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Review Article
Augmentation of Biofunctionality of Dahi

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Abstract

Dietetic significance of dahi, an Indian fermented milk product is well documented. Consumer's inclination towards healthful foods has resulted in renewed interest in dahi. Adoption of diverse technology for dahi manufacture results in wide variation in the chemical and microbiological quality of dahi available in the market. Attempts should be made towards process standardization for dahi manufacture to have a consistent quality product with augmented dietetic properties to project dahi into the global market as a potential functional food. Attempt has been made to review literature on technological and microbiological aspects of dahi manufacture to recommend innovative approaches to augment the functional properties of traditional dahi. Both review and research papers related to biotechnological aspects influencing the nutritional and therapeutic of dahi published in diverse Journals have been considered. Reviewed literature indicated that functional properties of traditional dahi could be enhanced either by modification of basic milk, exopolysaccharide producing starter cultures, bacteriocin producing starter cultures, introduction of probiotic cultures and inclusion of diverse food additives such as fruit juices, herbs and spices. Adoption of recommended biotechnological modifications in the traditional method of dahi manufacture would enhance the biofunctionality of dahi and can be projected as a functional food in the world market.

Key words: Dahi (curd), lactic fermentation, biofunctionality, biotechnological modifications, probiotics, health promotion, functional food

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INTRODUCTION

Dahi is considered the oldest Indian fermented milk product and may be considered the western equivalent to yoghurt. Dahi is obtained by lactic fermentation through the action of single or mixed strains of lactic acid bacteria or by lactic fermentation accompanied by alcoholic fermentation by yeast from milk. Dahi does not include milk coagulated by the addition of acids or milk coagulating enzymes[1]. Traditionally, dahi was obtained by natural culturing of boiled and subsequently cooled cow, buffalo or mixed milk or with earlier day's curd, resulting in variability in its quality due to undefined starter cultures and uncontrolled fermentation[2,3]. Several market survey reports indicated diversity in physico-chemical, microbial, nutritional and therapeutic properties of dahi[3-8].

BIS[1] recommended application of single culture of *Streptococcus lactis*, *Streptococcus diacetylactis* and *Streptococcus cremoris* or in combination with or without *Leuconostoc* species. Conjugated use of above starter combination with *Lactobacillus bulgaricus*, *Lactobacillus acidophilus* and *Lactobacillus casei* and *Streptococcus thermophilus* may also be adopted. Consumer's inclination towards healthful food has resulted in renewed interest in dahi owing to its nutritional and therapeutic significance[9] and consumption of probiotic dahi as a functional food is recommended[10]. Recently, attempts have been made to include certain probiotic and beneficial bacteria, different herbs, fruit pulp or juice with the objective of enhancing the dietetic properties of traditional dahi[10].

In the present article attempt has been made to review diverse research findings to suggest biotechnological modifications that can be adopted for optimizing dahi production with augmented functional properties to project dahi as a functional food in the world market.

UPGRADATION OF BIOFUNCTIONALITY OF DAHI

Attempt has been made to produce dahi with enhanced nutritional and therapeutic attributes with the modification of basic milk, employing starter cultures capable of producing exopolysaccharide (EPS) or bacteriocin, introduction of probiotic cultures and inclusion of additives. Based upon recent research diverse modifications suggested to produce dahi with enhanced functional properties are delineated.

Modification of basic milk: Dahi may be obtained by culturing cow, buffalo and goat milk or their blends and the quality of dahi differs with the type of milk. Nutritional components of milk such as vitamins, proteins, minerals and carbohydrates are modified under the influence of metabolic activity of starter cultures during fermentation[11]. Higher volatile acidity production (32.5 vs. 29.2 mL/50 g) by dahi culture in buffalo milk than in cow milk was noted[12]. Nahar *et al.*[13] noted highest total viable count in dahi made from buffalo milk (5.996 ± 0.05) than those obtained from cow (5.878 ± 0.03) or goat milk (5.859 ± 0.05) suggesting preference of buffalo milk over other milk for dahi production. To obtain desirable body of dahi with lower syneresis, milk intended for dahi manufacture may be concentrated either by addition of soya milk[14], skimmed milk powder[15] or whey protein concentrate[16].

