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Development and characterization of functional cultured buttermilk utilizing *Aloe vera* juice

Deepak Mudgil*, Sheweta Barak, Palak Darji

Department of Dairy and Food Technology, Mansinhbhai Institute of Dairy and Food Technology, Mehsana, Gujarat 384002, India

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ABSTRACT

Cultured buttermilk is an ancient dairy beverage with high nutritive and therapeutic value. In the present study, a novel cultured buttermilk beverage was formulated using *Aloe vera* juice fortification. The developed cultured buttermilk was analyzed for viscosity, phase separation, acidity, pH and sensory properties. Cultured buttermilk fortified with *Aloe vera* juice (5–20%) showed non-significant changes in buttermilk acidity and pH. However, *Aloe vera* juice decreased the phase separation and increased the viscosity of the beverage. The viscosity of the cultured buttermilk samples increased proportionally with increased levels of juice fortification. Sensory characteristics of *Aloe vera* fortified cultured buttermilk samples were also evaluated such as color and appearance, body and mouthfeel, flavor and overall acceptability. Samples with 10% *Aloe vera* juice level obtained the highest scores in the sensory evaluation. *Aloe vera* juice fortification at 10% level in cultured buttermilk improved nutritive, physicochemical and desirable sensory characteristics.

1. Introduction

Functional foods have a potentially positive effect on human health beyond basic nutrition due to bioactive components present in them (Fardet, 2015). For centuries, milk and dairy products constitute an important part of human diet (Erzen, Kac, & Pravst, 2014). Cultured buttermilk, also known as "Chhash" in South Asian countries is a well known fermented dairy product with therapeutic value (Ghanshyambhai, Balakrishnan, & Aparnathi, 2015). In India, cultured buttermilk is usually consumed after the meal. The sweetened form of cultured buttermilk is known as *lassi*. The favourable effects of cultured buttermilk, yoghurt and other dairy fermented products on human health have been well studied and documented by scientists all over the world (Aneja, Mathur, Chandan, & Banerjee, 2002; Conway, Gauthier, & Pouliot, 2014; Gille, 2011; Mudgil & Barak, 2016; Shah, 2006). Cultured buttermilk forms an important part of several Ayurvedic formulations due to its health promoting effects (Devi, Rao, & Ravindra, 2010). Traditionally cultured buttermilk is prepared by churning of cultured cream or cultured milk curd. Modern method of cultured buttermilk preparation includes addition of culture to low-fat milk followed by fermentation and homogenization. In India, mixed strain of thermophilic and mesophilic homofermentative bacterial cultures are used for commercial production of dahi or cultured buttermilk. The white butter gets separated from curd by churning while the left over liquid is referred to as cultured buttermilk.

The commercial production of cultured buttermilk in India involves curd making, homogenization of curd and its subsequent dilution with water. Both cow and buffalo milk can be used for cultured buttermilk manufacturing. However, there occurs a difference in the color of buttermilk produced from them. Cow milk results in slightly yellow colored cultured buttermilk while buttermilk produced from buffalo milk is white in color. On industrial scale, mixed milk is generally used for making yoghurt & cultured buttermilk (Aneja et al., 2002). Although buttermilk is similar in composition to skim milk, it is much nutritious than the later due to the presence of health beneficial microorganisms (Kumar, Gupta, Kumar, & Kumar, 2015). Also, cultured buttermilk contains more phospholipids than skim milk (Conway et al., 2014). Cultured buttermilk is a good source of calcium, phosphorus, vitamin B_2, vitamin B_{12}, pantothenic acid-vitamin B_5, zinc, potassium, protein, iodine and molybdenum which makes it a nutritious and health-supportive food beverage. However, cultured buttermilk is deficient in iron, vitamin C and dietary fibre like milk and milk products. The consumption of cultured buttermilk in diet helps in digestion, boosting the immune system and reducing the serum cholesterol levels (Nirgude, Binorkar, Parlikar, Kirte, & Savant, 2013). Cultured buttermilk is considered a healthy food due to inherent nutritive value but is naturally deficient in vitamin C, iron and dietary fibre. The current recommended daily allowance (RDA) for ascorbic acid ranges between 100 and 120 mg/per day for adults (Naidu, 2003).

* Corresponding author.
E-mail address: dsmudgil@yahoo.com (D. Mudgil).

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Aloe vera has been utilized from ancient times for its therapeutic characteristics. Seventy five active components have been identified from the inner gel of *Aloe vera* (Eshun & He, 2004). Major active components of *Aloe vera* include acemannan, glycoprotein, anthraquinones, steroids, antioxidants etc (Surjushe, Vasani, & Saple, 2008). *Aloe vera* gel consumption can also improve digestion, blood and lymphatic circulation, as well as kidney, liver and gall bladder functions (Pisalkar, Jain, & Jain, 2011). *Aloe vera* contains a minimum of three anti-inflammatory fatty acids, which help in smooth functioning of the stomach, small intestines and colon. The research is still continuing on the medical use of *Aloe vera* for cure and treatment of AIDS and cancer (Kumar & Bhowmik, 2010). *Aloe vera* juice is low-viscous, tasteless, little greenish, odorless in nature and hence do not affect the product characteristics. There is an increasing demand among consumers for fibre enriched products due to its health benefits (Bary, 2010). The beneficial role of dietary fibre in human nutrition has led to a growing demand for incorporation of novel fibres into foods (Mudgil & Barak, 2013; Mudgil, Barak, & Khatkar, 2014). Dietary fibre offers many health benefits such as protection against cardiovascular disease, protection against type II diabetes, improved laxation, improved immune system and weight management (Kapusniak, Ptak, Zarski, Nebesny, & Kapusniak, 2014).

