

Fermented Milk and Milk Products as Functional Food: An Overview

Erina¹, Bhasker Partap Choudhary² and Ashwani K Sharma²

Department of Sciences, Chandigarh School of Business, Jhanjeri

¹Department of Applied Mathematics, Chandigarh Engineering College, Jhanjeri, Mohali-140307, Punjab, India

²Department of Applied Sciences, Chandigarh Engineering College, Jhanjeri, Mohali-140307, Punjab, India

Abstract: The main goal of this paper is to give a data of the latest studies which investigating the health-promoting properties of the fermented food. Fermentation process is known as one of the earliest and most inexpensive methods for preserving and manufacturing the foods. Fermented food products have the major carrier of probiotics. Dietetic importance of fermented milk products that is established by its several nourishing and medicinal properties. LAB is considered as one of the most significant groups of probiotic organism which is commonly used in fermented dairy products. Microorganism play the important role in fermented process and also it is associated with many health benefits. Functional food is also known as assembled food in which scientifically good health maintain can be manufacture. Milk is the only foodstuff that contains all the nutrients which is essential for the human health. The main bacterium that is used in the coagulation of milk is lactic acid bacteria. Products which is made from fermented milk have many advantages due to their medicinal and nutrition properties, many researches shows that the health beneficial properties of the fermented milk products. Products of fermented milk prevents from many diseases such as gastrointestinal disease, hypertension, diarrhoea, inflammatory bowel disease and cancer.

Introduction

Fermentation is the process in which food is acquired through the activity of microorganism such as bacteria, yeast and mycelia and their own enzymes. During the procedure of fermentation, carbohydrates and many associated compounds are partly oxidized and release the energy which is mainly occur in the lack of any external electron acceptor (Melini Francesca, et al, 2019). The process of fermentation in which the organic compound act as electron donor as well as the acceptor, and adenosine triphosphate can be formed by substrate level of phosphorylation (Müller, Volker et al, 2001). Fermentation process is investigated as a safe preservation technology for food products.

Fermented foods

The process of fermentation is firstly used to preserve food, increased shelf life and it also improve the flavour. But now a day's fermented food become an important part of the diet in many countries as well as many cultures (Sanlier, Nevin 2019). Various type of fermented foods are well known, some of them are consider as main course meals, others is consider as beverages while others are highly prized food condiments (Odunfa, S.A., and O.B. Oyewole, 1998). Various fermented foods which is related with a unique group of microflora which increases the level of vitamins, proteins, fatty acids and essential amino acids. There are many benefits of Fermented foods such as anti-oxidant, anti-inflammatory, anti-microbial, anti-diabetic and anti-fungal activity (Sanlier, Nevin 2019). The main advantage of Fermented food in the treatment of disease is that they do not exhibit any side effects (Tamang, Jyoti Prakash, ed., 2015). Many research shows that numerous functional protein and peptides in fermented food exhibits specific biological activities beyond their nutritional role. Milk products that is fermented by the use of lactic acid bacteria are considered that it is enriched with GABA which lower the blood pressure in spontaneously hypertensive rats (SHR). Consequently, the outcomes of GABA on the health of human are also of present interest in food production (Sun, Tiansong, et al., 2009).

Fermented milk:

Fermented milk products are obtained through the process of fermentation of milk by the use of many microbial consortia which include Bifidobacteria, Lactic acid bacteria and yeast which develop in a proto-cooperative relationship (Melini-Francesca, et al, 2019). Among the various microorganisms which are involved in the process of fermentation, Lactic acid bacteria comprises many members of Lactobacillus that can play a major role in giving the fermented milk with nutritional value, peculiar flavour and texture. Natural fermented milk is known as one of the oldest techniques of fermented milk which is also known as 'Back sloping method' in which a previous batch of fermented milk is inoculated into the new batch'. Dahi is the example of fermented milk product which is drunk as a refreshing non-alcoholic beverage in Bhutan.

History

The production of fermented milk products exact origin is tough to establish, but it is assumed by doing many researches that it could be more than 10,000 yr ago as the process of human life change from food collection to food manufacture. Fermented milks are produced all over the world, and it is around 400 generic names which are applied to conventional and industrialized products. There was a scheme proposed by Robinson and Tamime (1990) as follows:

Lactic fermentations —

- (a) Mesophilic type, e.g. cultured buttermilk.
- (b) Thermophilic type, e.g. yoghurt, Bulgarian and butter-milk,
- (c) Therapeutic or probiotic type, e.g. acidophilus milk and ABT. (Tamime, A.Y., 2002).

