Review Article

Food biotechnology applications in dairy and dairy products

A. Allwyn Sundarraj[1]*, A. Angeline Rajathi[2], Simon Cruz Vishaal[1], D. Rohit[1], M. Saran Prakash[1], A. Alexander Sam[1], S.S. Seihenbalg[1]

ABSTRACT

Biotechnological achievements of recent years have emerged as powerful tool to develop quality attributes of livestock products include dairy and dairy-based products. Biotechnology has applied to food processing in most developing countries makes use of microbial inoculants to enhance properties such as the taste, aroma, shelf-life, consistency, and nutritional value of foods/dairy products. Probiotic food products are a rapidly growing area of functional food, as found to be robustly accepted by the consumers. However, the food industry is looking for to produce diverse varieties of probiotic foods other than dairy products with prospective health benefits. In this review, the broad array of available dairy foods, by-product waste utilization of dairy and dairy processing challenges the microbiologist, engineer and technologist to find the best ways to prevent the entry of microorganisms, destroy those that do get in along with their enzymes and prevent the growth and activities of those that escape processing treatments. Various food matrices, dairy, and non-dairy, have been used with probiotics, by-product wastes utilization and were briefly acknowledged.

KEY WORDS: Biotechnology, Dairy processing, Dairy products, Food biotechnology, Food processing

INTRODUCTION

Biotechnology is utilized of the living system and organisms to build up products, or "any scientific use that uses natural systems, living organisms to make mutate products or processes for specific use." It has played a various role in the use of science in different spheres of life. Gene transfer, growth of vaccines together with DNA-vaccines, hybrid plants, genetic modification, etc., are a few of the areas in biotechnology have played a most important role. There are many applications of biotechnology in the fields of manufacturing zone, agriculture, pharmaceuticals, food, energy, etc.

Food processing is the revolution of raw ingredient, by material or substance means into food, or of food into other forms. Food processing combines raw food ingredient to manufacture profitable food products that can be simply prepared and serve by the consumer.

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Food engineering is a multi-disciplinary field of useful physical sciences which combine science, microbiology and engineering education for food and interrelated industries.

Food processing engineering make use of different unit operation and technology to transfer moderately large, consumable and normally inedible raw material into more valuable shelf-stable and edible foods, which have a longer shelf life the technique by which the microbial organisms and the derivative are used to enhance the edibility and the shelf life of foods, is known as fermentation. Roughly one-third of the diet in the whole world consists of fermented food. Fermentation is also used to prepared microbial cultures, food additives, preservatives, etc. Processing contribute to food security by minimize waste and sufferers in the food chain and by mounting food accessibility and marketability. Food is also processed to progress its quality and safety. Food safety is a systematic regulation that provides an assertion that food will not cause harm to the customer when it is organized or eaten according to its future use.[1] Foods are not only to convince hunger and to distribute

[1]Department of Food Processing and Engineering, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India, [2]Department of Control and Instrumentation Engineering, P.S.G. College of Engineering and Technology, Coimbatore, Tamil Nadu, India

***Corresponding author:** A. Allwyn Sundarraj, Department of Food Processing and Engineering, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India. Phone: +91-9443997989. E-mail: asrthegreat@gmail.com

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essential nutrients but also to avoid the expansion of nutrition-related diseases and to develop physical and mental well-being of consumers.[2,3]

FOOD BIOTECHNOLOGY

Food biotechnology is a moderately new and hastily developing division of molecular biology, which in progress with the formation of the first recombinant Gene 30 years ago. These technique is, in many dissimilar ways, altering the way we live by recovering the foods we eat, the beverages we drink, the clothes we wear, and the medicine we take.

For centuries, human beings have been select, sow and harvest seeds to manufacture food products that will continue them. In this present age, global food requirement has enlarged the need for better crops. Biotechnologies offer the essential technology to manufacture higher crop yields, plants that are obviously sheltered from disease and insects, and potentially more healthy and better-tasting foods. Crops created by biotechnology comprise soya beans, papaya, canola, corn, cotton, and squash. Furthermore, an enzyme used to make cheese and yeast to formulate bread is usually produced by biotechnology.