In the present study, *Aloe vera* juice fortification in cultured buttermilk was carried out to make it a complete nutritive beverage containing vitamin C, iron and dietary fibre. *Aloe vera* juice was selected for vitamin C, iron and dietary fibre fortification of cultured buttermilk as it is a good source of each of these components. There is very little information in the literature about fortification of buttermilk. Some researchers studied the effect of fortification of vitamins and minerals on buttermilk characteristics (Saviraite, Kersiene, Leskauskaite, & Jasutiene, 2012; Ziarno, Zareba, & Piskorz, 2009). However, dahi and flavoured milk fortified with *Aloe vera* gel has been prepared and characterized (Jothylingam & Pugazhenthi, 2013; Ramachandran & Srividya, 2014). There are lot of research papers on fortification of dairy products (Mudgil, Barak, & Khatkar, 2016a; Raju & Pal, 2014), bakery products (Mudgil, Barak, & Khatkar, 2012), processed foods (Mudgil, Barak, & Khatkar, 2016b, 2011), beverages etc, but research on fortification of cultured buttermilk still needs attention of food scientists and has a wide scope of research and commercialization. Cultured buttermilk can also be used as a vehicle for delivery of bioactive components and development of functional foods.

2. Materials and methods

2.1. Materials

Pasteurized and standardized double toned milk with 1.5% fat and 9.0% SNF was procured from Dudhsagar Dairy, Mehsana, India and stored at 4 °C until used. A freeze-dried direct vat set (DVS) yoghurt culture (RST-744 & CHN-11) containing a mixed strain of thermophilic and mesophilic homofermentative bacterial culture was obtained from Chr. Hansen Inc. (Milwaukee, WI). The culture was stored at −18 °C until used. *Aloe vera* juice was procured from Panchwati Prayogshala Pvt. Ltd., India and was stored in a refrigerator until used.

2.2. Preparation of cultured buttermilk

Control cultured buttermilk sample was prepared using pasteurized double toned milk of 1.5% fat and 9.0% SNF (Fig. 1). All the glasswares used in study were pre-sterilized. The contact surfaces of the incubator and blender were alcohol sanitized. The milk was heated to 42 °C on a table-top stirring hot plate (Nova Instruments Pvt. Ltd.) followed by inoculation with RST-744 (0.1 unit/litre) and CHN-11 (0.01 unit/l) culture blend and mixing the culture thoroughly in the milk. The milk was transferred to the pre-sterilized beakers (1 l capacity) with lids. The samples were incubated at 42 °C in temperature controlled incubator (Patel Instruments Ltd, India) for 7 h. After seven hours of fermentation curd setting was observed. After curd setting, agitation or breaking was carried out for 90 s using laboratory blender (Cello Blend-N-Mix 300, India) at a speed of 10,000 rpm, followed by addition of pasteurized chilled water and then homogenization was carried out. Two stage homogenization was carried out using laboratory homogenizer (SPX Flow Technology, Denmark) at pressures 1st stage = 100 kg/cm^2 and 2nd stage = 20 kg/cm^2. *Aloe vera* juice fortified cultured buttermilk samples were processed similarly as control cultured buttermilk sample except the step involving addition of pasteurized chilled water. *Aloe vera* juice fortification was carried out by addition of *Aloe vera* juice to the pasteurized chilled water at 5–20% levels on weight basis (Table 1). All cultured buttermilk

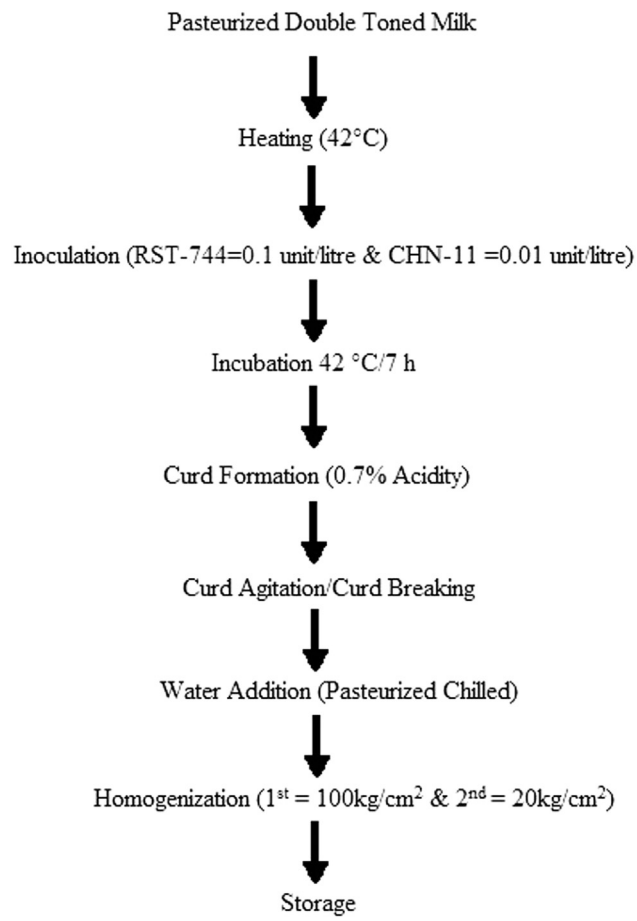

Fig. 1. Process flow chart for making buttermilk.

Table 1
Formulations of control and Aloe vera fortified buttermilk.

Buttermilk sample	Curd (per 500 g)	Aloevera (per 500 g)	Water (per 500 g)
T_1	300	0	200
T_2	300	25	175
T_3	300	50	150
T_4	300	75	125
T_5	300	100	100

T_1 = Control, T_2 = 5% Aloe vera juice, T_3 = 10% Aloe vera juice, T_4 = 15% Aloe vera juice, T_5 = 20% Aloe vera juice.