Shahid Bahonar University of Kerman
Agricultural Biotechnology Journal
Iranian Biotechnology Society
Print ISSN: 2228-6705 Online ISSN: 2228-6500

Future of food industry sustainability using biotechnological interventions in the dairy sector

Deepak Kumar Sahu

*Corresponding author. Assistant Professor, Department of Pharmacy, Kalinga University, Naya Raipur, Chhattisgarh, India. E-mail address: ku.deepakkumarsahu@kalingauniversity.ac.in

Lakhan Lal Kashyap

Assistant Professor, Department of Pharmacy, Kalinga University, Naya Raipur, Chhattisgarh, India. E-mail address: ku.lakhanlalkashyap@kalingauniversity.ac.in

Abstract

Objectives

The dairy industry, a prolific producer of waste and by-products, boasts a diverse array of goods that contribute significantly to our daily diet. However, the copious waste generated in the process, characterized by high Chemical Oxygen Demand (COD) and a rich nutrient profile comprising lactose, proteins, and fats, necessitates exploration of alternative biotechnological applications. This exploration is particularly crucial when considering both aerobic and anaerobic processing methods. Probiotic food items, having garnered widespread consumer acceptance, are experiencing substantial growth in the nutritional food industry. Recognizing this trend, the food industry is actively engaged in expanding the scope of probiotic meals beyond traditional dairy products. This expansion holds promise for delivering numerous health benefits to consumers. Consequently, this research delves into the extensive range of dairy products available, elucidating ways to harness by-product waste from the dairy industry.

Materials and methods

Thirty-five unpasteurized milk specimens were obtained from healthy nursing camels in various districts of Punjab, India. The specimens were gathered in a sterile receptacle. As a result of the lengthy trip, the samples were stored in iceboxes until they were transported to Laboratories. The specimens were thoroughly mixed (10% weight/volume) in a sterile alkaline with phosphate with a stomacher. Following incubation, colonies with distinct morphologies were chosen and brushed onto agar plates for pure isolation.

Results

The probiotic isolates A1, A3, and A8 exhibited a statistically significant ($p < 0.05$) increase in cholesterol elimination (62%, 56%, 78%, and 52%, correspondingly) after 12 hours of incubation compared to the other samples. Isolate A7 had the least capacity for cholesterol elimination, with a rate of 33%, whereas isolate A4 had a slightly higher rate of 39%. The efficacy of triglyceride elimination improves proportionally with the duration of incubating.

Conclusions

In conclusion, the dairy industry's waste management presents a dual opportunity: to mitigate environmental impact through responsible waste disposal and to extract valuable nutrients for application in diverse biotechnological realms. This comprehensive exploration contributes to our understanding of the potential of dairy waste by-products, shedding light on sustainable practices and innovative applications that align with the evolving landscape of the nutritional food industry.

Keywords: Food Industry, Biotechnology, Dairy, Sustainability

Paper Type: Research Paper.

Citation: Sahu DP, Kashyap LL (2024) Future of food industry sustainability using biotechnological interventions in the dairy sector. *Agricultural Biotechnology Journal* 16 (1), 319-336.

Agricultural Biotechnology Journal 16 (1), 319-336. DOI: 10.22103/jab.2024.22732.1537

Received: December 12, 2023. Received in revised form: January 31, 2024.

Accepted: February 01, 2024. Published online: February 20, 2024.

Publisher: Faculty of Agriculture and Technology Institute of Plant Production, Shahid Bahonar University of Kerman-Iranian Biotechnology Society.

Introduction

Biotechnology applies living things and creatures to develop goods or processes for particular purposes (Nielsen et al. 2022). It encompasses any technological utilization that involves the manipulation of natural systems and live organisms to create modified goods or procedures. Science has had a diverse and significant impact on numerous aspects of life. Gene

advancement, vaccine production using DNA vaccines, creation of hybrid plants, and genetic alteration are some of the critical topics in biotechnology that have had significant impact (Wang et al. 2021). Biotechnology has several uses in various sectors, such as manufacturing, farming, medicines, food, and energy.

Food manufacturing is the transformation of essential ingredients, using materials or substances, into food or different kinds of food (Galimberti et al. 2021). Food processing involves the integration of uncooked food ingredients to produce commercially viable food items that can be quickly cooked and consumed by the customer. Food technology is an integrated field that applies biological sciences, microbiological science, and engineering principles to studying food and associated sectors (Preethi and Sekar 2021).

Food biotechnology is a relatively recent and rapidly advancing branch of molecular science that began with the creation of the first transgenic gene thirty years ago (Nowosad et al. 2021). This technology is revolutionizing all aspects of our lives by enhancing the quality of the food, the drinks imbibe, the clothing, and the medication. Highly advanced developing nations are increasingly producing goods with value for use in both food and non-food preparation applications. Budding nations often acquire high-value-added items to be used in their food preparation operations. Biotechnology techniques in producing food and crops are a significant area of biotechnology that profoundly impacts society. By 2050, the global populace will probably exceed 10 billion, and there are concerns that there might be more resources to feed everyone adequately.

