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A Comprehensive Review on Survey on Lactic Acid Bacteria in Fermented Foods of West Bengal: Understanding Diversity and Functionality

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Abstract

The production of fermented foods is one of the oldest food processing technologies well known to mankind. In most cases, the procedures and knowledge associated with the manufacture of these food products were passed on from generation to generation within local communities, monasteries, and medieval farms. For many fermented foods particularly dairy products, the characterization of microorganisms that are responsible for fermentation is very important for their usage in the dairy industry. Lactic acid bacteria (LAB) are particularly recommended as starter cultures for the fermentation process due to their benefits in terms of probiotic properties, antimicrobial production, beneficial enzyme production, and enhancement of other functionality. LAB are amongst the most important groups of microorganisms used in the food industry. Odisha (formerly Orissa) and West Bengal are two neighbouring states in Eastern India. Rice is the main food in both states. The techniques of ethnic fermented food and beverage preparation by the rural people are somehow untouched or unmodified with the upgradation of the culinary culture of Indian civilization. Moreover, they unknowingly used the beneficial microorganisms (natural or starter added) to maintain the standard of fermented foods and beverages. Hence, in the present narrative review we aimed to describe and delineate on the lactic acid bacteria in fermented foods of West Bengal in order to understand the diversity and functionality of lactic acid bacteria.

Keywords: Lactic acid bacteria (LAB), Fermented foods, Beverages, Microbial diversity, West Bengal

Introduction

The production of fermented foods is one of the oldest food processing technologies well known to mankind. Since the beginning of civilization, methods of fermenting milk, cereals, legumes, vegetables, and meats have been described.[1] The preparation of these kinds of fermented foods will be with us in the far future, as they are a source of alcoholic foods/beverages, vinegar, pickled vegetables, sausages, cheeses, yogurts, vegetable protein amino acid/peptide sauces, and pastes with meat-like flavors, and leavened and sourdough breads, and so on. Fermented foods are of great importance because they provide and preserve an enormous amount of nutritious foods with a wide variety of flavors, aromas, and textures that enrich the human diet. As used herein, the term "nutrition" or "nutrient" will include providing the consumer with calories/energy, protein, essential amino acids/peptides, essential fatty acids, vitamins, and mineral requirements that contribute to the solution of nutritional problems and diseases in the human population.[2]

In most cases, the procedures and knowledge associated with the manufacture of these food products were passed on from generation to generation within local communities, monasteries, and medieval farms. In the mid-nineteenth century, two events occurred that had a significant impact on our understanding of the method and process of food fermentation. First, a huge number of residents from the villages started moving toward the towns and cities due to the more opportunities in industrial sectors. Hence, the practicing of conventional methods to prepare food for more population was no longer operative. This led to inventing new processes for the manufacturing of vast quantities of food products, which demanded the industrialization of the food sector. Second, the progress in the field of microbiology in the 1850s led to an understanding of the basic science of the fermentation process for the first time. Consequently, the important function of lactic acid bacteria, yeasts, and molds in the production of fermented foods was understood, which eventually led to a more controlled and efficient fermentation process.[3]

For many fermented foods particularly dairy products, the characterization of microorganisms that are responsible for fermentation is very important for their usage in the dairy industry. Therefore, in the late nineteenth-century isolation of starter cultures and manufacturing on a large scale was initiated to supply to the factories involved in the manufacture of dairy products.[3] Generally, starter culture strains are often used to improve the nutritive value and sensory characteristics of fermented foods, maintain safety and quality, and promote nutrition.[4] In recent years, it has been a great strategy in food microbiology to study microorganisms with various functions, to use as a starter culture.[5] Several studies have reported the preparation of food products using multifunctional microorganisms, wherein lactic acid bacteria (LAB) are particularly recommended as starter cultures for the fermentation process due to their benefits in terms of probiotic properties, antimicrobial production, beneficial enzyme production, and enhancement of other functionality.[6-8] They are normally considered safe and widely used as a starter culture in the production of fermented foods.[9] Due to the unique metabolic characteristics, they are involved in many fermentation processes of milk, cereals,

vegetables, and meats. They are effective as probiotics and exhibit beneficial properties such as the production of antimicrobial compounds, enzymes, involvement in immune regulation, and antioxidant activity.[10]

