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Manufacturing technology and production cost of probiotic (*L. acidophilus*) ice cream

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Abstract
In the present study, the proportion of probiotic culture (*L. acidophilus*) was optimized by incorporation of 5.0, 7.5, and 10.0% (w/w of mix) of probiotic culture. The highest score for sensory attributes of probiotic ice cream was recorded for treatment T2 i.e. ice cream prepared with 7.5 per cent probiotic culture. The cost of probiotic ice cream increased with the increase in the level of *L. acidophilus* culture. The production cost of most acceptable level i.e. T2 was ≠ 97.60/lit.
From the result of present investigation it may be observed that *Lactobacillus acidophilus* culture could be successfully utilized for preparation of probiotic ice cream. The most acceptable quality probiotic ice cream can be prepared by using 7.5 per cent *Lactobacillus acidophilus* culture and having production cost of ≠ 97.60 per lit.

Keywords: Probiotic, *L. acidophilus*, production cost

Introduction
India has a unique pattern of production, processing and marketing/consumption of milk, which is not comparable with any other large milk producing country. The country is the world's largest milk producer and the world's largest consumer of dairy products, consuming almost 100 per cent of its own milk production (Rao, 2017) [8].
The total production of milk in 2015-16 reached 156 million tonnes which is 6.28 per cent annual growth rate. The milk production during 2014-17 has increased by 16.9 per cent compared to the year 2011-14. Per capita availability of milk in India is 337g/day while world average is only 299 g/day. In Maharashtra, milk production increased from 9.54 million tonnes in 2014-15 to 10.1 million tonnes in the year 2015-16 with a growth rate of 6.4 per cent, which is more than country's growth rate of 6.28 per cent, but per capita availability of milk has been 239 g/day in 2015-16 which is substantially lower than national average (Anonymous, 2017) [1]. The term probiotic is derived from the Latin preposition pro (for) and the Greek adjective (biotic), the latter deriving from the noun (bios, life). According to a WHO/FAO report (2002), probiotics are "live microorganisms" which when administered in adequate amount promotes a health benefit on the host. International Life Science Institute (ILSI) Europe suggests a definition according to which a probiotic is "A live microbial food ingredient that, when ingested in sufficient quantities, exerts health benefits on the consumer".
Probiotics are extensively studied for their health promoting effects because they repopulate the beneficial bacteria which can help to kill pathogenic bacteria and fight against infection (Kedar *et al.*, 2010) [6]. Traditionally, probiotics have been associated with gut health as there is a presence of greatest concentration of commensal organisms spread over more than 400/m2 of surface area. The gut flora is required rapidly just after birth and remains stable throughout the life (Bhuwaneshwari *et al.*, 2012) [2]. They are also called friendly bacteria or good bacteria as supported by an increasing number of *in vitro* and *in vivo* experiments using conventional and molecular biologic methods (Rinkee *et al.*, 2011) [9].
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) [7, 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) [10].

Hence, considering the nutritional importance of probiotics culture and ice cream, the present research project entitled Process standardization of probiotic (*L. acidophilus*) ice cream 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 and stabilizer were purchased from local market. 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.

Treatment Details

T0: No addition of pro-biotic culture
T1: Addition of pro-biotic culture @ 5 per cent of ice-cream mix (w/w)
T2: Addition of pro-biotic culture @ 7.5 per cent of ice-cream mix (w/w)
T3: Addition of pro-biotic culture @ 10 per cent of ice-cream mix (w/w)
The trial was conducted with five replications.

RESULTS AND DISCUSION:

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.