The dairy industry's leftovers and byproducts can be used to produce various bio-based goods while lowering their ecological impact (Gao et al. 2021). Incorporating these waste materials into the biorefinery facilities will significantly contribute to the extraction and isolation of bio-products, the proliferation of microbes, and the development of the bioeconomy. To build waste-to-sustainable manufacturing procedures, it is essential to consider three factors (Freitas et al. 2021): (i) the technical viability of industrial operations, (ii) the possibility of techno-economic evaluation, and (iii) a life-cycle environmental evaluation. For instance, the generation of biogas and subsequent electricity will be constrained by significant initial investment expenses and extended periods required to recoup these expenditures, particularly in nations where there is a need for gas from natural sources. It is essential to evaluate the accessibility of suitable technology for the combined facilities and their interoperability with the current innovations.

Western blotting, or protein immunoblot, is a commonly used analytical method in cell and cellular biology (Meftahi et el. 2021). It is frequently employed in scientific investigations to isolate and characterize proteins and is particularly relevant in identifying food allergens. This method is used to identify a specific protein in a specimen of blood or muscle. The technique

entails using capillary gels to segregate the proteins present in the sample. Western blotting, also called western blotting, is a protein identification technique that combines electrophoresis of protein segregation with antigen-antibody identification.

The Enzyme-Linked Immunosorbent Test (ELISA) is the predominant technique employed by the food sector and government food control organizations (Tabatabaei et al. 2021). The immunodiagnostic approach has been extensively utilized in medical care, commercial, and bioanalytical contexts, making it the most prevalent method. These tests identify the existence of (concealed) allergenic amino acids in food items using a colorimetric response. The accessibility of polyclonal and monoclonal antibodies against several fungicides has made it a widely used and effective screening method.

Detecting food pathogens is crucial for ensuring food safety. Lateral Flow Assay (LFA) is a popular option for on-site detection due to its fast detection duration, excellent sensitivity, and easy operation (Sohrabi et al. 2022). This screening test technique is characterized by its rapidity, ease of use, specificity, and robustness. These approaches have garnered interest due to their capacity to promptly, inexpensively, and on-sitely identify infections. The dot-blot technique employs an antibody with a monoclonal structure that explicitly targets the peptide in Salmonella Enteritidis (Surti et al. 2022). It serves for the identification and measurement of proteins. It has garnered sufficient recognition for its ability to identify pathogenic, immunological, and allergenic substances via antibodies.

The objective of this study was to thoroughly analyze the composition and different types of by-products and waste materials generated by the dairy industry. It intended to explore the conventional methods of using these materials and their prospective uses in biological structures (Amiri et al. 2021). This study thoroughly examined the potential use of waste and by-products from the dairy sector in microbiological manufacturing procedures. The study presented the findings of many techno-economic evaluations conducted on value-added goods derived from dairy wastes.

The following sections are organized in the specified order: Section 2 explores the dairy business and the use of biotechnology techniques to treat, analyze, and enhance dairy products. Section 3 examines the empirical investigation and results. Section 4 presents the final findings and potential areas for further research.

Biotechnology-based Dairy Industry and its Analysis Process: Dairy processing is the act of converting raw milk into various dairy products. The manipulation of milk via genetic modification, the use of bio-preservatives that are safe for consumption, the incorporation of dairy catalysts and protein molecules, the inclusion of probiotics for health benefits, the development

Agricultural Biotechnology Journal; Print ISSN: 2228-6705, Electronic ISSN: 2228-6500

of nutritional foods and nutritional supplements, and the implementation of measures to manage dairy waste and reduce pollution. A wide range of industrial applications in biological sciences yield biotech products often used in daily domestic lives. Some examples include the utilization of catalysts in the food industry to enhance the quality of different types of food. Enzymes are crucial in producing yogurt, mozzarella, and other milk-based goods in the dairy industry. While certain enzymes are essential for manufacturing, others are explicitly used to enhance the smoothness or taste. The following is a description of five commonly encountered catalysts and their roles in the dairy business:

- **Rennet:** Milk includes proteins, particularly caseins, which maintain its liquid consistency. Proteases, or proteins, are incorporated into milk during cheese production to break down the caseins. Caseins play a role in maintaining the structure of micelles and preventing coagulation. Chymosin is an exceptionally commonly isolated protease in rennet. Chymosin is derived from various animals, microorganisms, or plants. However, microbiological chymosin from natural sources is unsuitable for producing cheddar and other harder cheeses. Bio-engineered chitin is involved in making about 70% of cheese goods. Milk includes a variety of proteins besides collagen. Proteases denature whey amino acids, such as lactalbumin and lactoglobulin, resulting in a yogurt product with a creamier consistency.

- **Lactase:** Lactase is an enzyme that catalyzes the hydrolysis of glycoside bonds in lactate, producing constituent carbohydrates of lactose are glucose and galactose. Lactase is employed in business to have lactose-free items, particularly milk, catering to those with lactose intolerance. It is also utilized in the production of ice cream to enhance its texture and sweetness. Lactase is often derived from Kluyveromyces sp. fungus and Aspergillus sp. fungi.