APPLICATIONS OF FOOD BIOTECHNOLOGY

The high value-added products are progressively more created in more scientifically highly developed budding countries for use in their food and non-food processing application. Many of these high value-added products are also imported by budding countries for use in their food processing applications. The applications of biotechnology method in the food and agricultural manufacturing are one of the many aspects of biotechnology that has great force on society. By the year 2050, it is likely that more than 10 billion people will be living on this planet, and it is also whispered that there may not be sufficient property to feed the world population.[4]

Biotechnology has a main application in the food segments. It helps in convalescing the edibility, texture, and storage of the food; in prevent the attack of the food, mostly dairy, by the virus-like bacteriophage produce antimicrobial outcome to destroy the unnecessary microorganisms in food that cause toxicity; to avoid the creation of mycotoxins and dreadful conditions of other toxins and antinutritional elements present obviously in food. It can also acting a significant role in protein engineering**.** The technology also helps in classification of pathogens, pesticides, and anti-nutritional factors present in the food.

FOOD BIOTECHNOLOGY IN MILK AND MILK BASED PRODUCTS

Milk is a white liquid biological secretion from the mammary glands of female mammals. Conventionally, milk has been considering the most entire food providing by nature. It is a vital resource of necessary nutrient required for the growth and growth of newborn. It is also extremely suggested in the diet of adult humans due to its high dietary assessment. It is, generally, composed of water, proteins, lipids, carbohydrates, vitamins, and minerals.[5,6]

Lactose is the main carbohydrate found in milk. It has been report that lactose can stimulate the combination of minerals together with calcium and magnesium.[7] Diglycerides, monoglycerides, esters, and cholesterol are initiate at low levels.[8] The purpose of the lipid materials in milk is to transport the fat-soluble Vitamins A, D, and E.[8,9] Furthermore, it has been established that milk not only contains nutritive compound but also in nature active ones, like caseins and whey proteins. It is the major resource of nourishment for young mammals before they are able to digest another type of food. Early lactation milk contains colostrum, which carries the mother's antibodies to its young and can decrease the hazard of many diseases.[10]

For human beings, the World Health Organization (WHO) recommend limited breastfeeding for 6 months and in addition to other food for at least 2 years.[11] In a few cultures, it is familiar to breastfeed children for 3–5 years and the period may be longer.[12]

Conventionally, milk has been considering the most entire food provided by the nature. It is also tremendously suggested diet of adult humans due to its high dietary value.[5] Fresh goat's milk is occasionally substitute for breast milk. This introduces the risk of the child embryonic electrolyte imbalance, metabolic acidosis and a host of allergic reaction.[13] Since of its high dietary content, milk can be used to manufacture a large array of dairy foodstuffs such as whole, skim, lactose-free, and skimmed milk powder. Milk is also used to make the fermented dairy products cheese, yogurt, kefir, and bulgaro. Butter, milk whey, lactic or renin, caseinates, lactose, enzymatically modified milk ingredients, ice cream, and other dairy beverages are the major commodities we attain from milk.[14,15]

Probiotics

Probiotic is a fairly new word meaning "for life," which is used to name microorganisms that are linked with the advantageous effect for humans and animals. The probiotic microorganisms consist mainly of the strains of the genera *Lactobacillus* and *Bifidobacterium*, but strains of *Bacillus, Pediococcus,* and some yeast have also been establish as appropriate candidates.[16]

Probiotics are defining as the living microorganisms administer in a plenty number to endure in the intestinal system. They should have a positive effect on the host.[17] The name "probiotic" was first used by Lilly and Stillwell[18] in 1965 to explain the substance concealed by one microorganism that motivates the growth of another. Probiotic foods are the best ever growing area of functional food development. In general, the collection strain of lactic acid bacteria is significant to ensure health benefits of probiotic foods. A number of health benefits linked with probiotic food products comprise treatment of diarrhea,[19] alleviation of a symptom of lactose intolerance,[20] reduction of blood cholesterol,[21] anticarcinogenic properties,[22,23] and improvement in immunity.[19,24] New food goods have been formulate with the adding together of probiotic cultures. Diverse types of various food matrices have been used such as diverse types of cheese, ice creams, milk-based desserts, powdered milk for newborn infants, butter, mayonnaise, powder products, and fermented food of vegetable origin.[25]

Dairy Products

In the manufacture of probiotics is a significant factor in the food substrate. Moreover, buffer the bacteria during the stomach; it may hold useful ingredients that interrelate with the probiotics, changing their actions. Yogurts with high-fat content showed inhibitory property beside probiotic cultures, mainly *B. bifidum* BBI. The supplementation with vitamins has been report to get better the viability of *L. acidophilus* in yogurts.[26] The addition of substance such as whey protein may also improve the viability of a number of probiotics, possibly due to their buffer property. In addition, the employment of prebiotics in yogurt formulations can stimulate the growth and activity of probiotics.