Fermented food was known to be expected the first food which was consumed by the human beings. It was supposed that thousands of years before, milk was assembled from a domesticated cow, goat or camel, it was consumed within a few hours otherwise it would become sour and turning into something we might today call buttermilk. It takes many years for human to determine how to influence or control the production of fermented food products (Hutkins, Robert W., 2008)

Fermented milk as a functional food:

The word 'functional food' was first arisen in Japan in the year of 1980s. Functional food is normally defined as a food that upgrade the health beyond the providing of basic nutrition. Roberfroid (1996) said that a food is functional if it contains all the components that affect the function in the body in a positive manner. Various food products have been considered to be related with various health benefits for many years; yoghurt and fermented milks are the examples. A functional food is produced in such a way that it shows beneficial effects on human health and allow well-being beyond their nutritional value. Fermented milk contains all the essential nutrients of the milks of its own; however, some of the components of the milk are altered during fermentation by lactic acid bacteria (LAB) in such a way that it mainly produce positive effect (Rogelj, Irena, 2000). Every fermented food is related with a distinctive group of microflora which enhance the level of vitamins, proteins, fatty acids and essential amino acids (Jeyaram, K., 2009). Fermented milk products are considered as the reliable source of proteins, vitamin D, calcium and other essential nutrients. The very first example of fermented milk was produced accidentally by nomads. Various types of milk products and their derivatives are produced all over the world. Most commonly used dairy products are cheese, curd, kefir and yogurt. (Kumar, Anil and Nikita Chordia, 2017)

Curd- Dahi is known as the oldest Indian fermented milk product and it can also be similar to western yogurt from which it derives from lassi and shrikhand. Sustainable quality of dahi could be obtained with the use of acid producing and also flavour producing organisms which adopt the two-stage fermentation (Sarkar, S., 2008). Various studies describe that the Indian fermented milk curd prepared by the traditional way was considered as a probiotic due to its health benefits in canine model. The process of making curd is curdling and coagulating which is done by adding acidic substance such as vinegar or lemon juice. These substances will be able to curdle the milk and separate it into two parts. The part of liquid is known as whey and the milk which is solid is known as curd. Raw milk which contains lactobacillus belongs to the genus of bacteria which converts sugar into lactic acid by the process of fermentation. (Kumar, Anil and Nikita Chordia, 2017)

Curd has beneficial effects on digestibility of some nutrients, intestinal microbial balance, hindgut health characteristics and haematology (Kore, K.B., et al., 2012).

Cheese- cheese is a product of fermented milk which is serves as a mean of preserving milk. Diversity in the cheese flavour, texture is due to the presence of different types of microbes. Lactic acid and other microorganism have the ability to degrade the amino acids into aroma compounds which is extremely strain dependent.(Kumar, Anil and Nikita chordia, 2017) .

yogurt- Most commonly used dairy product is yogurt which is mainly produced by adding various bacteria which includes *Streptococcus salivarius* subsp. *Thermophiles* and *Lactobacillus delbrueckii* subsp. *bulgaricus*. Consumption of yogurt has increased day to day life because it fulfils many of the current dietary needs. The usefulness outcome of yoghurt could be increased by the effect of bioactive peptides which are produced through the process of storage and fermentation. More recently, an important interest has been developed in the peptides that can help in lower the blood pressure of patients have hypertensive.

Yogurt is produced in large amount in industries that is affected by many factors i.e., milk standardization, heat-treatment choice of milk, de-aeration homogenization, additives, plant design and choice of culture milk. The milk which is used for the manufacture of yogurt contain highest quality of bacteriological substance (Kumar, Anil and Nikita chordia, 2017). Yogurt offers benefits such as it has an ability to kill pathogens and it also modulates the immune system.

Kefir- Kefir is known as fermented product which is arises from the mountains of the Caucasus. The constitution of kefir are varies suitably to the factors which includes milk type and their composition of culture types. Many microorganisms which are present in kefir can be able to produce various substances such as vitamins degrade protein and hydrolyse lactose which produce results in a highly nourishing and digestible foodstuff. Kefir is generally prepared from grains of kefir or mother cultures which is made from kefir grains. Generally, Kefir grains are considered as small in size, irregularly in shape, hard and yellowish white granules. (Arslan, Seher., 2015).