- **Catalase:** The catalase has been partially used in a particular aspect of cheese production. Catalases are typically derived from cow livers and are responsible for converting peroxide that contains hydrogen into water and oxygen molecules.

- **Lipases:** Lipases serve to hydrolyze milk triglycerides, hence imparting distinctive tastes to cheeses. The taste originates from the liberated fatty acid formed during the hydrolysis of milk lipids. Preferential hydrolysis of smaller fats is favored since it contributes to the desirable taste seen in many dairies. In contrast, longer chained lipids lead to soapiness or no flavor.

- **Gene Probes:** Gene sensors and immunological evaluations via poly or monoclonal antigens targeted against specific bacteria are very effective and essential tools for accurately identifying infections in food, even when there are low concentrations. Several firms are venturing into developing kits that use gene sensors and immunological indicators to identify specific pathogens in food rapidly.

Microbial Mechanisms for Transferring Dairy Products into Bio-products Using Biotechnology: The primary constituents of milk-related waste and by-products are milk sugar, fats, and proteins. Firstly, it is necessary to transform these intricate organic structures into monomeric chemicals to generate bioproducts. While milk wastes are generally regarded as appropriate starting points for microbiological products, milk sugar, the primary component, cannot naturally metabolize by some bacteria, such as *S. cerevisiae*, owing to the absence of lactose hydrolyzing enzymes. Saccharomyces cerevisiae is primarily used as a microbe for synthesizing alcohol and single-cell proteins. On the other hand, genetically modified strains of S. cerevisiae that possess lactose hydrolase and lactic acid carrier genetics, or additional bacteria is which naturally consume the lactose can be employed to generate various metabolites.

Additionally, fat, a beneficial component in dairy waste products, significantly contributes to the synthesis of microbial metabolites and affects the levels of Chemical Oxygen Demand (COD). 1 kilogram of fat equals 3 kg of COD. Using microorganisms with the ability to produce lipase in microbial procedures using dairy waste that contains fat is more appealing. Another stage in the hydrolysis procedure of the primary constituents of dairy waste is the transformation of peptides into amino acids by bacteria that can produce protease enzymes. Different sources of nitrogen like DNA, urea, and certain ion forms (NO_2, NO_3, $NH+_4$), as well as inorganic as organic phosphorus and several metals present in dairy contaminants, can facilitate the growth of microbes and the creation of valuable by-products. The hydrolyzed milk sugar, lipids, and amino acids, along with other nutrients, are utilized in distinct processes of metabolism, which vary based on the microbe kind (microbes, yeast, fungal microalgae), the desired product (alcohol, pigment, enzymes, organic acids, etc.), and the specific culture conditions (respiratory or anaerobically).

By inhibiting methane synthesis in anaerobic digestion processes (Figure 1), various volatile fatty acids, additional carboxylic acids, and hydrogen are produced. Due to this restraint, methanogens generate biogas by consuming hydrogen and Volatile Fatty Acids (VFAs). The VFAs developed in Anaerobic Digestion (AD) might be regarded as a precursor to the synthesis of polyhydroxyalkanoates (PHA). Alternatively, gene cultures can synthesize PHA using purified VFAs or dairy byproducts.

Agricultural Biotechnology Journal; Print ISSN: 2228-6705, Electronic ISSN: 2228-6500