LAB are a group of gram-positive bacteria that are devoid of cytochromes and preferring anaerobic conditions, they are usually non-motile, non- sporulating, catalase-negative, oxidase negative, acid-tolerant and strictly fermentative bacteria that produce lactic acid as a major or sole product of fermentative metabolism. They are either rod-shaped (bacilli) or spherical-shaped (cocci) that share common metabolic and physiological characteristics. LAB are nutritionally fastidious, requiring carbohydrates, amino acids, peptides, nucleic acid derivates, and vitamins. Based on their fermentative metabolism LAB are divided into two distinct groups. The homo-fermentative group that utilizes the Embden-Meyerhof-Parnas (glycolytic) pathway to transform a carbon source chiefly into lactic acid. Hetero fermentative bacteria produce equimolar amounts of lactate, CO_2, ethanol, or acetate from glucose exploiting the phosphoketolase pathway. The homo-fermentative group consists of *Lactococcus, Pediococcus, Enterococcus, Streptococcus,* etc and the heterofermentative group includes *Leuconostoc, Weissella,* etc.[11]

LAB are acid-producing (lactic acid) and are acid-tolerant which helps LAB to outcompete other bacteria in a natural fermentation thus inhibiting the growth of spoilage as well as pathogenic microorganisms.[12] Most fermented foods owe their origin to the fact that the processes used in their production are inhibitory to many microorganisms. As a result, fermented products generally have a longer shelf life than their original substrate and their ultimate spoilage is different.[13] LAB have been shown to produce uricase,[14] reduce acrylamide formation in bread,[15] produce exopolysaccharides,[16] remove tannins.[17] Some LAB strains have also been reported to increase folic acid levels in fermented milk.[18]

LAB are amongst the most important groups of microorganisms used in the food industry. The industrial significance of the LAB is further evidenced by their generally recognized as safe status, because of their ubiquitous appearance in food and their contribution to the healthy and sound microbiota of animal and human mucosal surfaces. LAB include members of the genera *Streptococcus, Enterococcus, Lactobacillus, Aerococcus, Carnobacterium, Leuconostoc, Lactococcus,* and *Pediococcus.* Peripherally *Oenococcus, Sporolactobacillus, Tetragenococcus, Vagococcus,* and *Weissella* also are regarded as LAB; these belong to the order Lactobacillales.

Odisha (formerly Orissa) and West Bengal are two neighbouring states in Eastern India. Due to close proximity and similar geo-climatic environment, West Bengal and Odisha have identical tradition and civilization. Rice is the staple food in both states. Rice, pulses, vegetables, milk and fishes are the major food stuff, and different varieties of non-fermented and fermented foods are prepared. The techniques of ethnic fermented food and beverage preparation by the rural people are somehow untouched or unmodified with the upgradation of the culinary culture of Indian civilization. The native knowledge and skillful technology for preparing varieties of the fermented products using carefully selected raw ingredients and other materials are unparalleled to the other communities of the world. Moreover, they unknowingly used the beneficial

microorganisms (natural or starter added) to maintain the standard of fermented foods and beverages.[19] Hence, in the present narrative review we aimed to describe and delineate on the lactic acid bacteria in fermented foods of West Bengal in order to understand the diversity and functionality of lactic acid bacteria.

Role of LAB in Fermented Foods

Fermented Rice Cake (Pitha)

Fermented rice cake is popularly known as pitha in West Bengal and Odisha.[19] There are different kinds of Pitha *viz.* Chakuli pitha, Enduri pitha, Munha pitha, Chhuchipatra pitha and Podo pitha.[20,21] Pitha is made up from either fermented rice or rice-legume batter. For its preparation, the rice is first soaked in water for 8–12 h and air-dried. Then the soaked rice is ground to make the fine flour by using a traditional grinder. The soaked legumes are pasted by traditional utensils. The rice flour and the pasted legume are then mixed with water to prepare the batter which is allowed to ferment for 4–5 h in summer and 10–12 h in winter. The fermented batter is fried over a pan. The food is taken at breakfast and lunch. Although these types of pitha are very popular in this region, surprisingly no such research efforts have been made to find out its nutritional and microbiological composition.[19]