A number of studies linked[25] report that Turkish white brined, Feta-type, Cheddar, Philippine white soft, Quarg, and cheese-based dips can be compared with yogurts in deliver probiotics. A few prebiotics could be used to develop the quality of the probiotic ice creams. Inulin confirmed to be helpful to the decisiveness, melting properties, and soaked time of the ice creams.[27]

Non-dairy Products

A few matrices have been use in the growth of non-dairy probiotic foodstuffs such as fruits, vegetables, legumes, and cereals. Fruits and vegetables can be measured good matrices because they enclose nutrients such as minerals, dietary fibers, and antioxidants. The growth of diverse probiotic fruit juices has been studied.[28-30] Describe a revision about an assortment of non-dairy probiotic beverages.

Prebiotics

The word prebiotic has been used to explain a dietary component that stimulates the growth and activity of a preferred group of microbes, thereby provide these organisms with a competitive benefit over other bacteria in the environment.[11] Mixture of both probiotics and prebiotics is known as Symbiotic. This mixture can progress the survival of the probiotic organism. Consuming a probiotic supplement that also includes the suitable prebiotic has many beneficial effects. The mixture of both probiotic and prebiotic has the capacity to heal and control the intestinal flora, mainly after the devastation of microorganisms following antibiotic, chemotherapy, or radiation therapies.

DAIRY INDUSTRY

Dairy products are recognized as healthy natural products.[31] Biotechnology can play an incredibly effective and forcefull role in enhancing the food and nutritional security in the country.

Modern developments in the biotechnology have opened up new and stimulating possibilities in dairying for enabling the accessibility of milk and milk products within the attain of poor and cater to the needs of large sections of the population. Dairy industry, in particular, can enormously promote through biotechnological interventions which can not only develop the overall quality and safety of processed dairy foods but also improve their commercial values for local consumptions and exports. Since, the major obligation of dairy industry is to offer high quality nutritious, healthful and inexpensive dairy foods to the consumers; it has become predictable to incorporate biotechnological intervention at a different stage of milk production and processing.

Global dairy industry is extraordinary by large. In 2005, world milk making was expected at 644 million tons, of which 541 million tons were cows' milk. The foremost producers of milk were the European Union at 142 million tons, India at 88 million tons, the United States at 80 million tons (20.9 billion gallons), and Russia at 31 million tons. Cheese making amounted to 8.6 million tons in Western Europe and 4.8 million tons in the United States.[32,33] The huge range of foodstuffs prepared from milk worldwide lead to a uniformly remarkable array of spoilage microorganisms.

LATENT APPLICATIONS OF BIOTECHNOLOGY IN DAIRY SECTOR

Biotechnology has previously made significant offerings in dairy industry. Some of the possible applications and future scenario are given below:

Dairy Production

- Recombinant bovine
- Recombinant vaccines

- DNA fingerprinting
- Embryo transmit technology
- Animal cloning
- Gene forming and transgenic.

Dairy Processing

- Conniving milk through genetic engineering
- Food grade bio-preservatives
- Dairy enzymes/proteins
- Probiotics
- Functional foods and nutraceuticals
- Dairy waste organization and pollution control.

In the field of biotechnology, there is a much manufacturing application that outcome in biotech goods that we use every day at home. A few of these are food science application that makes use of enzymes to make various improvements in the quality of diverse foods. In the milk industry, some enzymes are necessary for the manufacture of cheese's, yogurt and other milk products, although others are used in a more particular fashion to get better texture or flavor.

Five of the more familiar type of enzymes and their character in the dairy industry are described as follows:

Rennet

Milk contains proteins, especially caseins that uphold its liquid form proteases are enzymes that are added to milk throughout the cheese manufacture, to hydrolyze caseins, which stabilize micelle arrangement, prevent coagulation. The most familiar enzyme extracted from rennet is chymosin. Chymosin can also obtain from numerous other animals, microbial, or vegetable sources, but indigenous microbial chymosin is unsuccessful for making chedder, and other hard cheeses Bio-engineered chymosin may be concerned in the manufacture of up to 70% of cheese products.

Milk contains number of diverse type of proteins, in addition to the caseins. The denaturing of whey proteins such as lactalbumin and lactoglobulin using proteases result in the creamier yogurt product.