Soya bean contains approximately 35% protein, 31% carbohydrate, 17% fats, 5% mineral and 12% moisture[17] and contains essentialamino acidand secondary metabolites such as isoflavone, saponins, phytic acids, phytosterols, trypsin inhibitors and peptides[18]. Soy milk is a complete protein and can replace animal protein and other sources of dietary fiber, vitamins and minerals[19] and may also be utilized for dahi manufacture. Cow milk or soya milk blended with skimmed milk powder was cultured employing bacterial strain of *Streptococcus thermophilus* DG 1 isolated from home-made milk curd to obtain cow milk curd and soya milk curd. Greater increase in folic acid, riboflavin and thiamine contents was noted in soymilk curd than cow milk curd[16]. Administration of skimmed milk powder in soya milk can be suggested over cow milk during dahi manufacture due to greater enhancement in nutritional attributes. Singh *et al.*[20] suggested substitution of 25% buffalo milk with soymilk for misti dahi manufacture. Pushkala and Srividya[21] encountered lower whey syneresis in dahi obtained with substitution of skimmed milk powder by 0.15% Aloe gel even after storage at 10°C for 7 days.

Higher protein with lower fat content of coconut milk suggests its application as a promising food component that could prevent oxidative damage and reduce the risk of degenerative diseases[22]. Saha *et al.*[23] recommended substitution of skimmed milk with 10% coconut milk during manufacture of dahi with higher total viable count (8.27×10^5 vs. 8.07×10^5 CFU g^{-1}).

Exopolysaccharide producing starter cultures: Certain strains of LAB are capable of producing EPS[24] either as capsular polysaccharides that are tightly associated with the cell surface or slime EPS that are secreted into the extracellular environment[25] Mozzi 2006 and possess thickening and gelling properties[26]. The EPS from LAB are categorized into two groups, homo and hetero-EPS. Homo-EPS are composed of one type monosaccharide, whereas hetero-EPS consist of regular repeating units of 3-8 different carbohydrate molecules. Vijayendra *et al.*[27] reported EPS produced by non-ropy strain of *Leuconostoc* sp. CFR 2181, isolated from dahi consisted mainly of 91% glucose with minor quantities of 1.8% rhamnose and 1.8% arabinose.

Good quality fermented milk could be produced from a milk without enhancing its total solid content with the adoption of EPS producing starter cultures. Well known EPS producers are *Lactobacillus fermentum*, *Lactobacillus casei*, *Lactobacillus acidophilus*, *Lactobacillus brevis*, *Lactobacillus curvatus*, *Lactobacillus delbrueckii* subsp. *bulgaricus*, *Lactobacillus helveticus*, *Lactobacillus rhamnosus*, *Lactobacillus plantarum*, *Lactobacillus johnsonii* etc. Advantages proclaimed with the application of EPS producing cultures are optimum acid production, lesser whey separation, higher viscosity, increased adhesiveness and stickiness[28] and improved sensory properties[29]. Besides acting as a bio-thickening agent exopolysaccharide (EPS) produced by LAB exhibited beneficial effects on human health due to their greater ability to withstand both technological and gastrointestinal stresses, thereby increasing protection during heat stress (60 fold), acid stress (20 fold) and simulated gastric juice stress (15 fold)[30]. Another *in vitro* experiment revealed EPS of *L. rhamnosus* GG to act as a protective layer for probiotic microorganisms during gut transit[31] and conceal the bacterial surface facilitating an adhesive interaction with other bacteria[32].

Further, EPS may induce positive physiological responses including lower cholesterol levels[33], reduced formation of pathogenic biofilms[34], modulation of adhesion to epithelial cells[35] and increased levels of bifidobacteria showing a prebiotic potential[36]. Therefore inclusion of EPS producing starter cultures should be preferred over non EPS producing ones due to several additional advantages.

Bacteriocin producing starter cultures: Bacteriocins are compounds elaborated by LAB which posses a biogically active protein moiety, capable of exhibiting bactericidal action[37] and are safe for application in food to control the frequent developement of pathogens and spoiling microorganisms[38]. A wide array of antimicrobial substances such as reuterin, reutericyclin[39], bacteriocins, diacetyl and hydrogen peroxide are elaborated by LAB[40] and could be employed to enhance the shelf-life of cultured milk products[41]. Demonstration of antimicrobial activity by neutralized extracellular culture filtrates of *L. plantarum*, *L. fermentum*, *Leuconostoc mesenteriodes*, *Streptococcus bovis* and *Pediococcus pentosaccus* isolated from dahi against *Staphylococcus aureus*, *Bacillus subtilis*, *Salmonella enterica* and *Escherichia coli* suggested their application for biopreservation[42]. Utilization of isolated strains of *L. acidophilus* and *L. casei* isolated from curd capable of exhibiting antagonism against *Staphylococcus* sp., *Pseudomonas* sp., *Klebisiella* sp., *E. coli* and *Proteus* sp. resulted in dahi with a total viable count of 13-15$\times$10^7 CFU mL^{-1} [43]. Culturing of pasteurized milk with isolated cultures of *Brevibacillus brevis* MMB 12 at 42°C/5 h resulted in curd with low acidity in contrast to the curd obtained employing *L. delbrueckii* subsp. *bulgaricus* and the microbial count declined (3.50$\times$10^{10}-2.9$\times$10^9 CFU mL^{-1}) with an increase in acidity (0.58-0.66%) during storage at 16-24°C/8 days[44]. Utilization of isolated cultures, capable of exhibiting antagonism against pathogens for dahi manufacture is recommended due to greater viability of lactic acid bacteria and better stability during storage, desired for exhibiting prophylactic effects.