Chakuli Pitha

Chakuli pitha, a round-shaped flattened pancake is similar to a popular South Indian food called dosa. The food is popular in West Bengal and Odisha.[19] The principal ingredients are rice (*Oryza sativa*) and black gram dal (*Phaseolus mungo*). The batter is prepared by the coat free black gram dal and rice and left for fermentation about 10–12 h.[20] After fermentation, the batter is fried over a pan with a structure of round shape. Chakuli pitha's microbiological composition is unknown so far. Considering its preparation process which is similar to the dosa, it is likely that LAB and yeast might play the major role in this fermentation. Looking into its nutrient enrichment, it was suggested that the amount of vitamin B, vitamin C, zinc and iron are increased during fermentation. Moreover, fermentation helps to increase the bioavailability of the minerals by degrading the phytate, which is an antinutrient in cereals.[22]

Enduri Pitha

Enduri pitha is the flavoured cake prepared in West Bengal and Odisha. It is prepared by rice and black gram dal. In its preparation, the fermented batter is kept and folded in turmeric (*Curcuma longa* L.) leaf followed by cooking over steam.[19] *Lactobacillus (Lb.) fermentum* is one of the fermenting bacteria in this fermentation.[21] It was reported that it helps in boosting the immune system,[23] and acts as a protective agent in different seasonal infections.[20] The health benefits probably come from the turmeric leaf and the participating lactic acid bacteria.

Munha Pitha

Munha pitha is a spongy fermented cake which is very famous in West Bengal and Odisha. The principal ingredients are rice and black gram dal which are used for batter preparation.[21] Usually, a short fermentation time is required. After fermentation, the fermented batter is kept in cloth which is then placed in the mouth of an earthen pot containing half-filled water. Then it is boiled

until the batter becomes spongy. Usually, this food is served with sugar and vegetable curry. The microbiology and nutritional values of this product are unexplored so far. Clearly, a detailed analysis is needed.[19]

Chhuchipatra Pitha

Chhuchipatra pitha is a square-shaped pitha. The food is nutritious, palatable and delicious.[21] The batter is similar to the Chakuli batter. However, sometimes the curd (fermented milk) is added for better fermentation.[20] Then the fermented batter is spread as a thin smear over the pan. Then coconut, cheese and sugar are kept in the centre of the pancake followed by folding in a square shape and then allow frying more. As the curd (locally known as dahi) is added for fermentation, it is likely that the food might contain lactic acid bacteria. Again, no such studies have been conducted to explore its microbial contents.[19]

Podo Pitha

Podo pitha is a slow-cooked pitha. Like the other pitha, rice and black gram dal are used for the batter preparation. The fermentation time is only 2–4 h. The fermented batter is mixed with coconut, cashew nuts and sugar.[21] The mixture is wrapped with the banana (*Musa paradisiaca* L) or sal (*Shorea robusta* C.F. Gaertn) leaves and baked slowly for 5–10 h in the traditional earthen oven which is covered by hot charcoal.[21] The outside of the product is usually slightly burnt, whereas the white spongy soft inside. The microbiology of Poda pitha was unknown so far. It was reported that the food is energy rich because of the high carbohydrate content, sugar and fibres.[21]

Sour Rice

Sour rice is popularly known as panta bhat in West Bengal and pokhalo/pakhala in Odisha. It is a naturally fermented rice product which is consumed during lunch and breakfast.[19] In its preparation, the boiled rice is cooled down at room temperature followed by the addition of adequate water. Then it is kept in the room temperature for 10–12 h for fermentation. This is a natural fermentation; no starter is required. However, sometimes curd, salt and some vegetables are added for better fermentation and taste enhancement.[21] The sour rice is consumed with onion and cooked spicy vegetables. LAB [especially *Lb. casei, Lb. bulgaricus, Pediococcus (Pd.) acidilactici, Streptococcus thermophilus*] and yeast [*Saccharomyces* (S.) sp.] actively participated in this fermentation.[20]

After fermentation sour rice is enriched with vitamins (B complex and K) and minerals (iron, sodium, potassium, calcium, etc.).[20] It is an energy-rich food and helps to restore the gastrointestinal flora during intestinal ailments such as irritable bowel syndrome, duodenal ulcers, Crohn's disease, etc..[21,24] Moreover, the food was also reported to prevent constipation.[20]