Kumis(Koumiss)- koumiss is known as a traditional fermented milk of nomad in Central Asia, and it is also considered as a popular milk among the people of the Kirgizstan, Kazakhstan, Mongolia and some other regions of the Russia (Kumar, Anil and Nikita chordia, 2017). It is generally made from camel's or mare's fermented milk by its normal microbiota, and it has been also used in the treatment of many disease such as lung ailments and tuberculosis. kumis is the dairy product which is produced from a liquid starter culture, it contain mild milk alcohol content. Koumiss commonly contains 2–4% of milk sugar, 2% of alcohol, 0.5–1.5% of lactic acid and 2% of fat (Sun, Tian Song, et al, 2009). It is famous in some region of Russia and Bulgaria. Kumis has three types i.e.; strong, moderate and light (Kumar, Anil and Nikita chordia, 2017)

Probiotic Bacteria

Past studies shows that microorganisms have been progressively comprise in various types of food products, mainly in fermented milk (Saarela, Maria, et al., 2000). Numerous health beneficial effects have been maintained by probiotic bacteria like as *Bifidobacterium* spp, *Lactobacillus casei*, *Bifidobacterium* spp and *Lactobacillus acidophilus* (Shah, N.P., 2000). Various probiotic foods have been already in the market such as yogurt and fermented milk are fresh product which is generally consumed within days or weeks of manufacture. The importance of probiotic bacteria-containing products is due to the maintaining of health and well-being is becoming a key factor which affects the consumer choice, which results in fast growing and extension of the market for such products, in addition to increase commercial interest in exploiting their proposed health benefits. (Stanton, C., et al., 1998). Probiotic bacteria are used as a starter organism which combines the positive images of fermentation and probiotic cultures (Heller, Knut J., 2001). The most important need of probiotic bacteria is that it is survive in adequate numbers in the product, that their physical and genetic stability during storage of the product be guaranteed, and that all of their properties which are important for expressing their health benefits after consumption can be maintained during manufacture and storage of the product. Long term consumption of fermented milk containing probiotic enhanced intestinal mucosa immunity (de LeBlanc, A. de Moreno, et al., 2008). In humans, probiotic bacteria have potential which

consist of preventative effects against diseases such as intestinal dysfunctions, inflammatory bowel disease, gastro-intestinal infections and possibly colon cancer(Marteau, P., and M.C. Boutron-Ruault, 2002).

Lactic acid bacteria

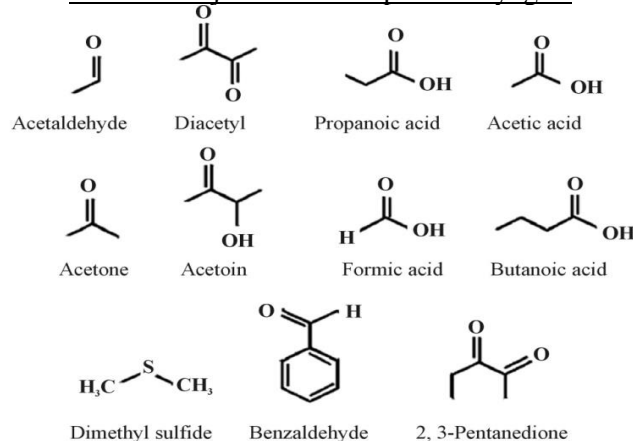
Lactic acid bacteria (lab) is account as gram positive bacteria, nonsporing and nonrespiring, it produce lactic acid which is known as the end product during the fermentation of carbohydrate. LAB is used in various fermented milk products throughout the world for many centuries(Millette, M.F. Luquet, and M.Larcroix, 2007).The immune-stimulatory effects of LAB are well known(Elmadfa, Ibrahim, Petra Klein, and Alexa L. Meyer, 2010).The term LAB is associated with bacteria which is involved in food and feed fermentation.(Axelsson, Lars, et al, 2004). Lactic acid bacteria have a major potential to enhance the storage life and increased the safety of food by the use of natural microflora and their antibacterial product(Stiles, Michael E., 1996). LAB used as a starter culture in the process of fermentation because it acidified the raw material so rapidly. LAB produces many substances such as vitamins, aromatic compounds, sweeteners, sugar molecules and many useful enzymes.(Leroy, Frederic and Luc De Vuyst, 2004). The main bacterium which is isolated from the fermented milk is Lactobacillus spp and Lactococcus. LAB can produce exopolysaccharides which play a major role in texture formation. Lactic acid bacteria (LAB) species belong to the genus under the family of Lactobacillaceae(Widyastuti, Yantianti and AndiFebrisiantosa, 2014).The fermented milk that is produced by the use of LAB will produce good quality of products and also prevent from toxic substances.Among the several health-related properties of fermented foods which are effects on blood pressure have been explained after casein hydrolysis by lactic acid bacteria(Brunser, O., M. Gotterland, and S.Cruchet, 2007).