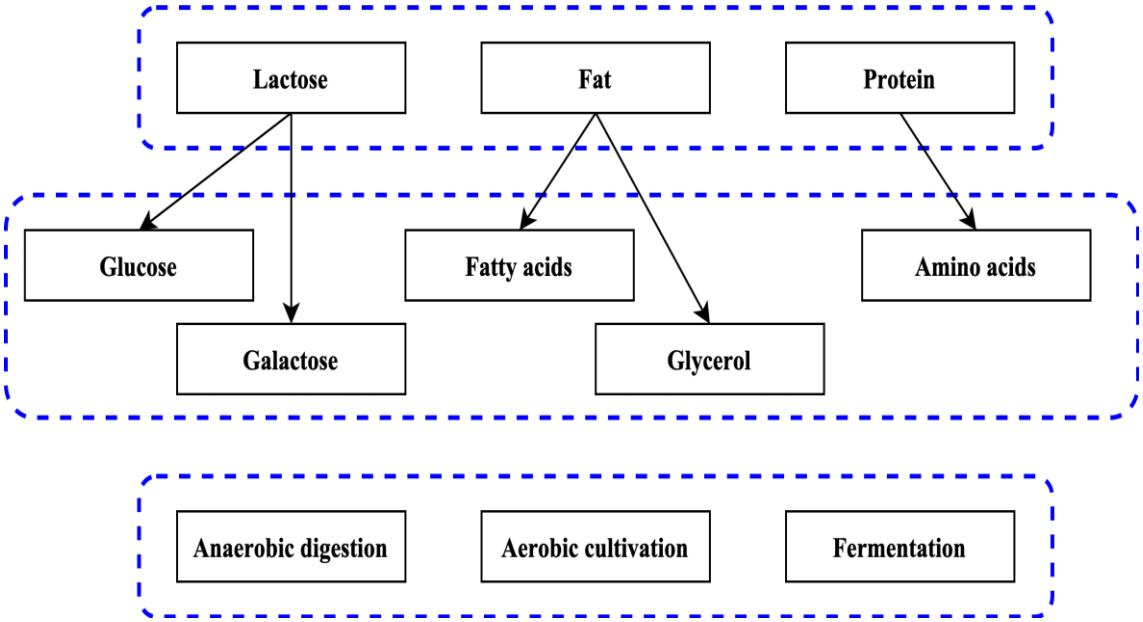


Figure 1. Biotechnology-based dairy industry into by-products production

Monomeric molecules are converted into essential nutrients that provide energy for the metabolism of bacteria. Microbes develop many vital metabolites, including ethanol, carbon dioxide, acetic acid, and citric acid. These metabolites can be obtained by culturing microbes on milk residue or by-products. While actively growing, microbes generate diverse secondary compounds, such as pigments, antimicrobial agents, vitamins, poisons, alkaloids, and fatty acids. Creating these valuable metabolites is achieved, like generating primary combinations. Some procedures need stressful circumstances, such as introducing or eliminating metal ions, carbon-based, and nitrogen sources, to enhance the formation of additional metabolites. One can get cultured bio-products or nutritional additions by fermenting milk by-products using microbes like whey to get health-promoting goods.

Materials and Methods

Thirty-five unpasteurized milk specimens were obtained from healthy nursing camels in various districts of Punjab, India. The specimens were gathered in a sterile receptacle. As a result of the lengthy trip, the samples were stored in iceboxes until they were transported to the Microbiology of Food and Bioengineering Laboratories. Upon getting there, they were promptly tested.

The specimens were thoroughly mixed (10% weight/volume) in a sterile alkaline with phosphate with a stomacher. Following the creation of diluted solutions in clean water (0.85% weight/volume sodium chloride), the specimens were placed onto Man Rogosa Sharpe (MRS)

agar, which included an additional 0.05% weight/volume of L-cysteine. The plates were placed in an anaerobic container and incubated at 37°C for 48 hours. Following incubation, colonies with distinct morphologies were chosen and brushed onto agar plates for pure isolation.

Screening of Bifidobacterium: All 35 samples were examined for their morphology, gram staining, catalase activity, motility, and presence of endospores. Following the initial examination, eight models were classified as belonging to the genus Bifidobacterium based on their characteristics of being Gram-positive, catalase-negative, non-spore producing, non-motile, and rod shapes resembling the letters V or Y. The isolated cells underwent further analysis to determine their growth properties, namely their ability to develop under various environments (12°C, 35°C, and 40 °C), NaCl quantities (4%, 6%, and 8%), and pH levels (ranging from 4.7 to 9.5). The isolates were also examined for their capacity to generate carbon dioxide and undergo fermentation of different sugars utilizing the API 50CH kit. The EVOS FL Auto Cell Image Technology was used for microscopic evaluation. The uncontaminated specimen was stored in MRS broth with 30% glycerin at a temperature of -85°C as a refrigerated backup. Before usage, the starter culture was revived by sub-cultivating it at least every three weeks in MRS soup.

Survival Under Gastrointestinal Scenarios and Phenol Tolerance: The isolates were tested for resistance to extreme digestive tract conditions, including low stomach pH, bile salts, and 0.5% (w/v) phenolic. The isolates were cultured in MRS broth to achieve the target cell count of 100 logarithmic colony-forming units per milliliter (CFU/mL) after 15 hours of incubation at 35 degrees Celsius. The Simulating Gastric Juice (SGJ) was generated by adding pepsin (3 g/L) to a sterile solution of saline (0.88%, w/v NaCl) and adjusting the pH to 3 or 4 using 1 M HCl. One milliliter of the cell suspension was cultivated overnight, and 100 colony-forming units per milliliter were combined with nine milliliters of sanitized SGJ under sterile circumstances. The mixture then underwent incubation at 38 degrees Celsius for two hours. The tolerance to the bile salts and phenolic was assessed by introducing a microbial of bacterial cells (1 mL with a density of 100 logs CFU/mL) into MRS broth containers with varying concentrations of bile salt (0.5%, 1.5%, and 2% w/v) and phenolic (0.5% w/v). The usable population was assessed after incubation using plating techniques and represented as CFU/mL.

Auto-Aggregation Assay: All the examined isolates were cultured overnight overnight by centrifuging at 3000× g, at 3°C for 15 minutes. The cells were rinsed twice with Phosphate Buffer Saline (PBS) and then submerged in PBS until they reached an absorption of (0.6 ± 0.04) at 500 nm at 0 hours (A_1). 1 mL of each microbial solution was vigorously mixed for 10 seconds using the vortex method and then subjected to incubation at 35°C for 2 hours, 8 hours, 10 hours, and 12

Agricultural Biotechnology Journal; Print ISSN: 2228-6705, Electronic ISSN: 2228-6500

hours. The absorption of the residue was determined at a wavelength of 500 nm after 2 hours, 8 hours, 10 hours, and 12 hours of incubating (A_F) as described by Equation (1).

$$AAA = 1 - \left(\frac{A_F}{A_I}\right) \quad (1)$$

A_I represents the absorbance at the start of the experiment, which is 0 hours. A_F represents the absorbance at several time points throughout the experiment, namely 2 hours, 6 hours, 12 hours, and 24 hours after incubation.

