Optimization of enrichment levels of vitamin D in Ice cream

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Abstract

The study was conducted to optimize the level of enrichment of vitamin D in ice cream to rectify the deficiency. Vitamin D3 in the form of emulsion enriched at three different levels viz. 1000IU, 1500IU and 2000IU in one litre of ice cream mix. The developed product was subjected to sensory evaluation for its acceptance using 9-point hedonic scale. Further, mechanical way of analyzing the attributes with the help of texture profile analyzer was carried out. The retention percentage of enriched vitamin D was carried out by high performance liquid chromatography. Hence it was concluded that vitamin D at 1500IU/L could be enriched in ice cream mix to counteract vitamin D deficiency at large in general public.

Keywords: Vitamin D3, Ice cream, enrichment, Sensory Evaluation, Ice cream Texture, Fortification

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Introduction

Vitamin D (also referred to as “calciferol”) plays an important role in maintaining a healthy mineralized skeletal system for most land vertebrates including humans. Animals and humans get vitamin D through food and by exposure to sunlight. Exposure to sunlight leads the photo production of vitamin D, in the skin. Once synthesized, vitamin D₃ is metabolized sequentially in the liver and kidney of the human and animal body to 1,25-dihydroxyvitamin D. The biological function of 1,25-dihydroxyvitamin D is to maintain the serum calcium and phosphorus concentrations within the normal range to sustain essential cellular functions and to promote mineralization of the skeleton (Holick, 1996).

Vitamin D not only plays an important role in maintaining mineralized skeletal system, but also act as an immunomodulatory hormone (Priest et al., 2013; Holick, 2007). Various studies showed that vitamin D has significant effect on both the innate and adaptive immune systems. Animal studies clearly revealed that the incorporation of optimum quantity of vitamin D or its metabolites in the regular diet leads to the less occurrence and progression of various immune-related diseases (Aranow, 2011). Most of our regular diet do not contain required level of vitamin D. Foods fortified with vitamin D have a variable amount present and cannot be depended on as a sole source of vitamin D nutrition. Exposure to sunlight provides most humans with their vitamin D requirement. Aging, sunscreen use and the change in the zenith angle of the sun can dramatically affect the cutaneous production of vitamin D. Vitamin D insufficiency and vitamin D deficiency is now being recognized as a major cause of metabolic bone disease in the elderly. Vitamin D deficiency not only causes osteomalacia but can exacerbate osteoporosis. Arora et al. (2014) reported that food fortification is thought to be a highly effective solution and among the most cost-effective public health interventions currently available. Thus present study was conducted to enrich vitamin D in ice cream which is relished by all age groups.

Materials and Methods

Vitamin D₃ in an emulsified form, Vitex D (205,000IU/mL) was used for enrichment in ice cream. Two milliliters of the emulsified vitamin D were blended in 2mL of butter oil to obtain a final concentration of 100,000 IU/mL (Kazmi et al., 2007). Emulsion vitamin D₃ was added at three different

levels namely, 1000IU, 1500IU and 2000IU in one litre of ice cream mix before homogenization. The vitamin D₃ enriched ice creams were subjected to sensory evaluation by a panel of seven members using 9 point hedonic scale (Singh et al., 2014). Then the enriched product was also subjected to texture profile analysis according to Chansathirapanich et al. (2016). The analysis was performed at 15°C using a TA.XT plus Texture Analyzer (Stable Micro System, United Kingdom). The enriched vitaminD₃ in ice cream was estimated by high performance liquid chromatography to assess the retention (Kazmi et al., 2007). All the statistical analyses were performed by using SPSS. Results were expressed as the mean± 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 emulsion vitamin D₃ enriched Ice cream was assessed by sensory evaluation using 9-point hedonic scale by a panel of semi trained seven members and the scores were presented in Table-1 and Figure -1.

