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Formulation and Evaluation of Skim Milk Curd Substituted with Inulin

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Abstract
Roots of *Cichorium intybus* were pulverized and boiled with five parts of water for 20 minutes. The extract was cooled and transferred to bottles and kept at a temperature of -10 ºC for 3 days for the separation of inulin. The frozen extract was melted at 25 ºC for inulin to precipitate. After discarding the supernatant, the precipitated inulin was mixed in different quantities with skim milk. The mixture was inoculated with active cultures obtained from homemade curd and was incubated at room temperature, overnight and compared with curd prepared using standardized milk (control). The samples were tested for physico-chemical and sensorial parameters. The titratable acidity of the control (0.372%) was the highest; total solids and viscosity were higher in variation2 as 48% and 2.600 respectively. Syneresis was lowest in variation2. The results of the sensory analysis on a five-point hedonic scale showed variation1 to be acceptable with an overall acceptability of 4.8.

Keywords: Inulin, Skim milk curd, Fat replacer, Prebiotic, Functional foods.

1. Introduction
Curd is an important fermented product used in India as a refreshing beverage. It has mild pleasant flavour, with a clean acidic taste, a creamy white colour with a smooth, glossy surface and cream layer on top. (Srinivasan al. 2011) [12]. Curd forms the richest source of "Probiotics". Prebiotics are "selectively fermented ingredients that allow specific changes, both in the composition and/or activity in the gastrointestinal micro-flora that confers benefits upon host wellbeing and health". It is used in the treatment of Insomnia, AIDS, Cancer etc (Milind al.; Jyoti al. 2014) [11]
Symbiotic are "mixtures of probiotics and prebiotics that beneficially affect the host by improving the survival and implantation of live microbial dietary supplements in the gastrointestinal tract" are generally accepted (Henrik Andersson al. 2001) [5]. Inulin is a prebiotic that has symbiotic action with probiotic.
Fat is a major constituent of milk. Removing fat from milk changes its rheological and sensory properties such as mouth feel, color and flavor (Brennan al.; Tudorica al. 2008). Despite the consumer awareness of the health benefits of low fat / low calorie diet, sensory properties are still a very strong factor motivating selection of food and many consumers are reluctant to sacrifice taste in favor of health benefits. Hence, it is desirable to address this consumer need by offering food products that deliver optimal sensory attributes along with nutritional advantage. (McIlveen al.; Armstrong al. 1995) [10]
Inulin has been found to mimic properties of fat in food products (Kip al.; Meyer al.; Jellema al.; 2006) [8]. Approximately, 0.25 gram of inulin can replace 1g of fat in food (Coussement al. 1999) [3]. Roots of *Cichorium intybus* (chicory plant) are one amongst the richest sources of inulin next to Jerusalem artichoke. Addition of inulin to food products like low fat yogurt not only makes them rich in dietary fiber, but also improves their physicochemical and sensory properties by imparting fat like textures (Coussement al. 1999) [3].
Inulin forms microcrystals when mixed with water or aqueous food materials. These microcrystals are too small for detection in the mouth, but interact to form a particle gel that provides a smooth, creamy, fat-like texture. Inulin has a clean, neutral flavor and it has been widely used to replace fat in cheese, fermented milk products etc.

2. Materials and Methods

2.1 Preparation of inulin extract

Inulin extract was obtained from semi-dried chicory roots, for which the roots were ground to a powder in a pulveriser with a standard mesh size. With one part of the pulverised root, about five parts of water was added and allowed to boil for 20minutes, cooled and transferred to bottles and kept at a temperature of -10 °C for 3 days. The frozen extract was melted at 25 °C and inulin was precipitated. The supernatant was discarded and the precipitated inulin was alone used for subsequent development of the product. (Gupta, A.K., Kaur, N. and Kaur, N. 2003) [1].

2.2 Preparation of curd (general methodology):

Skim milk was fermented with active cultures obtained from the homemade curd (back slopping). The curds after fermentation were stored at refrigerated temperature.