Jalebi

Jalebi is a popular Indian sweetened fermented product. It is usually sold in mela (social gathering) and sweet shops. It is made from maida (wheat flour), dahi (curd) and water.[25] The batter is fermented for 4–6 h in room temperature. For its preparation, the batter is squeezed through an embroidered hole (about 4 mm in diameter) in a thick and durable cotton cloth and dispensed in the hot oil in a manner as it gets a unique shape (round shaped with a network like

arrangement The fried one is immersed in sugar syrup for 2–5 min.[26] *Lb. fermentum, Lb. buchneri, Streptococcus lactis, Streptococcus faecalis* and *S. cerevisiae* were found in the fermented batter.[27] The pH in the fermented batter is around 3–4. Moreover, the content of amino nitrogen and free sugar were also decreased during fermentation.[25]

Bari

Bari is a pulse-based traditional fermented food. Different types of pulses (Urad dal, Chana dal, Matar dal) are used in its preparation.[28] In its preparation, the pulses are soaked with water for 10–12 h followed by grinding to make the paste. Then some spices (chilli, coriander, cumin seeds, etc.) and salts are added to that paste. The dough is pressed to make an oval or round shape and kept in a cloth followed by sun drying for 5–10 days. Due to this drying process, moisture content is very low in bari. Hence, bari can be preserved in a container for 6 months to 1 year. Bari is consumed after cooking with vegetable curry or directly after frying. It is a protein-rich food. It reduces flatulence-causing oligosaccharides.[29,30]

Goyna Bari

Goyna bari is a decorated bari. It is designed like the traditional ornaments. The fermented batter is kept in a cloth and squeezed through a hole into a dish containing poppy seeds. The poppy seeds help to maintain the texture of the Goyna bari and to easily separate the Goyna bari form its base. Then the Goyna bari is dried under sunlight and kept in the airtight container. Surprisingly there are no such reports on its microbial and nutritional compositions. Yeast and LAB are the predominant microbes in this food.[19]

Role of LAB in Fermented Beverage

Haria or Handia

A popular ethnic rice-based alcoholic fermented beverage in this area is known as Haria in West Bengal or Handia in Odisha. The principal ingredient of this beverage is low-graded boiled rice which is mixed with the traditional starter called Bakhar. In its preparation, the charred boiled rice is mixed with the Bakhar, and allowed to ferment within an earthen pot for 4–5 days.[31] The fermented material is diluted with drinking water and sieved by the cloth. The glutinous material is then consumed with spicy vegetables. Mould, yeast, LAB and *Bifidobacterium sp.* were the predominant microbes in Haria.[32]

Toddy or Tari

Toddy or Tari is an alcoholic drink mainly prepared in West Bengal and Odisha. The principal ingredients are the sap from date tree (*Phoenix sylvestris* L.), coconut palm (*Cocos nucifera* L.) or Asian palmyra palm (*Borassus flabellifer*).[33] The sap is collected from these trees by cutting the tip of an unopened peduncle. An earthen pot (containing little amount of old Toddy or Tari) is placed in the tree to collect the sap. It takes only 6–8 h to complete the fermentation. The fresh sap contains sucrose (12–15% by weight) and other monosaccharides which favour the growth of fermenting microflora. The shelf life of this drink is only 12–24 h. After fermentation, a white colour sweet material is consumed with some spicy vegetables. Acetic acid bacteria and LAB, specifically *Leuconostoc* (Leuc.) sp., *Lactobacillus sp.* and *Zymomonas sp.*, were involved in the early fermentation.[25] Later *S. cerevisiae* produced the alcohol.[27]

The alcohol percentage is only 4–6%. Toddy is believed to be good for the health particularly for eyesight and also used as a sedative. Moreover, it is a mild laxative relieving constipation.[27] It is prescribed as a tonic for those recovering from diseases such as chickenpox.[25]

Role of LAB in Plant-Based Fermented Products

Achar/Chadnee

Pickle (achar) is one of the oldest methods of food preservation. Pickle is usually made from chopped fruits (cucumber, olive, tomato, mango, lemon) and vegetables (cabbage, cauliflower, mustard vegetable). At first, the chopped fruits and vegetables are lightly fried in oil. Then salt, chilli, turmeric and some other spices are added there. After that, the mixture is kept in a container and allowed to ferment for 1–2 weeks. Pickle is mainly two types: sour and sweet. In a sweet pickle, a high amount of sugar is added. The naturally occurring lactic acid bacteria actively participate in this fermentation. The bacteria produce lactic acid and as a result, the pickle becomes acidic (sour). Pickle is enriched with dietary fibres, minerals and vitamins. It exerts the health benefits associated with lactic acid bacteria.[19]

Karadi

Karadi is an ethnic fermented bamboo shoot (*Bambusa arundinacea* L.) product of Odisha. The tip of the youngling bamboo is sliced into small pieces and dipped into water for 1 day for fermentation.[21] After fermentation, the product is cooked with the other vegetables. Sometimes the powdered fermented product is sun-dried and stored for 1 year.[34] The microbiology of Karadi is unknown so far.