Cell Surface Hydrophilicity: Cell surface hydrophilic properties that could adhere to petroleum were assessed on all eight isolated microbes. Cells cultivated overnight were gathered by centrifugation at 4900g at a temperature of 5 degrees Celsius for 15 minutes. The tissues were rinsed twice with PBS solution with a pH of 5 and then submerged in PBS solution until they reached an absorption value of (0.6 ± 0.05) at a wavelength of 600 nm at the start of the experiment (A_I). 1 mL of hydrocarbons (xylene) was combined with 3 mL cell suspensions and subjected to pre-incubation at 35°C for 15 minutes. The suspension of cells and hydrocarbon mixture were vigorously agitated for 4 minutes and then allowed to settle for 25 minutes to facilitate the segregation of the aqueous and hydrocarbon phases. Following gathering the water phase, its absorption was quantified at a wavelength of 500 nm (A_F) using Equation (2).

$$CSH = 1 - \frac{A_F}{A_I + A_F} \quad (2)$$

A_I is the initial absorbance and A_F is the final absorbance.

DPPH Free Radical Scavenging Activity: A volume of 100 µL of recently produced cells, with a concentration of 109 CFU/mL, was combined with 1 mL of a DPPH mixture with a concentration of 0.05 mM. The combination was agitated and incubated for 30 minutes in a light-restricted environment. The absorption measurement was conducted at a wavelength of 517 nm, and the efficiency of scavenger DPPH was determined using the formula provided in Equation (3).

$$DFRSA = 1 - \left(\frac{A_T - A_0}{A_C}\right) \quad (3)$$

A_T refers to the combination of a bacterial cell or DPPH solutions. A_0 represents a mixture of alcohol and a bacterial cell. A_C represents the DPPH solutions.

Depletion of Sodium Nitrite: To prepare a solution with a concentration of 150 µg/mL, 1 mL of sterilizing sodium nitrite mixture with a concentration of 1500 µg/mL was combined with 9 mL MRS broth at a pH of 6.0. An inoculum of 120µL of a newly produced bacterial culture containing 109 CFU/mL was introduced and subjected to anaerobic incubation for 24 hours at 35°C. For the control specimens, clean water was substituted for the infection. The colorimetric nitrite technique was employed to quantify the starting point and ultimate absorbance at a

wavelength of 535 nm. The deproteination and defatting of a 10 mL mixture of inoculum, MRS liquid, and nitrates was achieved by adding 12 mL of $ZnSO_4$ (0.48 mol/L) and filtration. 2 mL of each of the three-color development solutions (0.4% (w/v) a substance called 0.3% (w/v) N-1-naphtyethylene diamine dihydrochloride, and 42.5% (v/v) HCl) was added to the supernatant and well stirred. The solution was stored in a light-free environment at 35°C for 10 minutes. The color mixture's transparency was measured at 535 nm relative to a blank sample. A solution of sodium nitrite with a concentration of 2000 μg/mL was made, and a typical curve was created using the same procedure outlined in Equation (4).

$$DSN = 1 - \frac{N_x}{N_f} \quad (4)$$

N_x represents the quantity of nitrite found in MRS soup at the start (0 hours), whereas N_f is the quantity of nitrite remaining in MRS liquid after 48 hours.

Hemolytic Activity: The strains' hemolytic capacity was assessed using Columbia agar supplemented with 5% (w/v) sheep plasma. The plates were then maintained at 37°C for 48 hours. After the incubation process, the hemolytic capability of separated isolates was assessed and categorized on the assumption of rupture of blood vessel cells in the media surrounding the spores. The α-hemolysis refers to the green areas around territories, and the β-hemolysis relates to the transparent regions surrounding colonies. In contrast, γ-hemolysis refers to the absence of zones surrounding colonies on Columbian plates made of blood agar. Strains that exhibit γ-hemolysis are the only ones regarded as acceptable.

Statistical Analysis: The clinical trials were duplicated, with every experiment being analyzed in duplicate. The findings were reported as the average value plus or minus the standard deviation. The results were subjected to statistical analysis utilizing a fully randomized design with the assistance of Statistics 8.1. The threshold of significance ($p < 0.05$) was determined using an Analysis of Variance (ANOVA) with two-factor narratives under a completely randomized design, then using Tukey's multiple comparisons testing.

Results

Preliminary identification was conducted on 35 samples obtained from fresh milk. Among them, eight samples (A1, A2, A3, A4, A5, A6, A7, and A8) exhibited the presence of bifidobacteria on the MRS media and were chosen for further experimentation based on their cultural, structural, miniature, psychological, and metabolic traits. Most samples exhibited white to off-white, lustrous, round colonies on the agar gelatin. The first analysis indicated that the chosen models were all Gram-positive, rod-shaped bacteria with either a V or Y shape. They were

Agricultural Biotechnology Journal; Print ISSN: 2228-6705, Electronic ISSN: 2228-6500

found to be unfavorable for the enzyme catalase and did not exhibit any motility or create any spores.