Dahi obtained by culturing pasteurized milk employing *L. casei* MTCC1408, *L. fermentum* MTCC 903, *L. rhamnosus* MTCC1462, *Lactobacillus ingluviei* ADK10, *Enterococcus faecium*, *Enterococcus durans* ADK14 and *S. thermophilus* MTCC 1938 exhibited antagonism against *E. coli* ATCC 25922, *Klebsiella pneumonia* ATCC 15380, *Streptococcus mutans* ATCC 25175 and *Bacillus subtilis* ATCC 6633[45]. Culturing of milk with nisin producing *Lactococcus lactis* W8 revealed nisin production after 3 h of fermentation which reached its maximum level after 6 h and resulted in dahi exhibiting antibacterial property against spoilage and pathogenic bacteria[46]. *Lactobacillus gasseri* elaborate a gassericin like bacteriocin[47] which has a broad antibacterial spectrum than nisin A[48,49] and is capable of exhibiting health benefits like anti-obesity, antimucosal inflammatory, prevention of colonization of *Helicobactor pylori*[50,51] but careful screening of *L. gasseri* strains is important as its few strains exhibited antagonistic behaviour against dahi cultures[52].

Introduction of probiotic cultures: The FAO/WHO defined probiotics as live micro-organisms that when administered in adequate amounts confer a health benefit on the host[53] and the definition has been endorsed by the International Scientific Association for Probiotics and Prebiotics[54]. For exhibiting prophylactic properties, cultured milk products must retain sufficient population of viable organisms throughout its anticipated shelf-life. Recently, attempts have been made to include certain probiotic and beneficial bacteria with the objective of enhancing the dietetic properties of traditional dahi. Reviewed literature on prophylactic properties by probiotics towards normalization of intestinal flora, anticarcinogenesis, hypocholesterolemic effect, alleviation of lactose malabsorption and allergy suggested their application as functional foods[55]. Endeavour has been made to administrate diverse probiotics with proven health claims with the objective of enhancing functional properties of traditional dahi and to evaluate its efficacy on the basis of both animal and human trials.

Animal and human trials revealed that probiotics can target the gut microflora, immune function[56] and alleviate intestinal inflammation, normalize gut mucosal dysfunction and down-regulate hypersensitivity reaction[57]. Probiotic dahi obtained employing *Lactococcus lactis* ssp. *lactis* biovar *diacetylactis* in conjugation with probiotic culture *Lactobacillus acidophilus* and *Lactobacillus casei* retained acceptable viable counts of 10^7 CFU mL^{-1} [58] and produced higher content of conjugated linoleic acid (18.3$\pm$0.9 vs. 6.1$\pm$0.5%) in contrast to control dahi[59] during refrigerated storage. Higher viable count and conjugated linoleic acid in probiotic dahi may confer nutritional and therapeutical value to the product.