Role of LAB in Dairy-Based Fermented Products

Dairy-based fermented foods in West Bengal and Odisha are usually naturally fermented. The ethnic people use the black-slopping method where the previously fermented product is used as an inoculum to ferment the new batch.[35] The examples of some dairy-based products in this region are dahi (curd), paneer, lassi and chhena poda. These dairy-based foods and beverage are rich in proteins, carbohydrates, vitamins and minerals and exert different therapeutic activities.[36]

Dahi

Dahi is naturally fermented milk (lactic acid fermentation) consumed as a refreshing food.[26] In its traditional preparation, milk (from cow or buffalo) is boiled and cooled at room temperature. A small amount of old dahi (served as inoculum) is added on that and allowed to ferment for 6–12 h. A number of lactic acid bacteria (*Lb. alimentarius, Lb. bifermentans, Lb. paracasei, Lb. delbrueckii subsp. indicus, Lb. acidophilus, Lb. bulgaricus, Lb. cremoris, Lb. helveticus, Lb. fermentum, Lactococcus (Lc.) lactis, Streptococcus lactis, Streptococcus cremoris, Streptococcus thermophilus, Pd. acidilactici, Pd. pentosaceus, Weissella cibaria*) and yeast (*Saccharomycopsis sp.* and *Candida sp.*) were isolated from Dahi.[37,38]

Dahi is nutritious and easy to digest. The number of vitamins (thiamine, riboflavin, folic acid, niacin),[39-42] proteins, essential amino acids and lactic acid was significantly increased in dahi.[36] Dahi exerted the antimicrobial effects against the pathogenic bacteria due to the high content of lactic acid and production of antimicrobial agents such as bacteriocin, antimicrobial

peptides by the participating lactic acid bacteria.[43,44] It is also effective in reducing cardiovascular diseases and tumours and increasing immunity.[45]

Misti Dahi

Misti dahi is a sweetened fermented milk product prepared mainly in West Bengal. It is an indigenous product of West Bengal. It is mildly acidic, a sweetened product which appears in a light brown (like caramel) colour.[19] Traditionally, the milk is boiled with sugar (sometimes sugarcane) for 2–3 h in low flame. The boiling helps to develop the unique red-brown colour and makes it slightly viscous. As like the dahi preparation, after cooling the milk, previously prepared old misti dahi is added and allow fermenting for 6–12 h in the earthen pot at room temperature. *Lb. acidophilus, Lc. lactis subsp. lactis, Lb. delbrueckii subsp. bulgaricus, Streptococcus salivarius subsp. thermophilus* and *S. cerevisiae* were isolated from misti dahi.[46,47]

Bandel Cheese

Bandel cheese is an indigenous unripe, salted soft variety of cheese. The name is derived from the place Bandel located near Kolkata, West Bengal. The Bandel cheese is unique due to its dry, crumbly, smoky and aromatic flavour. There are two varieties of Bandel cheese: plain and smoked. The raw ingredient is cow milk. After preparing the curds, the whey is separated by the addition of lemon juice. Then it is moulded and drained in small containers. It is further smoked in the fire as required for smoked cheese preparation. The finished Bandel cheese is flat round shaped. The cheese is salted for long preservation. Just before the consumption, it is soaked in water overnight to remove the excess salt.[19]

Although it is a popular cheese product in the Kolkata region, there are no scientific evidence about its microbial and nutritional compositions. As dahi is one of the important ingredients in Bandel cheese, it is likely that the lactic acid bacteria participate in the dahi fermentation may engage in the Bandel cheese fermentation. Clearly, a detailed study is needed to explore this traditional cheese product.[19]

Lassi

Lassi is a dairy-based low-fat beverage which is consumed in the summer as a refreshing drink. It is prepared by mixing dahi with water, salt, sugar and rose water.[48] There are two main variants of lassi: sweetened lassi and salted lassi. Sweetened lassi is prepared by mixing dahi with sugar syrup and flavour.[49] For salted lassi, an adequate amount of salt is added instead of sugar. The LAB is mainly involved fermentation process.