Properties of lactic acid bacteria

Preservative property of lactic acid bacteria:LAB plays a major role in acidification of milk, Homofermentative species of LAB which convert sugar in milk into lactic acid. The preservative property of LAB observed in many fermented products such as cereals (Chelule, P.K., M.P, Mokoena, and N.Gqaleni, 2010). On the other side, heterofermentative sp. converts lactose into lactic acid, acetic acid, ethanol and CO₂.Raw milk of goat and cow considered as reservoir of antifungal LAB. Bacteriocins are substances of protein structure that possesses antibacterial activities. Most of various LAB bacteriocins are small cationic, heat-stable, cationic, amphiphilic and membrane permeabilizing peptides, it can also used as a partially purified or purified supplement of food products(Widyastuti, Yantianti and AndiFebrisiantosa, 2014).

Flavour formation: Various types of fermented milk are available in the market worldwide. Flavour formation occurs during the ripening process by both starter and non-starter LAB. The LAB culture which is used in the manufacture of yogurt is Lactobacillus bulgaricus and streptococcus thermophilus. Yogurt flavours are supported by many compounds, in which lactic acid represents as the major contributor, and other aroma compounds(Widyastuti, Yantianti and AndiFebrisiantosa, 2014).

Table 1: Major aroma compound in yogurt



Ref: Widyastuti, Yantianti and AndiFebrisiantosa, 2014

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Vol. 6 (Special Issue 4, November 2021)

International Journal of Mechanical Engineering

Table 2: Major aromacompounds in cheese derived from amino acids.

Amino acids	Aldehydes	Alcohols	Carboxylic acids	Thyl/divers
Leucine	3-Methylbutanal or Isovaleraldehyde	3-Methylbutanol	3-Methylbutanoic acid or isovaleric acid	
Isoleucine	2-Methylbutanal	2-Methylbutanol	2-Methylbutanoic acid	
Valine	2-Methylpropanal or isobutyraldehyde	2-Methylpropanol	2-Methylpropanoic acid or isobutyric acid	
Phenylalanine	Phenylacetaldehyde, benzaldehyde (-2C)	Phenylethanol	Phenylacetic acid	
Tyrosine	OH-Phenylacetaldehyde, OH-benzaldehyde (-2C)	OH-Phenylethanol	OH-Phenylacetic acid	<i>p</i> -cresol, phenol
Tryptophane	Indol-3-acetaldehyde, indol-3-aldehyde	Tryptophol	Indol-3-acetic acid	Skatole, indole
Methionine	3-Methylthiopropional, or methional	3-Methylthiopropional	3-Methylthiopropionic acid	Methanethiol