Lactase

Lactase is a glycoside hydrolyzes enzyme that cut lactose into its essential sugars, galactose, and glucose. Lactase is used commercially to organize lactose-free products, mainly milk, for such individuals it is also used in the preparation of ice cream, to make creamier and sweeter tasting manufactured goods. Lactase is as frequently organized from *Kluyveromyce*s sp. of yeast and *Aspergillus* sp. of fungai.

Catalase

The enzyme catalase has established partial use in one exacting area of cheese manufacture. Catalase enzymes are characteristically obtain from bovine livers and are further to transfer the hydrogen peroxide to water and molecular oxygen.

Lipases

Lipases are used to break down milk fats and give attribute flavors to cheeses. The flavor comes from the free fatty acid created when milk fats are hydrolyzed. Hydrolysis of the shorter fats is preferred, since it results in the popular taste of many cheeses and the longer chain fatty acids can effect in also soapiness or no flavor at all.

Gene Probes

Gene probes and immunological assays using poly or monoclonal antibodies besieged against the specific pathogen, sensitive and have turned out to be an enormously valuable tool for the reliable detection of pathogens in foods even at low levels. Numbers of companies are entering into the expansion of kits based on the gene probes and immunological values for quick detection of targeted pathogen in the foods. Many such kits are commercially accessible now.

BY-PRODUCT WASTE FROM THE MILK INDUSTRY

In the past few years, a public, political, technical, and hi-tech importance in ecological safety has emerged. An international endeavor is in progress to determine solutions to ecological problems and to generate a balance involving human growth and care of our environment.[34]

Biomass

In the development of olive oil isolation, 20% of the oil is isolated, and the other 80% is a waste called oil press, where 50% of oil press is composed of water. This water contains a combination of isolates from the plant materials, soft tissue of olives and water used in any step of the isolation process.[35]

Bioplastics

In the manufacture of bioplastic like polyhydroxyalkanoates (PHA), which have revealed to be good substitute for plastics resulting from extremely polluting oil. The use of PHAs is not only accommodating for the surroundings but has also come to have a great contact in the medical field. *Brevibacterium casei* SRKP2, which can make use of industrial wastes milk as a carbon source, also create polyhydroxy butyrates.[36]

Biofuels

The ignition of biofuels releases less pollute agents into the atmosphere than flaming fossil fuels.[37] Dairy wastes have been planned as a solution since they can be use as substrate for fermentation

by yeast-like *Kluyveromyces fragilis*. This type of yeast is, generally, used to hydrolyze lactose present in milk whey. The acquire ethanol from the hydroxylation might be used to manufacture alcoholic beverages.[38]

Bioactive Peptides

Bioactive peptides have been defined as inactive amino acid sequence establish in the middle of a originator protein, which have organic manners after being released by a enzymatic hydrolysis. Depending on the character of the precursor protein resource, the type of enzymes concerned and the condition below which the active peptides are released varies.[39] The bioactive peptides created can be used as a nutritional supplement for human utilization as of their structure quick incorporation and timely exclusion.[40,41]

Organic Acids

The developed industrial sectors of food, beverages, and pharmaceuticals require a variety of chemical compound, which are used as an additive for the manufacture of many products.[42] The propino bacteria have been used also as silage inoculants or to produce numerous functional compounds, include propionic acid. The propionic acid is mainly used as a preservative, to manufacture Vitamin B12, as it is considered a probiotic agent.[42,43]

CONCLUSION

Biotechnology is one of the frontier areas of scientific growth in the world today. While the beginning of pasteurization has help to make sure the protection of dairy products, improvement has been slower in prevent the microbial spoilage of cheese and dairy products. The feasibility of probiotics is a key factor for mounting probiotic food products. Latest studies have recommended that probiotics have established valuable effect to human and animal health. In the dairy production, a few enzymes are necessary for the manufacture of cheese's, yogurt, and other dairy foodstuffs, while others are used in a more focused fashion to develop texture or flavor. New biotechnology products being developed for use in livestock manufacture, but they are also being developed for use in food processing. Dairy by-products can be used to achieve important chemical compounds that are helpful in the fields of health, pharmaceuticals, food, plastics, and fuels. Dairy industry, in particular, can enormously benefit throughout biotechnological intervention which can not only progress the overall quality and safety of processed dairy foods but also enhance their commercial values for local consumption and exports. This will convey many challenges to the dairy processor, but maintain the value and shelf life of this extremely healthful food should not be one of them.

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