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Sensory and texture analysis to optimize vitamin D enrichment 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 D_3 in the form of crystalline enriched at three different levels viz.1000 IU, 1500 IU and 2000 IU 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 1500 IU/L could be enriched in ice cream mix to counteract vitamin D deficiency at large in general public.

Keywords: Ice cream, sensory evaluation, texture analysis, vitamin D enrichment

Introduction
Vitamin D plays an essential role in maintaining a healthy mineralized skeleton for most land vertebrates including humans. Sunlight causes the photo production of vitamin D, in the skin. Once formed, vitamin D3 is metabolized sequentially in the liver and kidney to 1, 25-dihydroxyvitamin D. The major biological function of 1, 25-dihydroxyvitamin D is to keep the serum calcium and phosphorus concentrations within the normal range to maintain essential cellular functions and to promote mineralization of the skeleton (Holick, 1996) [1]. Most foods do not contain any 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) [2] 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 D_3 in Crystalline form was procured from Sigma Aldrich (Saint Louis, MO, USA). Crystalline vitamin D3 was added at three different levels viz., 1000 IU, 1500 IU and 2000 IU in one litre of ice cream mix before homogenization. The vitamin D_3 enriched ice creams were subjected to sensory evaluation by a panel of seven members using 9 point hedonic scale (Singh *et al.,* 2014) [3]. Then the enriched product was also subjected to texture profile analysis according to Chansathirapanich *et al.* (2016) [4]. The analysis was performed at 15 °C using a TA.XT plus Texture Analyzer (Stable Micro System, United Kingdom). The enriched vitaminD_3 in ice cream was estimated by high performance liquid chromatography to assess the retention (Kazmi *et al.,* 2007) [5]. 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 crystalline vitamin D_3 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.

Table 1: Enrichment of crystalline vitamin D_3 in Ice cream assessed by sensory evaluation using 9-point hedonic scale (Mean ± SE) [#]

Sensory attributes	Control	T_1	T_2	T_3
Flavour	8.62±0.08 [b]	8.50±0.08[b]	8.55±0.08[b]	7.41±0.10[a]
Body & Texture	8.52±0.09[c]	8.36±0.10[bc]	8.10±0.06[b]	7.29±0.12[a]
Colour & Appearance	8.07±0.11	8.50±0.10	8.07±0.11	8.00±0.10
Melting quality	8.38±0.10	8.50±0.11	8.36±0.11	8.21±0.12
Overall acceptability	8.60±0.09[c]	8.38±0.09[c]	8.14±0.09[b]	7.45±0.09[a]

[#]Mean ± SE with different superscripts in a row differ significantly ($p<0.05$).
C- Control (not enriched); T_1 - Treatment with 1000 IU/L Vit.D_3;
T_2 - Treatment with 1500 IU/L Vit.D_3; T_3 - Treatment with 2000 IU/L Vit.D_3
n = 42 for each treatment
Sensory scores based on 9-point hedonic scale, where 1: dislike extremely and 9: like extremely

The statistical analysis revealed that T_2 showed better sensory scores than T_1 and T_3 and hence crystalline vitamin D_3 at 1500 IU 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 T_2 was comparable with that of control than T_1 and T_3. The retention of crystalline vitamin D_3 in enriched ice cream was assessed by high performance liquid chromatography and the results were presented in Table-3. The T_2 had better retention than T_1 and T_3 and hence crystalline vitamin D_3 could be incorporated at 1500 IU per litre ice cream mix for enrichment in ice cream. The findings were in accordance with Kazmi *et al.* (2007) [5] and Leskauskaite *et al.* (2016) [6].

Table 2: Enrichment of crystalline vitamin D_3 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 (not enriched); T_1 - Treatment with 1000 IU/L Vit.D_3;
T_2 - Treatment with 1500 IU/L Vit.D_3; T_3 - Treatment with 2000 IU/L Vit.D_3
n = 6 for each treatment

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 crystalline vitamin D_3 in ice cream at 1500 IU per litre of mix which evinced better overall sensory acceptability, texture profile and retention in the finished product. Therefore, it might be concluded that vitamin D_3 enriched ice cream could be a public health intervention to address vitamin D deficiency.

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