Ref: Widyastuti, Yantyanti and AndiFebrisiantosa, 2014

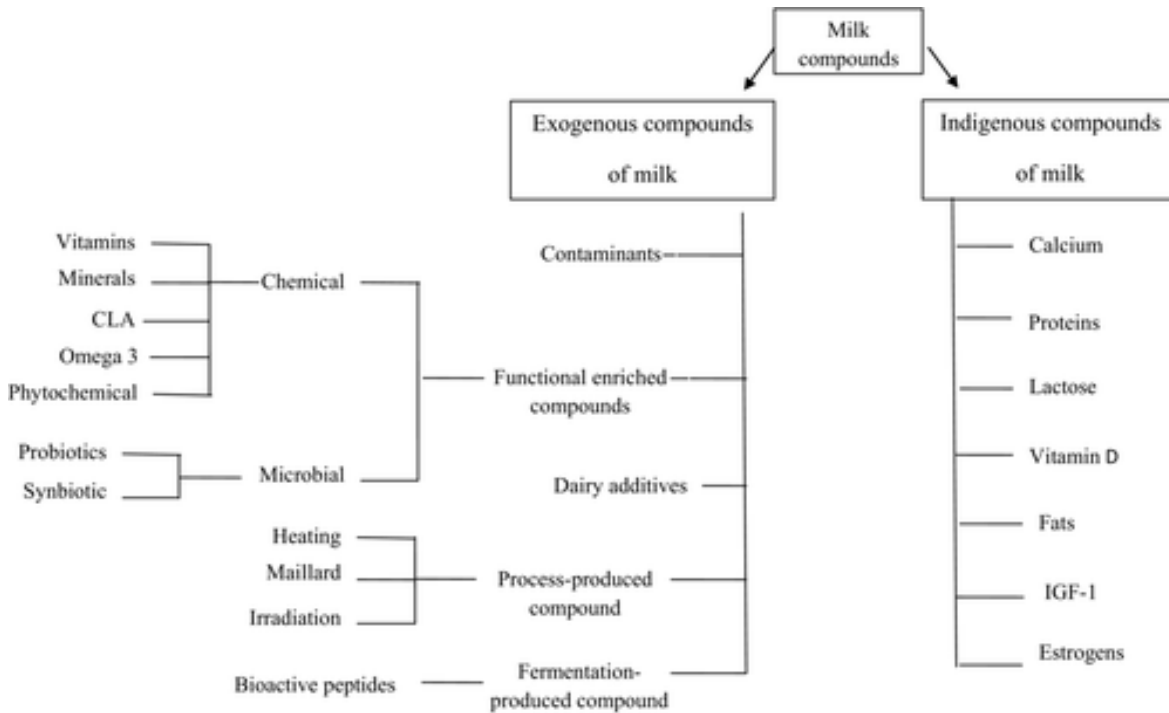
Health promoting activity of LAB: *L. Helveticus* showed many health benefit effect such as anti-cancer, antihypertensive, immunomodulatory activity and calcium binding ability. The demand of the fermented milk increase day by day due to their health Beneficial properties. (Widyastuti, Yantyanti and AndiFebrisiantosa, 2014).

Product name	Origin	Culture	Functional benefit	Reference
Probiotic yogurt	Ontario, Canada	<i>L. rhammosus</i> CAN-1	Nutrition and immune function for people living with HIV	[58]
Mix ewe's and goat's milk yoghurt	Antakya-Hatay, Turkey	<i>S. thermophilus</i> and <i>L. delbrueckii subsp. bulgaricus</i> (codes: CH-1 and YF-333)	High short chain free fatty acids	[59]
Ayran (yoghurt from goat milk)	Turkey	<i>L. plantarum</i> , <i>L. brevis</i> <i>L. paracasei</i> subsp. <i>paracasei</i> , <i>L. casei</i> subsp. <i>pseudopantarum</i>	High exopolysaccharide	[60]
Gioddu, traditional fermented sheep or goat milk	Sardinian, Italy	<i>S. thermophilus</i> , <i>L. lactis</i> subsp. <i>lactis</i> <i>L. delbrueckii subsp. bulgaricus</i> , <i>L. casei</i> subsp. <i>casei</i> , <i>L. mesenteroides</i> subsp. <i>mesenteroides</i>	Probiotic	[61]
Tarag	Mongolia	<i>L. helveticus</i> , <i>L. lactis</i> subsp. <i>lactis</i> , <i>L. casei</i>	Probiotic	[62]
Fermented milk	Japan	<i>L. casei</i> strain Shirota	Maintenance treatment for myelopathy/tropical spastic paraparesis (HAM/TSP) patients	[63]
Koumiss from mare's milk	Italy	<i>L. delbrueckii</i> subsp. <i>bulgaricus</i> <i>S. thermophilus</i>	Antiallergic	[64]
Lben	Marocco	Spontaneously/not identified	Low fat and high calcium traditional product	[65]
Functional fermented milk	Italy	<i>L. lactis</i> DIBCA2, <i>L. plantarum</i> PU11	Enriched of Angiotensin-I Converting Enzyme (ACE)-inhibitory peptides and G-amino butyric acid (GABA)	[66]
Kumis	West Colombia	<i>E. faecalis</i> , <i>E. faecium</i>	ACE Inhibitor	[67]
Ewe milk, traditional yoghurt	Iran	<i>L. brevis</i>	cholesterol reduction	[68]
Maasai	Kenya	<i>L. plantarum</i> , <i>L. fermentum</i> , <i>L. acidophilus</i> , <i>L. paracasei</i>	Diarrhoea and constipation	[69]
Suusac	Kenya	<i>L. curvatus</i> , <i>L. plantarum</i> , <i>L. salivarius</i> , <i>L. raffinolactis</i> <i>Leuconostoc mesenteroides</i> subsp. <i>mesenteroides</i> .		[70]