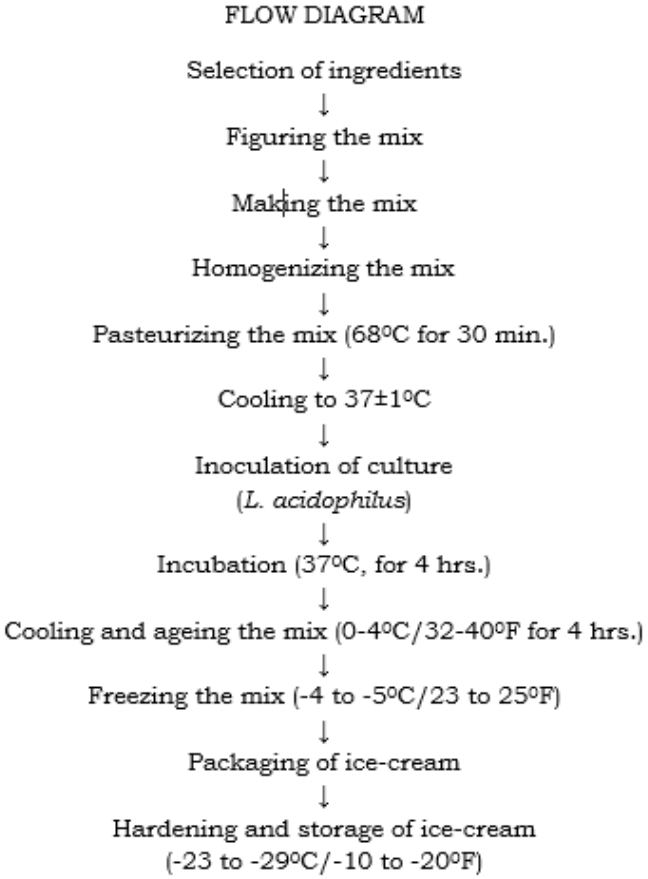

Fig 1: Flow chart for preparation of probiotic ice cream

The prepared 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 probiotic culture of *L. acidophilus* was finalized.

Production cost of probiotic ice cream:

One of the objectives of the study was to know the effect of addition of probiotic culture on the cost of 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 (≠103.40/lit) was recorded in case of ice cream prepared with 10.0 per cent *L. acidophilus* culture (T3) while lowest cost (≠ 89.60/lit) was recorded in case of ice cream prepared without addition of *L. acidophilus* culture (T0). It was observed that the cost of probiotic ice cream increased with the increase in the level of *L. acidophilus* culture. The production cost of most acceptable level i.e. (T2) was ≠ 97.60 per lit.

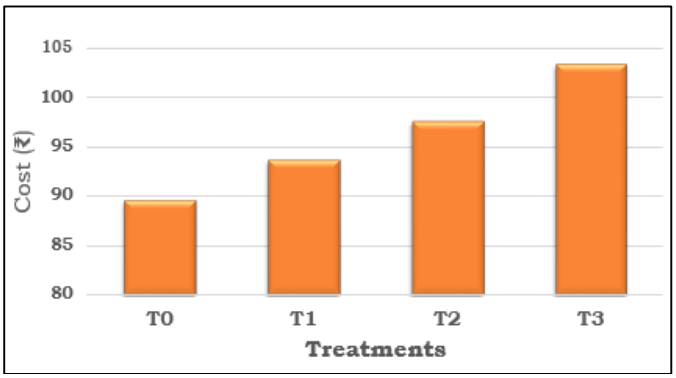

Fig 2: Production cost of probiotic ice cream/lit.

Table 1: Production cost of probiotic ice cream

Treatments		T0	T1	T2	T3
Milk	Qty. (g)	530	530	530	530
	Cost (□)	28.62	28.62	28.62	28.62
Sugar	Qty. (g)	150	150	150	150
	Cost (□)	5.70	5.70	5.70	5.70
Gelatin	Qty. (g)	5	5	5	5
	Cost (□)	15	15	15	15
Skim Milk Powder	Qty. (g)	95	95	95	95
	Cost (□)	30.40	30.40	30.40	30.40
Cream	Qty. (g)	220	220	220	220
	Cost (□)	40	40	40	40
Culture	Qty. (g)	0	50	75	100
	Cost (□)	-	16.83	26.25	35.00
Total Quantity Ice Cream mix prepared (g)		1000	1050	1075	1100
Total Cost of Ice Cream mix (□)		119.72	136.55	145.97	154.72
Ice + salt + Electricity		20	20	20	20
Total cost of Ice cream making		139.72	156.55	165.97	174.72
% Over Run		56.0	49.04	58.14	53.64
Quantity Ice Cream obtained (ml)		1560	1670	1700	1690
Cost of Ice Cream 100 (ml) (□)		8.96	9.37	9.76	10.34
Cost of Ice Cream per lit (□)		89.60	93.70	97.60	103.40

Rate of ingredients (During 2017-2018):

1. Milk: 54 /Lit.
2. Sugar: 38/kg
3. Gelatin: 3000/kg
4. Skim Milk Powder: 320/kg
5. Cream: 182/kg
6. Culture: 300/Ampoule

Conclusion

From the results of the present investigation, it may be concluded that *Lactobacillus acidophilus* culture could be successfully utilized for preparation of probiotic ice cream. Addition of *Lactobacillus acidophilus* 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 probiotic ice cream can be prepared by using 7.5 per cent *Lactobacillus acidophilus* culture and having production cost ≠ 97.60 per lit.

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