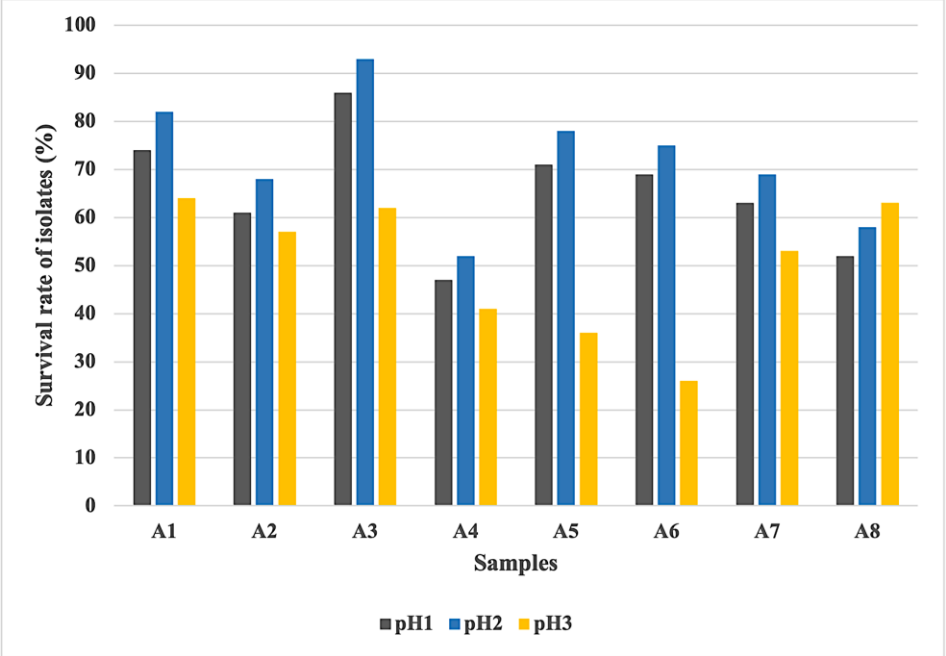
The isolated strains exhibit resilience, enduring pH levels of 1, 2, and 3 for 2 hours under incubation conditions (Figure 2(a)). The survival rate of all investigated samples decreased at pH 2 instead of pH 3. The results also indicated that A1 to A8 exhibited a considerably ($p < 0.05$) high level of immunity to gastroenteritis (78%, 88%, and 72%, correspondingly) at pH 3. Each of the isolates can endure different levels of bile salt content (0.2%, 0.4%, and 0.6%) for 3 hours of incubation (Figure 2(b)). The highest survival rate was recorded at a bile salt level of 0.3%, while the lowest was noticed at a biliary salt dosage of 1%—higher concentrations of bile salt lead to lower survival rates. The strain exhibited superior survival rates compared to other stresses, even in the presence of an elevated level (1%) of bile salt.

The cell surface characteristics, such as auto aggregation and cell membrane hydrophilic properties, play a crucial role in the ability of probiotics to colonize and protect the bacteria. Every tested isolate exhibited significant auto aggregation capability. The A1 and A7 isolates showed the highest levels of auto-aggregation, with rates of 62% and 67%, respectively, while the A3 sample had the lowest level of auto-aggregation at 45%. The phenomenon of auto-aggregation becomes more pronounced as the duration of incubation grows. Consequently, every sample exhibited a substantial rise in auto-aggregation after 24 hours of pregnancy, as seen in Figure 3.

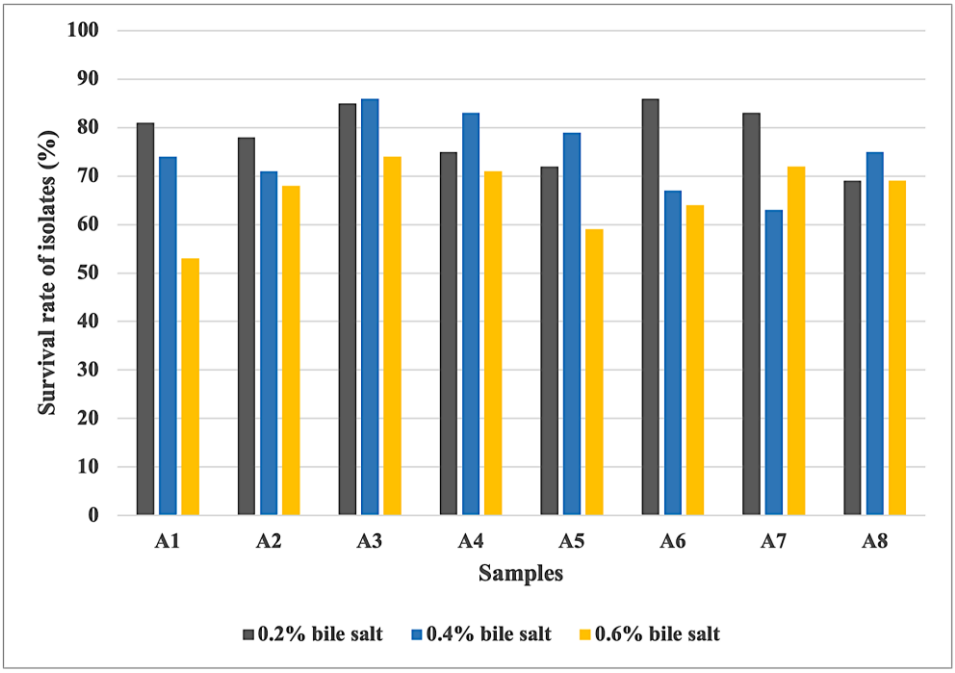
All the examined samples exhibit resistance to H_2O_2. The results showed that the survival of pieces was significantly affected by increasing concentrations of H_2O_2, resulting in a downward trend. In A5, the highest number of living cells (8.7 log CFU/mL) was recorded, while the most minuscule amount was found in A5 (4.35 log CFU/mL) at a concentration of 1.8 mM H_2O_2 (Figure 4).