Ref: Widyastuti, Yantyanti and AndiFebrisiantosa, 2014

ADVANTAGES OF FERMENTED MILK PRODUCTS: fermented milk products have many advantages due to their medicinal and nutrition properties, many researches shows that the benefits of health properties of milk products which are fermented.

Anticarcinogenic property: Milk (fermented) products play a role in preventing the body from different types of cancers(Parmjit, S.,2011).Antitumor activity is linked with the cell wall of starter bacteria, so the activity persist even after drying(Shiby, V.K., and H.N. Mishra, 2013) Many inventions show that LAB possesses anticarcinogenic activity which prevents the cancer initiation in the body.*Lactobacillus acidophilus* possess anticarcinogenic property, it can also be able to survive the hostile environment(Mitall, Brij K., and Satyendra K. Garg., 1995). In cancer risk, dairy milk product is considered as protective for human body.



Ref: (Davoodi, H., S. Esmaeili, and A.M.Mortazavian, 2013)

The components of the dairy milk products that affect the cancer

Many studies show that colon cancers reduced by increase the consumption of milk; also cell proliferation is reduced in the small intestine (colon) with intake of dairy products. Cenin which is present in the cow milk has the ability to increase lymphocyte and simulate phagocytic activities, it also protect against colon cancer. Many studies show that milk (low fat) consumption was inversely associated with the ovarian cancer (Davoodi, H., S. Esmaeili, and A.M.Mortazavian, 2013).

Protection against gastrointestinal infection: Gastrointestinal infection includes diarrhoea is caused by the change in the gut microflora due to invading the pathogen. Lactic acid bacteria prevent the body from the infection as it has the ability to suppress the growth of pathogen(Parmjit, S., 2011)

Stimulation of immune system: The immune system provides the defence system against the pathogen entered our body(Parmjit, S., 2011). LAB act as a mediator and regulator of immune system. It also produces defence against various pathogen and viruses.

Antiallergenic activities: probiotic can prevent allergic reaction in individual at a high risk of food allergies(Parmjit, S., 2011). Lactic acid bacteria enhances the production of interferon(TYPE 1 and TYPE 2) , LAB promotes the interferon expression, it can also reduce allergen-stimulated production of interleukins (IL-4 and IL-5) (Cross, M.L., L.M. Stevenson, and H.S.Gill., 2001). *Lactobacillus kefiranofaciens* M1 is a lactic acid rod shaped bacteria which is first isolated from grains of Kefir. *Lactobacillus kefiranofaciens* M1

play a major role in antiallergic activities. Kefir considered as good for health because of their immunoregulatory effect (Hong, Wei- Sheng, Yen- Po Chen, and Ming- Ju Chen, 2010).

Conclusion

It is concluded that fermented milk and milk products have more beneficial effect than the harmful effect in the prevention of diseases. The immune-stimulatory effects of lactic acid bacteria are well known. Fermented food contain viable probiotic microorganism that confer health benefits on the host. The consumption of yogurt, probiotics and other fermented dairy products, improves GIT. Increase in scientific evidences confirms risk for various chronic disorders such as coronary heart disease, osteoporosis cancer, and hypertension. These can be decreased by the regular consumption of fermented milk and its supplement. LAB fermented milk products enhance the immune system and it also build up the body in the fight against pathogenic bacterial infection. Fermented milk products play a role in preventing the body from different types of cancers. There are many benefits of Fermented foods such as anti-oxidant, anti- inflammatory, anti- fungal, anti- microbial, anti- diabetic and activity. The main advantage of Fermented food in the treatment of disease is that they do not exhibit any side effects.

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