Role of LAB in Fish-Based Fermented Products

Fish is an important component of the human diet in West Bengal and Odisha. More than 90% of the population in this region consume fish. As fish is a perishable food, drying of fish can preserve it for a long time. In its preparation, salt is applied to the fishes (3–4 kg/100 kg of raw fish) to remove the water.[50] It takes 7–10 days for complete drying. When the salt is added into fish, a certain degree of fermentation occurs and that eventually increases the nutritive value and the sensory properties.[51]

Sukuti or Shutki

Sukuti or Shutki is a very popular sun-dried fish product in West Bengal. Bacteria (*Lb. lactis subsp. cremoris, Lb. lactis subsp. lactis, Lb. plantarum, Lb. mesenteroides, Enterococcus faecium, Enterococcus faecalis, Pd. pentosaceus*) and yeasts (*Candida chiropterorum, C. bombicola and Saccharomycopsis spp.*) were isolated from Sukuti prepared in other parts of India.[52,53] Considering this, it can be assumed that similar bacteria might be involved in the Shutki fermentation in West Bengal and Odisha.

Fermented Milk Products: Microbial Diversity

The scientific discovery by the Nobel laureate Elie Metchnikoff in 1907 relating fermented milk products to the positive impact on the longevity of Bulgarian peasants led to the search for microorganisms responsible for this unique phenomenon. Further, studies revealed the presence of LAB in most of the fermented milk products to be of vital importance in imparting the nutritional characteristics to the fermented product.[54,55] It is generally accepted from all the studies that LAB, and non-starter LAB (NSLAB) play a vital role in the lactose (lactate and citrate) metabolism, proteolysis and lipolysis involved in the preparation of indigenous fermented milk products.[56]

The most common LAB genera in milk include *Lactococcus, Lactobacillus, Leuconostoc, Streptococcus* and *Enterococcus*. In addition, psychrotrophic bacteria, yeasts and moulds, which particularly establish themselves during cold storage, are also major components of traditional fermented milk products.[57,58] These microorganisms can bring about the fermentation of milk through the production of lactate and other metabolites that have a variety of different impacts on the techno-functional, and sensory properties of resultant products.[59]

The typical consortia of microbes have a profound influence on the techno-functional properties of these fermented milk products. Each one of the traditional Indian fermented milk products is naturally fermented by a unique blend of culturable, difficult from culturable and non-culturable micro-organisms that confer several gustatory and olfactory attributes to these products. Of late, holistic attempts have been made using integrative approaches to unearth this complex microbial diversity of fermented milk products besides correlating their quality, safety and techno-functional attributes with the microbial groups (phylotypes). These microorganisms enter milk from a variety of sources and, once in milk system, can play several roles, such as facilitating dairy fermentations (e.g., *Lactococcus, Leuconostoc, Lactobacillus, Streptococcus, Propionibacterium* and fungal populations), causing spoilage (e.g., coliforms, heterofermentative lactic acid bacteria, *Pseudomonas*, *Clostridium*, *Bacillus* and other spore-forming or thermoduric microorganisms), promoting health (e.g., *lactobacilli* and *bifidobacteria*) or causing disease (e.g., *Listeria*, *Salmonella, Escherichia coli*, *Campylobacter* and mycotoxin-producing fungi.[60] Most of our present knowledge with respect to the diversity of microorganisms that are present in raw milk, and resultant dairy products, has been acquired through the established ‘culturing’ techniques, and subsequent analysis of these cultured microorganisms by phenotypic and/or genotypic methods. Though, high-throughput or next-generation sequencing (HTS or NGS) technologies have revolutionized the genomic era of 21st century, very few efforts have been

made in India to explore these technologies to unveil the complex diversity of microorganisms present in Indian fermented milk products.

Conclusions

Indigenous fermented foods have been essential to human health throughout history. They are reasonably inexpensive to produce and distribute. They are usually very nutrient-dense, offering most consumers affordable prices for calories, protein, vitamins, and minerals. Because of the diverse cultures and varying climates, West Bengal and Odisha have a wide range of traditional fermented foods. These elements eventually affect the variety of microbes and crops. The majority of the fermented products are made utilizing traditional methods passed down from ancestors. They are mostly totally oblivious to the microbes involved and how they affect fermentation.

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