2.3 Preparation of curd (experimental methodology)

The skim milk (1000 ml) was separated into two 500 ml quantities and used for the product development (Table 1). They were separately boiled and to this boiling skim milk, precipitated inulin was added in two different quantities as 5.13 g and 20.52 g. The mixture was cooled and inoculated with active cultures obtained from the homemade curd and allowed to ferment overnight. These curds were compared with the curd prepared from standardized milk.

Table 1: Preparation of curd (experimental methodology)

Ingredients	Control	Variation1	Variation2
Standardised milk	500 ml		
Skim milk		500 ml	500 ml
Active culture	5 g	5 g	5 g
Inulin (as fat replacer and prebiotic)		5.13 g*	20.52 g*

*1g of fat was found to be replaced by 0.25g of inulin (paper)
4% fat as in standardized milk (compared to skim milk) was compensated by 20.52 g of inulin.

2.4 Methodology for tests performed

a) Preparation of Sample of curd for tests

To get a representative sample particularly in case of a thick-set product, the whole of the contents was poured out into a mortar and mixed thoroughly until homogenous mass was obtained. Aliquots were weighed out from this well mixed sample.

b) Treatable acidity

The titratable acidity was analyzed based on neutralization with standard NaOH solution as per AOAC procedure.

c) Total solids: AOAC procedure

Total solids content was found by gravimetric analysis method as per AOAC procedure.

d) Syneresis

The gel strength of the curd was found out by centrifuging the curd sample at 1500 rpm for 15min and measuring the supernatant separated. (Coussement al.1999) [3].

e) Viscosity

The viscosity of the curd was found using Ostwald's viscometer.

3. Results and Discussion

3.1 Titratable acidity

The titratable acidity of the variations was comparable to that of the standard (Figure 1). This result was in line with the findings of (Guven al. 2005) [4] which revealed that use of inulin did not significantly affect the pH of curd. Also, Mazloomi, S. M. *et al*. (2010) reported that addition of inulin and synergistic microorganisms to curd had no effect on the rate of increase in the pH and acidity compared to adding either of them and fermenting for 4 hours reported. (Refer Figure 1).

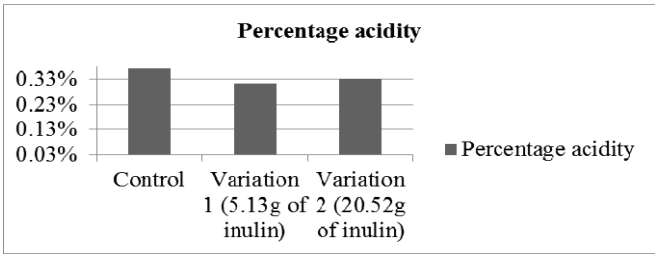

Fig 1: Titratable acidity in curd

3.2 Total Solids

Total solids were higher in variation 2 (48%) as compared to the standard and variation1 which was found to be 38% and 41.5% respectively. The significant increase in total solids may be attributed to the higher quantity of inulin present in variation 2, which is absent in the standard and in the variation1 equaling to 1g of fat. (Refer Figure 2)

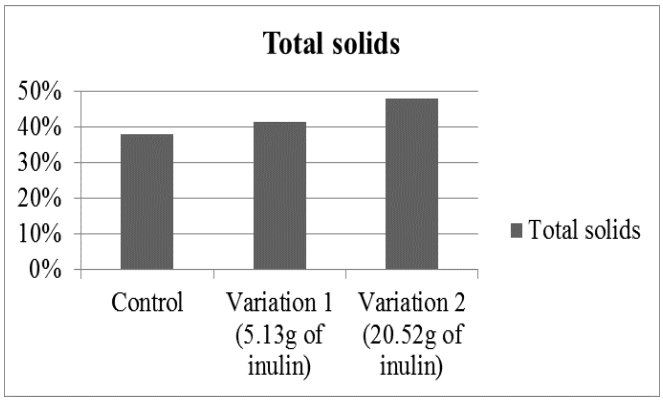

Fig 2: Total solids in curd

3.3 Syneresis

The syneresis of the standard (1.6ml) and variations (1- 1.0ml and 2- 0.6 ml), reveals that the quantity of whey decreased with increase in inulin content because inulin has excellent water binding capacity which allows lesser quantity of whey to get separated. (Refer Figure 3)

