Manufacturing technology and production cost of ginger (Zingiber officinale L.) and Aloe vera (Aloe barbadensis) juice enriched probiotic (L. acidophilus) ice cream

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Abstract
In the present study, the proportion ginger (Zingiber officinale L.) and Aloe vera (Aloe barbadensis) juice was optimized by incorporation of 1.5, 3.0, 4.5% and 2.0, 4.0, 6.0% (w/w of mix) respectively. The highest score for sensory attributes of ginger and Aloe vera flavoured probiotic ice cream was recorded for treatment C2A3 i.e. ice cream prepared by using 3.0 per cent ginger juice and 6.0 per cent Aloe vera juice. The cost of ginger and Aloe vera flavoured probiotic ice cream increased with the increase in the level of ginger and Aloe vera juice. The production cost of most acceptable level i.e. C2A3 was ₹ 106.80 per lit. From the result of present investigation it may be observed that ginger (Zingiber officinale L.) and Aloe vera (Aloe barbadensis) juice could be successfully utilized for preparation of probiotic ice cream.

Keywords: Probiotic, L. acidophilus, Aloe barbadensis

Introduction
A large part of Indian population including 70 million rural household, primarily, small and marginal farmers and land less labourers in the country are connected, either directly or indirectly, with the dairy sector. Not only does it bring immense benefits to the economy in terms of raising agricultural yields, meeting productivity targets, creating employment throughout the country, especially in the rural areas, it also has an enormous potential in contributing to the future industrial growth of the economy. Hence, the rapid and coordinated up gradation of this sector attains enormous significance in India’s development.

Probiotic cultures especially Lactobacillus group have a long association with dairy products. Lactic acid bacteria are industrially important organisms recognized for their fermentative ability, as well as their health and nutritional benefits (Evans and Lopez, 2004) [5]. Some species of LAB are components of the normal human intestinal microflora and play an important role in the normal function of digestive tract, as well as in the prevention of intestinal disorders. These bacteria have been widely used as starter cultures for fermentation in the dairy products, like cheese, yoghurts, fermented milk products, as well as in meat, beverages and other food industries (O’Bryan et al., 2015; Burgain et al., 2014) [6,3].

The market for foods that provide nutritional benefits and novel eating experiences to consumers is growing rapidly. Ice cream is one of the most widely consumed dairy products in the world; however, the ice cream available commercially is generally poor in natural antioxidants until fortified with such herbal ingredients. In India, as elsewhere in the world, incidence of diabetes and coronary diseases are on the rise, and hence people have become conscious about their diet. The growing interest of consumers in therapeutic products has led to the incorporation of probiotic cultures into ice cream to result in dietetic ice cream. Some studies have demonstrated that it is possible to produce ice cream type frozen yoghurt using different ratios of fermented mixes. Fermented ice cream products are considered a healthy challenge to the ice cream industry which emphasizes the ways of avoiding or masking too strong yoghurt flavour and the use of other cultured milk products as a base for healthy ice
cream products. Probiotic microorganisms are added to the ice cream mixture in producing fermentative ice cream. Probiotic ice cream has the ability to survive in the human digestive system due to its neutral pH which provides protection for probiotic bacteria. Therefore, it is important to explore the possibility of improving the nutritional attributes of ice cream using ingredients with established health benefits, e.g. natural antioxidants, natural colorants, flavours etc. (Waterhouse et al., 2013) [11].

Ginger (Zingiber officinale L.) is extensively used as a spice for a variety of food and beverages. It is considered as an important medicine since its roots contain several biologically active compounds. These compounds are responsible for many medical applications (Hanou et al., 2016) [8]. Ginger has been used as a spice and as natural additives for more than 2000 years (Bartley and Jacobs, 2000) [2]. Also, ginger has many medicinal properties. Studies have shown that, the long term dietary intake of ginger has hypoglycaemic and hypolipidaemic effect (Ahmed and Sharma, 1997) [1]. Ginger has been identified as an herbal medicinal product with pharmacological effect.

