubility, the concentration of calcium in the formula, processing stability, and flavour profile (Weaver, 1998). The challenge for food manufacturers is to provide a product with high calcium content without sacrificing quality for the added health value. Commonly used calcium salts might negatively affect the taste and stability of the final product (Gerstner, 2002). Calcium and Vitamin D enrichment of food and dairy products has increased awareness about the importance of higher calcium and vitamin D intake (Rajarajan, 2020). Dairy products are an excellent source of dietary calcium, which can be further enriched with calcium salts to achieve higher calcium intake per serving (Vyas and Tong, 2004).

Materials and Methods

Calcium in an organic salt form as calcium citrate was used for enrichment in ice cream. The calcium citrate was added at three different levels to contain 500mg, 1000mg and 1500mg in one litre of ice cream mix before homogenization. The calcium-enriched ice creams were subjected to sensory evaluation by a panel of seven members using 9 points hedonic scale (Singh *et al.*, 2014). Then the enriched product was also subjected to texture profile analysis according to Chansathirapanich *et al.* (2016). The texture analysis was performed at 15°C using a TA.XT plus Texture Analyzer (Stable Micro System, United Kingdom). The enriched calcium in ice cream was estimated by Atomic absorption spectrometry to assess the retention (Kazi, 2015). All the statistical analyses were performed by using SPSS. The results were expressed as the mean $\pm$ S.E., and in all applications (ANOVA) the differences were considered statistically significant at $P < 0.05$ and highly significant at $P < 0.01$.

Results and Discussion

The developed calcium citrate enriched ice cream was assessed by sensory evaluation using the 9-point hedonic scale by a semi-trained panel of seven

Table 1: Calcium enriched ice cream assessed by sensory evaluation using the 9-point hedonic scale

Sensory attributes	Control	T ₁	T ₂	T ₃
Flavour	8.625 $\pm$ 0.078 ^d	8.550 $\pm$ 0.080 ^c	7.725 $\pm$ 0.101 ^b	6.925 $\pm$ 0.136 ^a
Body & Texture	8.500 $\pm$ 0.087 ^d	8.400 $\pm$ 0.100 ^c	7.575 $\pm$ 0.079 ^b	6.825 $\pm$ 0.129 ^a
Colour & Appearance	8.100 $\pm$ 0.112 ^c	8.075 $\pm$ 0.097 ^{bc}	7.550 $\pm$ 0.080 ^b	7.050 $\pm$ 0.134 ^a
Melting quality	8.400 $\pm$ 0.106 ^c	8.375 $\pm$ 0.099 ^c	7.400 $\pm$ 0.078 ^b	6.800 $\pm$ 0.130 ^a
Overall acceptability	8.600 $\pm$ 0.093 ^c	8.550 $\pm$ 0.087 ^c	7.375 $\pm$ 0.078 ^b	6.650 $\pm$ 0.116 ^a

Mean $\pm$ SE with different superscripts in a row, differs significantly ($P < 0.05$).

C- Control (not enriched); T1- Treatment with 500mg/L Calcium citrate;
T2 -Treatment with 1000mg/L Calcium citrate; T3- Treatment with 1500mg/L Calcium citrate;
n = 42 for each treatment

Sensory scores based on 9-point hedonic scale, where 1: dislike extremely and 9: like extremely

Table 2: Calcium enriched ice cream assessed by texture profile analysis

Texture parameters	Control	T ₁	T ₂	T ₃
Firmness (g)	363.712±154.794 ^a	338.975± 51.304 ^b	358.497±34.401 ^c	407.169±54.044 ^d
Consistency (g/sec)	5315.251 ±3654.653 ^d	5189.573 ±786.848 ^c	5684.735 ± 468.836 ^b	6013.743 ±1618.333 ^a
Cohesiveness(g)	-312.671 ±166.421 ^a	-302.963 ±100.964 ^{ab}	-149.125 ± 34.929 ^b	-498.341 ±124.578 ^{ab}
Viscosity index (g/sec)	-234.129±212.824 ^c	-233.110±219.267 ^d	-288.637±84.618 ^b	-295.204±139.085 ^a

Mean± SE with different superscripts in a row differs significantly (P<0.05).

C- Control (not enriched);

T₁- Treatment with 500mg/L Calcium citrate

T₂ - Treatment with 1000mg/L Calcium citrate; T₃- Treatment with 1500mg/L Calcium citrate

n = 6 for each treatment

members, and the scores were presented in Table-1.

The statistical analysis revealed that T₁ showed better sensory scores than T₂ and T₃ and hence calcium citrate at 500 mg per litre ice cream mix may be incorporated for enrichment in ice cream.

The enriched ice cream samples were also subjected to texture profile analysis and the results were presented in Table-2, and the results revealed that T₁ was comparable with that of control ice cream

than T₂ and T₃.

The recovery of calcium citrate in the enriched ice cream was assessed by Atomic absorption spectrometry and the results were presented in Table-3. The T₁ had better recovery than T₂ and T₃ and hence calcium citrate could be incorporated at 500 mg per litre ice cream mix for enrichment in ice cream. The findings were in accordance with Chansathirapanich *et al.* (2016).

Figure 1. Recovery of calcium from ice cream enriched with calcium citrate by Atomic absorption spectrometry

Table 3: Recovery of calcium from ice cream enriched with calcium citrate by Atomic absorption spectrometry

Parameters	Control	T ₁	T ₂	T ₃
Quantity of calcium retained in ice cream (mg/L)	2767.500±6.980	2987.500±38.261	3204.667±13.703	3543.500±48.672
Recovery percentage in enriched ice cream		73.34%	70.02%	69.79%

C- Control (not enriched);

T1- Treatment with 500mg/L Calcium citrate

T2 - Treatment with 1000mg/L Calcium citrate; T3- Treatment with 1500mg/L Calcium citrate

n = 6 for each treatment

Conclusions

Adequate calcium intake has been demonstrated to reduce the risk of chronic diseases such as osteoporosis, hypertension, colon cancer, breast cancer, kidney stones, polycystic ovary syndrome and ovarian cancer. Several advanced nations have launched nationwide fortification programs to improve children's calcium status, elderly persons, and post menopause women. Foods are rarely enriched with calcium in India. Hence an attempt has been made to enhance calcium citrate in ice cream at 500mg per litre of the mix which evinced better overall sensory acceptability, texture profile and retention in the finished product. Therefore it might be concluded that calcium citrate enriched ice cream could be a mass intervention to address calcium deficiency.

Authorship contribution statement

G. Rajarajan: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, **R. Annal Villi:** Conceptualization, Methodology, Writing - review & editing. **B. Mohan:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing. **Irshad A:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing.

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Declaration of Competing Interest

All authors declare that there exist no commercial or financial relationships that could, in any way, lead to a potential conflict of interest.

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