A feeding trial with probiotic dahi obtained with the supplementation of *L. acidophilus* and *L. casei* revealed amelioration of *Salmonella enteritidis* infection by stimulating specific and non-specific immune response[60] and complete suppression of elevation of total and ovalbumin-specific IgE in the serum of ovalbumin-injected mice[61]. Feeding of probiotic dahi containing *L. acidophilus* NCDC 13 increased faecal and caecal bifidobacterial count in mice fed high-fat diet[62]. A randomized controlled clinical trial indicated that a fermented milk Actimel containing *L. casei* DN-114001, *L. bulgaricus* and *S. thermophilus* was more effective than Indian dahi cultured with *L. lactis*, *L. lactis* subsp. *cremoris* and *Leuconostoc mesenteroides* subsp. *cremoris* in reducing the duration of diarrhoea in children[63]. However, amongst various constituting flora of Actimel, only *L. casei* DN 114001 was effective for the reduction of *Clostridium difficile* toxins in the gut of patients receiving antibiotics and reduced the risk of acute diarrhoea in patients receiving antibiotics[64]. Probiotic dahi made employing probiotic *L. casei* (10^7 CFU mL^{-1}) in association with mixed dahi cultures (10^4 CFU mL^{-1}) was more efficacious in protecting against *Salmonella enteritidis* infection in male Swiss albino mice by enhancing innate and adaptive immunity than normal dahi (10^7 CFU mL^{-1}) obtained using mixed dahi cultures[65]. In an another animal feeding trial oral administration of probiotic dahi containing *L. acidophilus* LaVK2 and *B. bifidum* BbVK3 prevents whey proteins hypersensitivity and suppresses IgE and IgG levels and can be recommended as a new alternative therapeutic agent for prevention of allergic diseases[66].

Certain LAB are known to suppress the activity of carcinogen-activating enzymes such as azoreductase, nitroreductase, 7-α-dehydrogenase, β-glucosidase and β-glucuronidase and neutralize the carcinogens[67], whereas probiotic exhibits antimicrobial effect against carcinogen producing microorganisms and alterat the tumour differentiation processes[68]. Probiotic dahi obtained by culturing buffalo milk with *Lactococcus lactis* ssp. *cremoris* NCDC-86 and *L. lactis* ssp. *lactis* biovar *diacetylactis* NCDC-60 in association with *L. acidophilus* LaVK2 and/or *Bifidobacterium bifidum* BbVK3 proved to be a potential nutraceutical intervention to combat oxidative stress and molecular alterations associated with ageing[69] and feeding of probiotic dahi to mice resulted in reduction in myeloperoxidase, β-glucoronidase activity, improved disease activity scores and offer effective adjunctive treatment for management of ulcerative colitis[70], revealed anti-neoplastic and anti-proliferative activities and is capable of preventing colorectal carcinogenesis[71] and may be an effective chemopreventive agent in the management of colorectal cancer[72]. A reduction in DNA damage (54.7 vs. 88.1%) in 1, 2-dimethylhydrazine dihydrochloride (DMH) administered rats were noted due ingestion of dahi cultured with *L. lactis* biovar. *diacetylactis*, *L. acidophilus* and *L. casei* and curd culture in contrast to control dahi[73] or in conjugation with wheat bran[74] indicating enhanced protective potential of dahi against DMH induced molecular alteration in colonic cells during carcinogenesis[75,76]. Lowering of levels of thiobarbituric acid reactive substances, faecal β-glucuronidase and a decline in tumor incidence, tumor multiplicity and tumor volume in gastrointestinal tract[77] and decline in 35% plasma total cholesterol and 72% triglycerides[78] were reported in DMH induced rats due to ingestion of probiotic dahi containing *L. acidophilus* LaVK2 and *L. plantarum* Lp9. Probiotic dahi has been recommended as a potential nutraceutical intervention in prophylaxis and treatment of colorectal cancer[79] and for management of ulcerative colitis[69].

Various studies have revealed cholesterol removing properties in certain lactobacilli[80] as well as in probiotics such as *Bifidobacterium animalis* subsp. *lactis* Bb12[75], *Bifidobacterium lactis*[76], *L. Casei*[80], *L. acidophilus*[80,81], *L. plantarum*[82,83] *L. reuteri*[84], *Pediococcus acidilactici*, *Bifidobacterium adolescentis* and *L. rhamnosus*[85]. Hypercholesterolemic effect of probiotic may be attributed to diversemechanisms like the ability of LAB to bind cholesterol in the small intestine[86], bile salt hydrolase activity, production of compounds that inhibit enzymes such as 3-hydroxy-3-methylglutaryl coenzyme A and cholesterol assimilation[84]. Feeding of rats with Probiotic LaVK2 dahi induced a decline in 22.6% plasma total cholesterol, however an elevation over 70% were noted in rats fed buffalo milk or buffalo milk dahi employing *Lactococcus lactis* ssp. *cremoris* and *Lactococcus lactis* ssp. *lactis* biovar *diacetylactis*[87]. Further, greater decline in the ratio of high density lipoprotein to low density lipoprotein+very low density lipoprotein (91.2 vs. 13.1%) was noted in rats ingesting Probiotic LaVK2 dahi than those consuming buffalo milk or buffalo milk dahi[87].