Aloe barbadensis miller (Aloe vera) is a plant native from Africa well known for its considerable medicinal properties (Radha and Laxmipriya, 2015) [10]. This plant is considered to be the most biologically active of the approximately 420 Aloe species identified and characterized till date. Aloe vera is an outstanding source of natural compounds and contains more than 200 different biologically active substances, including vitamins, minerals, polysaccharides, amino acids, anthraquinones, saponins, phytosterols and salicylic acids (Radha and Laxmipriya, 2015; Yeturu et al., 2015) [10, 12]. Several studies have shown that Aloe vera and its constituents act as antimicrobial agents (Pandey and Mishra, 2010; Ferro et al., 2003) [9]. For this reason, as well as for its probiotic properties, Aloe vera represents a valuable functional ingredient for the food industry (Hussai et al., 2015) [7]. Hence, considering the nutritional importance of probiotics, ginger and Aloe vera juice, the present research project entitled Process standardization of probiotic ice cream enriched with ginger (Zingiber officinale L.) and Aloe vera (Aloe barbadensis) juice was conducted.

Materials
For preparation of probiotic ice cream, Fresh buffalo milk was collected from instructional dairy farm of College of Agriculture, Dapoli. Ingredients like cream, skim milk powder, sugar, stabilizer and fresh ginger were purchased from local market. Aloe vera juice was purchased from Patanjali shop. Freeze dried culture of Lactobacillus acidophilus (015) were procured from The National Collection of Dairy Cultures, NDRI, Karnal (Haryana). These were sub cultured and maintained in the laboratory of Dairy microbiology, Department of Animal Husbandry, of the University at Dapoli. The working cultures, maintained in plain skim milk were sub cultured once in a week.

Results and Discussion
Manufacturing Technology
The ice cream having standard composition (10% fat, 37% total solids, 11% milk solid not fat, 0.5% stabilizer and 15% sugar) was prepared as per the standard procedure, narrated by De (2015) [4] with slight modifications. The prepared ginger and Aloe vera juice enriched probiotic ice cream was evaluated for its sensory attributes through panel of 7 to 8 semi trained judges. On the basis of sensory score the acceptance level of ginger and Aloe vera juice was finalized.

Production Cost of Ginger and Aloe vera Juice Enriched Probiotic Ice Cream
One of the objectives of the study was to know the effect of addition of different level of ginger and Aloe vera juice on the cost of probiotic ice cream preparation. The cost of probiotic ice cream production was worked out by considering the prevailing retail market prices of ingredients, similarly other input cost like ice salt as well as electricity consumption was also consider. However it is found that the cost of ice, salt and electricity was constant for all the treatments, as amount of ice and salt required as well as freezing period required was same for all treatments. The cost data are depicted in Table: 1 and illustrated graphically in Fig. 2.

The highest cost (₹ 107.70/lit) was recorded in case of ice cream prepared with 4.5 per cent ginger and 6.0 per cent Aloe vera juice (C3A3) while lowest cost (₹ 103.30/lit) was recorded in case of ice cream prepared with 1.5 per cent ginger and 2.0 per cent Aloe vera juice (C1A1). It was observed that the cost of ice cream increased with the increase in the level of ginger as well as Aloe vera juice. The production cost of most acceptable treatment i.e. ice cream prepared with 3.0 per cent ginger and 6.0 per cent Aloe vera juice (C2A3) was ₹ 106.80/lit.

In present research project, different levels of ginger and Aloe vera juice were evaluated. Optimum level of probiotic culture 7.5% (w/w of mix) was used commonly for all treatments. The trial was conducted with five replications.

Treatment Details

| Treatment | Details |
|-----------|---------|
| C1A1 | Addition of ginger juice @ 1.5 per cent and Aloe vera juice @ 2.0 per cent of ice cream mix (w/w) |
| C1A2 | Addition of ginger juice @ 1.5 per cent and Aloe vera juice @ 4.0 per cent of ice cream mix (w/w) |
| C1A3 | Addition of ginger juice @ 1.5 per cent and Aloe vera juice @ 6.0 per cent of ice cream mix (w/w) |
| C2A1 | Addition of ginger juice @ 3.0 per cent and Aloe vera juice @ 2.0 per cent of ice cream mix (w/w) |
| C2A2 | Addition of ginger juice @ 3.0 per cent and Aloe vera juice @ 4.0 per cent of ice cream mix (w/w) |
| C2A3 | Addition of ginger juice @ 3.0 per cent and Aloe vera juice @ 6.0 per cent of ice cream mix (w/w) |
| C3A1 | Addition of ginger juice @ 4.5 per cent and Aloe vera juice @ 2.0 per cent of ice cream mix (w/w) |
| C3A2 | Addition of ginger juice @ 4.5 per cent and Aloe vera juice @ 4.0 per cent of ice cream mix (w/w) |
| C3A3 | Addition of ginger juice @ 4.5 per cent and Aloe vera juice @ 6.0 per cent of ice cream mix (w/w) |
Flow Diagram