The statistical analysis revealed that T₂ showed better sensory scores than T₁ and T₃ and hence emulsion vitamin D₃ at 1500IU 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 T₂ was comparable with that of control than T₁ and T₃. The retention of emulsion vitamin D₃ in enriched ice cream was assessed by high performance liquid chromatography and the results were presented in Table-3. The T₂ had better retention than T₁ and T₃ and hence emulsion vitamin D₃ could be incorporated at 1500IU per litre ice cream mix for enrichment in ice cream. The findings were in accordance with Kazmi et al. (2007) and Leskauskaitė et al. (2016).

Conclusions

Vitamin D deficiency with its multifarious effects on health status, levies a huge burden on the healthcare system worldwide. Several advanced nations have launched nationwide fortification programs to improve vitamin D status. India must follow suit. Foods are rarely fortified with vitamin D in India. Hence an attempt has been made to enrich emulsion vitamin D₃ in ice cream at 1500IU per litre of mix which evinced better overall sensory acceptability, texture profile and retention in the finished product. Therefore it might

Table 1: Enrichment of emulsion vitamin D₃ in Ice cream assessed by sensory evaluation using 9-point hedonic scale (Mean± SE) [#]

Sensory attributes	Control	T ₁	T ₂	T ₃
Flavour	8.625±0.078 ^b	8.525±0.080 ^b	8.550±0.080 ^a	8.425±0.101 ^a
Body & Texture	8.500±0.087 ^c	8.350±0.105 ^{bc}	8.425±0.087 ^b	8.300±0.114 ^a
Colour & Appearance	8.100±0.112	8.025±0.104	8.100±0.112	8.025±0.098
Melting quality	8.400±0.106	8.325±0.110	8.375±0.111	8.225±0.121
Overall acceptability	8.600±0.093 ^c	8.510±0.095 ^c	8.525±0.095 ^b	8.450±0.094 ^a

[#]Mean± SE with different superscripts in a row differ significantly (P<0.05).

C- Control (unfortified);

T₁ - Treatment with 1000 IU/L Vit.D₃;

T₂ - Treatment with 1500 IU/L Vit.D₃; T₃ - Treatment with 2000 IU/L Vit.D₃

n = 42 for each treatment

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

Table 2: Enrichment of emulsion vitamin D₃ in Ice cream assessed by texture analysis (Mean± SE) [#]

Texture parameters	Control	T ₁	T ₂	T ₃
Firmness (g)	31.372±0.389 ^a	29.605±0.356 ^b	30.689±0.371 ^c	28.637±2.114 ^c
Consistency (g/sec)	510.603±21.134 ^c	489.280±18.614 ^c	506.005±21.753 ^{ab}	499.356±27.401 ^a
Cohesiveness (g)	-14.925±1.153 ^b	-12.524±1.127 ^c	- 13.504±1.461 ^a	-13.517±0.642 ^a
Viscosity index (g/sec)	2.368±0.823 ^a	1.915±0.644 ^{ab}	2.311±1.357 ^b	2.779±0.524 ^b

[#]Mean± SE with different superscripts in a row differ significantly (P<0.05).

C- Control (unfortified);

T₁ - Treatment with 1000 IU/L Vit.D₃;

T₂ - Treatment with 1500 IU/L Vit.D₃; T₃ - Treatment with 2000 IU/L Vit.D₃

n = 6 for each treatment

be concluded that vitamin D₃ enriched ice cream could be a public health intervention to address vitamin D 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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Table 3: Retention of vitamin D₃ in Ice cream enriched with emulsion vitamin D₃ by high performance liquid chromatography

Parameters	Control	T ₁	T ₂	T ₃
Quantity of vitamin D ₃ retained in ice cream	9.154±0.303	902.583±7.721	1402.838±5.601	1784.101±9.430
Retention percentage (%)		90.26	93.52	89.21

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

C- Control (unfortified);

T₁ - Treatment with 1000 IU/L Vit.D₃;

T₂ - Treatment with 1500 IU/L Vit.D₃; T₃ - Treatment with 2000 IU/L Vit.D₃

n = 6 for each treatment

Figure 1: Enrichment of emulsion vitamin D₃ in Ice cream assessed by sensory evaluation using 9-point hedonic scale (Mean± SE)*

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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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