Figure 5 illustrates the elimination of lipids by six probiotic cultures cultivated in MRS broth enriched with 0.4% oxygen. All of the examined isolates demonstrated the capability to absorb and use cholesterol. The findings indicated that the extent of cholesterol elimination differed considerably ($p < 0.04$) across each sample at the same incubation period, namely 6 hours, 8 hours, and 12 hours.

The probiotic isolates A1, A3, and A8 exhibited a statistically significant ($p < 0.05$) increase in cholesterol elimination (62%, 56%, 78%, and 52%, correspondingly) after 12 hours of incubation compared to the other samples. Isolate A7 had the least capacity for cholesterol elimination, with a rate of 33%, whereas isolate A4 had a slightly higher rate of 39%. The efficacy of triglyceride elimination improves proportionally with the duration of incubating.



(a)



(b)

Figure 2. The survival rate of samples. (a) under different pH conditions (b) under different bile salt conditions

Agricultural Biotechnology Journal; Print ISSN: 2228-6705, Electronic ISSN: 2228-6500

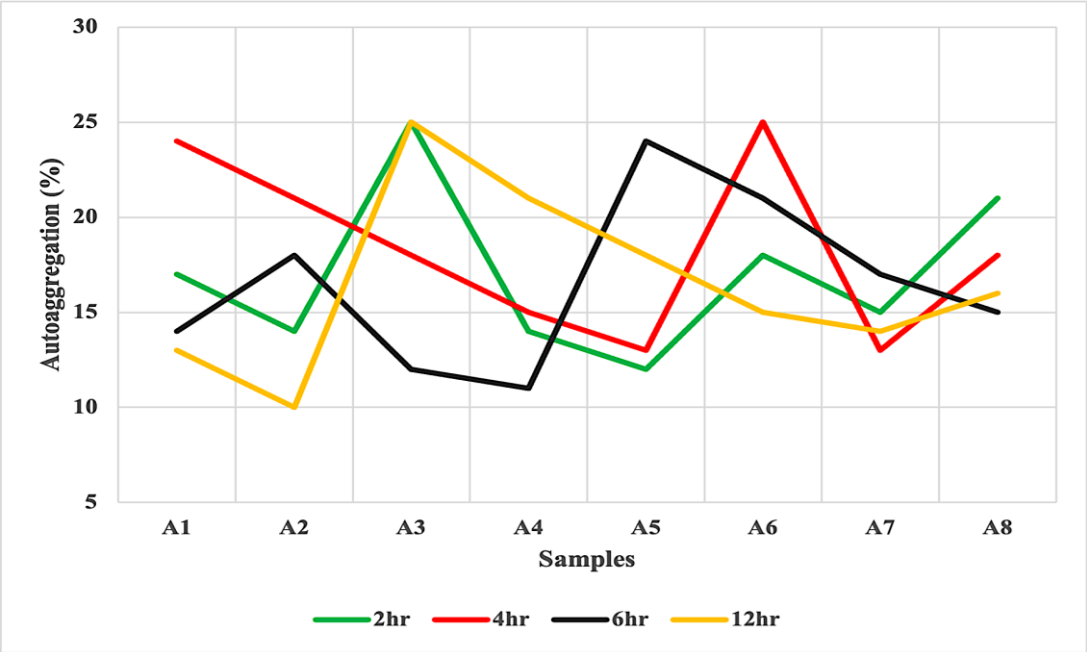


Figure 3. Auto aggregation analysis of samples under different duration

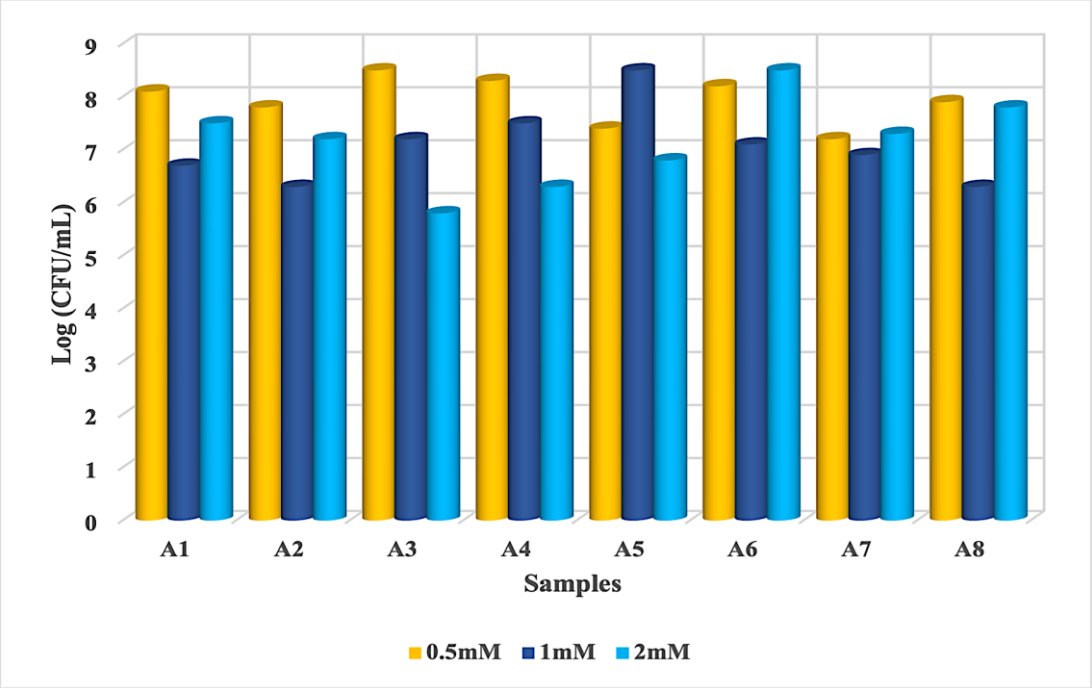