Animal feeding trial with dahi obtained by culturing buffalo milk, employing *Lactococcus lactis* subsp. *lactis* biovar *diacetylactis* NCDC60 and having a viable count of 67×10^8 induced lowering of fasting blood glucose, glycosylated haemoglobin, insulin, free fatty acid and triglyceride levels complications[88]. Animal feeding trials were also conducted with probiotic dahi obtained by culturing with probiotic cultures *L. acidophilus* and *L. casei* in high fructose-induced diabetic rats and to streptozotocin-induced diabetic rats. Significantly delayed the onset of glucose intolerance, hyperglycemia, hyperinsulinemia, dyslipidemia and oxidative stress[89], significant increased the counts of lactobacilli adherent to epithelial walls and free in the lumen of the small and large intestine and decreased attached as well as free coliform counts were noted, indicating a therapeutic regimen to diminish the gastropathic consequences of diabetes[90,91]. Rats fed with probiotic dahi containing *L. casei* NCDC 19 along with mixed dahi cultures of *L. lactis* ssp. *lactis*, *L. lactis* ssp. *cremoris*, *L. lactis* ssp. *lactis* biovar. *diacetylactis* exhibited lower blood glucose level (117.50 ± 21.60 mg dL^{-1}) and significant higher caecal bifidobacteria count (7.99 ± 0.05 log CFU g^{-1}) than those fed with plain dahi (172 ± 14.54 mg dL^{-1} and 7.17 ± 0.03, respectively) after 8 weeks of dietary intervention[92].

Inclusion of additives: Fortification of food products with natural resources such as fruits, cereal, etc. have been considered as one of the best ways to enhance the nutritional value with minimal toxic effects. Fruits and vegetables are good source of fiber, carbohydrate, minerals (high in Potassium, low in Sodium), vitamins (vitamin C, B6) and antioxidants and are relatively, low in calories and fat and have no cholesterol. Boeing *et al.*[93] report on a convincing evidence of the decreasing risk for hypertension, coronary heart disease and stroke and a probable evidence for cancer, overweight, type 2 diabetes mellitus and some other disorders due to enhanced consumption of fruit and vegetables. Most promising potential beneficial effects of fruit juices are prevention of cardiovascular diseases[94,95], Alzheimer's disease[96], spina bifida[97], blood clot formation[98], cancer[99] and premature birth[100]. Fruit juices play a major role in the maintenance of nitric oxide levels in blood vessels[101], enhances the bioavailability of iron in the diet[102] and improve bone health[103,104] and maintenance of nitric oxide levels in blood vessels[101].

Attempts have been made to produce dahi with the addition of natural fruit juice and fruit slices. Fruit juices like strawberry, orange and grape were pasteurized prior to addition to pasteurized whole milk to obtain dahi[105] with higher shelf-life. Islam *et al.*[106] encountered lowest total viable bacterial count ($69.53\pm11.86\times10^4$ CFU mL^{-1}) in dahi fortified with 5% carrot juice in contrast to dahi containing no ($70.90\pm9.38\times10^4$ CFU mL^{-1}) or higher concentration (0-15%) of carrot juice ($86.82\pm14.03\times10^4$-$92.7a\pm16.07\times10^4$ CFU mL^{-1}). Better quality probiotic custard apple dahi can be prepared by using cow milk containing 12% total solids, 2% custard apple powder and 1% starter culture of *L. acidophilus* strain with a viable count of 22.5×10^6-$26.25\ 10^6$ CFU gm^{-1} [107].

Mango is a rich source of antioxidants, polyphenols and possess functional properties to cure degenerative diseases[108] and therefore may be added to skim milk to prepare dahi. Addition of 10% mango juice with skim milk was suggested to obtain dahi and the resultant product had viable count comparable with control dahi[109]. Rakhi *et al.*[110] suggested addition of 5-10% mango juice for the remove of beany flavour from soy based dahi. It was concluded that level of both sugar and culture have an impact on the quality of dahi. A combination of 10% sugar with 2% culture or 12% sugar with 3% culture was recommended for dahi making[111]. Ara *et al.*[112] also noted higher acid production due to presence of high concentrations of fermentable sugars in fruit juice and recommended inclusion of 5-10% juice of jack fruit and mango into the milk to obtain fruit dahi.

Pomegranate juice is rich in ellagitannins like punicalagin[113], which are antioxidative and antiinflammatory. Reeta *et al.*[114] noted that total viable count of probiotic Greek dahi fermented employing *L. acidophilus* NCDC195, *L. casei* NDRI 184 and *L. plantarum* NDRI RTS increased with the increasing quantum of pomegranate pulp (0- 20%), highest being noted with 20% pomegranate pulp (3.24 ± 0.04 x10^7 log CFU mL^{-1}).