Selection of ingredients ↓
Figuring the mix ↓
Making the mix ↓
Homogenizing the mix ↓
Pasteurizing the mix (68 °C for 30 min.) ↓
Cooling to 37±1 °C ↓
Inoculation of culture ↓
(Optimum level of L. acidophilus)
Incubation (37 °C, for 4 hrs.) ↓
Addition of ginger juice and Aloe vera juice (As per treatment) ↓
Cooling and ageing the mix (0-4 °C for 4 hrs.) ↓
Freezing the mix (-4 to -5 °C) ↓
Packaging of ice-cream ↓
Hardening and storage of ice-cream (-23 to -29 °C)

Fig 1: Flow chart for preparation of probiotic ice cream enriched with ginger and Aloe vera juice

Fig 2: Production cost of ginger and Aloe vera juice enriched probiotic ice cream/lit.

Table 1: Production cost of ginger and Aloe vera juice enriched probiotic ice cream

| Treatments | C1A1 | C1A2 | C1A3 | C2A1 | C2A2 | C2A3 | C3A1 | C3A2 | C3A3 |
|------------|------|------|------|------|------|------|------|------|------|
| Ice cream mix with 7.5% L. acidophilus culture | 1075 | 1075 | 1075 | 1075 | 1075 | 1075 | 1075 | 1075 | 1075 |
| Cost (₹) | 145.97 | 145.97 | 145.97 | 145.97 | 145.97 | 145.97 | 145.97 | 145.97 | 145.97 |
| Ginger juice | Qty. (g) | 15 | 15 | 15 | 30 | 30 | 30 | 45 | 45 |
| Cost (₹) | 1.5 | 1.5 | 1.5 | 3.0 | 3.0 | 3.0 | 4.5 | 4.5 | 4.5 |
| Aloe vera juice | Qty. (g) | 20 | 40 | 60 | 20 | 40 | 60 | 40 | 60 |
| Cost (₹) | 4.0 | 8.0 | 12 | 4.0 | 8.0 | 12 | 4.0 | 8.0 | 12 |
| Total Quantity of enriched Ice cream mix (g) | 1110 | 1130 | 1150 | 1125 | 1145 | 1165 | 1140 | 1160 | 1180 |
| Total Cost of Ice cream mix (₹) | 151.47 | 155.47 | 159.47 | 152.97 | 156.77 | 160.47 | 154.47 | 158.47 | 162.47 |
| Ice + salt + Electricity | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Total cost of Ice cream making | 171.47 | 175.47 | 179.47 | 172.97 | 176.77 | 180.47 | 174.47 | 178.47 | 182.47 |
| % Overrun | 49.54 | 49.11 | 48.70 | 46.67 | 45.85 | 45.49 | 44.74 | 44.40 | 43.64 |
| Total Quantity Ice cream obtained (ml) | 1660 | 1685 | 1710 | 1650 | 1670 | 1695 | 1650 | 1675 | 1695 |
| Cost of Ice-Cream 100 (ml) (₹) | 10.33 | 10.41 | 10.50 | 10.48 | 10.60 | 10.68 | 10.57 | 10.65 | 10.77 |
| Cost of Ice Cream per lit (₹) | 103.30 | 104.10 | 105.0 | 104.80 | 106.00 | 106.80 | 105.70 | 106.50 | 107.70 |

Rate of ingredients (During 2017-2018):

1. Milk: 54 /Lit.
2. Sugar: 38/kg
3. Ginger Juice: 100/Lit.
4. Aloe vera Juice: 200/Lit.
5. Gelatin: 3000/kg
6. Skim Milk Powder: 320/kg
7. Cream: 182/kg
8. Culture: 300/Ampoule
Conclusion
From the results of the present investigation, it may be concluded that ginger and Aloe vera juice could be successfully utilized for preparation of probiotic ice cream. Addition of ginger and Aloe vera juice and probiotic culture in ice cream improved the sensory as well as chemical quality and acceptability of the product. Besides typical flavour, it also adds medicinal properties to the product. Such flavouring did not appreciably affect the composition of ice cream. The most acceptable quality ginger and Aloe vera juice enriched probiotic ice cream can be prepared by using 3.0 per cent ginger and 6.0 per cent Aloe vera juice with optimum level of probiotic culture (Lactobacillus acidophilus) 7.5% (w/w of mix) was used commonly for all treatments. Production cost of most acceptable quality ginger and Aloe vera juice enriched probiotic ice cream was ₹ 106.80 per lit.

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