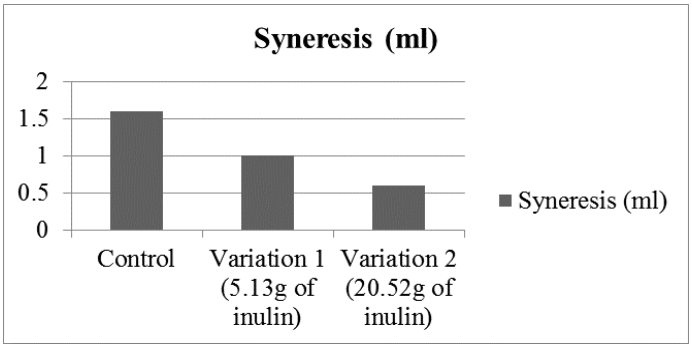

Fig 3: Syneresis and gel strength of curd

3.4 Viscosity

Viscosity measurement revealed that inulin incorporation in higher amounts increased the viscosity of the curd (2.600Cp) compared to the standard (Refer Figure 4). Whereas viscosity of Variation1 (2.454Cp) was comparable to that of standard

(2.300Cp). Thus presence of optimum quantity of inulin significantly contributes to mouth-feel as that of standard curd.

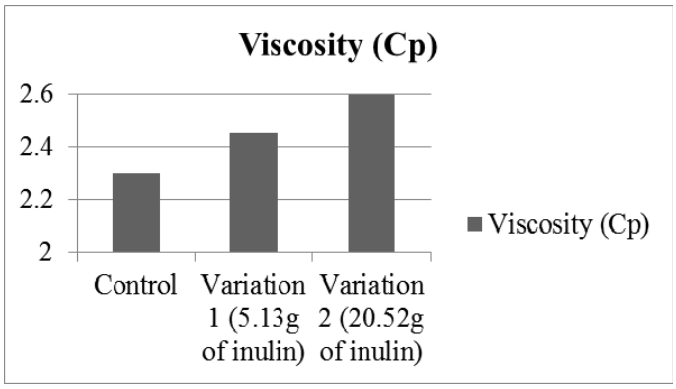

Fig 4: Viscosity of curd

3.5 Sensory Analysis

Sensory analysis was carried out for the standard and variations1 and 2 with 20 semi-trained panelists on a 5-point hedonic scale. Characteristics such as flavor, texture, appearance and overall acceptability were measured. The results showed that variation1 was better accepted than the standard and variation2. The texture of variation1 was given a score of 4.7, flavor 4.5, appearance 4.5 and overall acceptability 4.8. (Refer Figure 5)

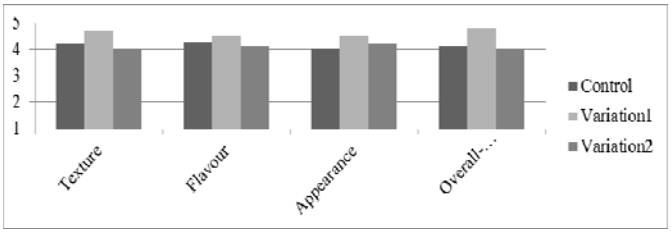

Fig 5: Sensory analysis

4. Conclusion

The development of functional food is an opportunity to contribute to the improvement of the quality of the food offered to consumers as well as benefit his well-being and health. Inulin incorporation in curd making has significant benefits as pre biotic and as fat replacer in low fat curd. In the present study, Variation 1 had acceptable physicochemical and sensory characteristics including the acidity, gel strength, texture, mouth-feel and overall acceptability.

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