Cereals are rich source of vitamins, minerals, carbohydrates, fiber, fats, oils and protein and its consumption helps to prevent weight gain and heart disease[115] being richest in protein content among all the cereal grains and possessing higher level of lysine in the globulin fraction than in the glutelin and prolamin fractions accounts for the its better nutritional value[116]. Kale *et al.*[117] formulated a value added stirred dahi containing 1% oat flour, 1% whey proein concentrate, 5% papaya pulp and 4% sugar.

Spices and herbs are known to possess a variety of antioxidant effects and other biological activities and may protect human body against oxidative stress and inflammatory processes[118]. Amongst different herbs such as betel leaves, mint leaves, ajwain and garlic, highest antagonism against *E. coli* was exhibited by garlic[119]. Further they reported an improvement in the antagonistic behaviour of dahi against *E. coli* was encountered with increasing concentration of herbal extract such as nutmeg extract and mint leaves extract, higher being noted with nutmeg extract at 15% level. Aloe vera gel has nutritional and therapeutic properties due to presence of bioactive components including vitamins, minerals, saccharides, amino acids, anthraquinones, enzymes, lignin, saponins, phytosterols and salicylic acids[120] and better utilization of *Aloe* polysaccharides by human colonic bacteria[121]. Hussain *et al.*[122] formulated probiotic dahi fortified with *Aloe vera* juice by culturing buffalo milk with *L. lactis* subsp. *diacetylactis* NCDC-60 and isolated stain of *Lactobacillus paracasei* subsp. *paracasei* NCDC-627. Attempts have also been made to obtain herbal dahi employing Tulsi (*Ocimum sanctum* L.) and Cinnamon (*Cinnamomum verum* L.) and the resultant products had better physicochemical, functional and sensory characteristics in comparison to plain dahi[123]. Sharma *et al.*[124] noted growth inhibition of both *S. thermophilus* and *L. bulgaricus* in the presence of herbs like arjuna and ashwagandha, however growth acceleration of later organism were encountered with herbs like shalampanja and ashwagandha. Therefore growth characteristics of starter cultures in herbs must be determined prior to industrial application.

Reviewed literature indicated that beyond nutritional ingredients such as carbohydrates, organic acids, proteins, amino acids, minerals, polyphenols, vitamins and aroma compounds honey also exhibit both bacteriostatic and bactericidal effects towards diverse pathogenic strains[125]. Honey contains fructo-oligosaccharides such as inulobiose, kestose and nystose, which may serve as prebiotic agents[126] and induced an increase in viable count of probiotic lactobacilli[127] and bifidobacteria[126,128].

Attempt has been made to obtain dahi by culturing toned milk containing 5% honey employing *S. thermophilus* MTCC 5460 and *Lactobacillus helveticus* MTCC 5463 intended for synbiotic *lassi* preparation[129]. Flax lignan have many potential health benefits such as atherosclerosis, in reducing cardiovascular disease, diabetes, arthritis, osteoporosis, cancer, autoimmune, neurological disorders and lowering the blood cholesterol. Attempt has been made to manufacture anti-diabetic misti dahi by culturing milk containing 3.75% of lignan and honey as sweetener[130].

CONCLUSION

Dahi, an Indian fermented milk product may be categorized as functional food owing to its nutritional and therapeutic significance. Functional properties of traditional dahi could be enhanced either by modification of basic milk, exopolysaccharide producing starter cultures, bacteriocin producing starter cultures, introduction of probiotic cultures and inclusion of diverse food additives such as fruit juices, herbs and spices. Probiotic dahi may serve as a vehicle to deliver probiotics and have a potential global market.

SIGNIFICANCE STATEMENT

This study discovers that nutritional and therapeutic properties of traditional dahi can be further enhanced with certain biotechnological modifications in the processing method and can beneficial for projecting dahi as a functional food in the world market. Functional properties of traditional dahi could be enhanced either by modification of basic milk, exopolysaccharide producing starter cultures, bacteriocin producing starter cultures, introduction of probiotic cultures and inclusion of diverse food additives such as fruit juices, herbs and spices. This study will help the researcher to uncover the critical reasons for inconsistency in the chemical, microbiological and dietetic value of dahi available in the market that many researchers were not able to explore. Thus a new theory on process standardization for dahi manufacture with augmented functional properties, may be arrived at.

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