Figure 4. Log analysis of samples under different conditions

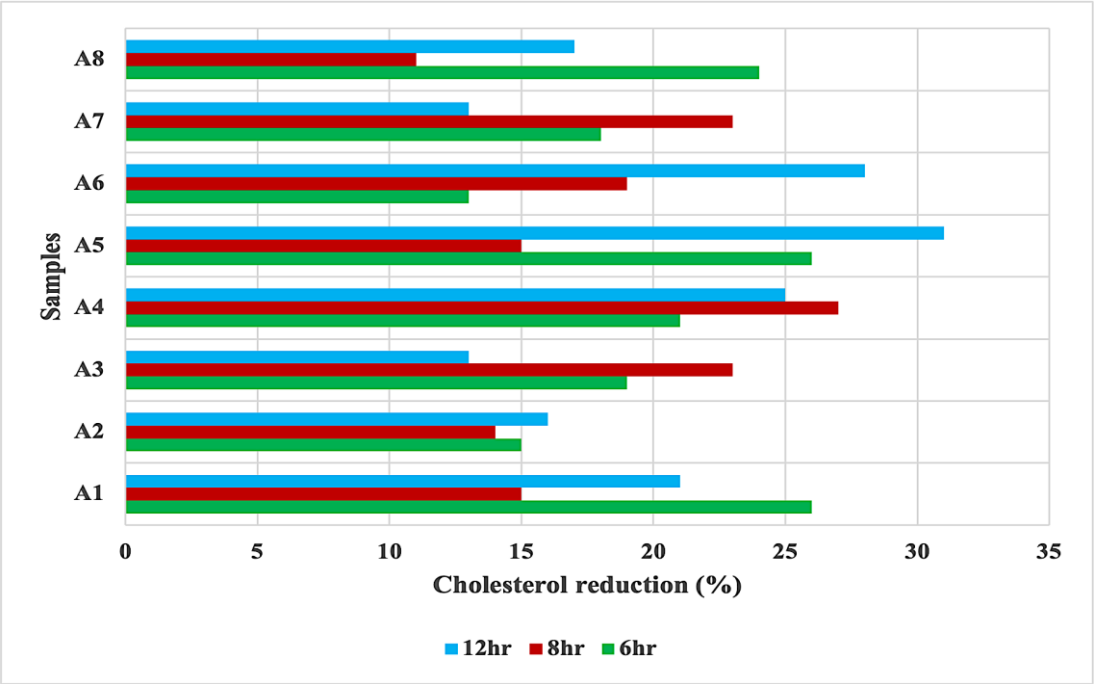


Figure 5. Cholesterol reduction analysis of samples under different duration

Conclusions: The lactose, proteins, and fat levels of dairy industry residues and contaminants make them significant pollution sources. An appropriate treatment approach has yet to be established for effectively managing such wastes with high COD levels. The feasibility of using milk waste as carbon sources in microbiological manufacturing procedures, including biofuels, acidic substances, enzymes, polymer compounds, and biomass, has been extensively assessed, and its suitability as a base material has been established. Dairy wastes are combined with other substances, such as cow dung or potato stems, and incorporated into anaerobic breakdown systems. Based on a techno-economic assessment, several studies have demonstrated that this co-digestion procedure might be financially beneficial for facilities. Further studies are needed to obtain goods from dairy contaminants, as the current techno-economic evaluations primarily focus on biogas generation. This study should (1) examine the utilization of lapsed or eliminated dairy goods such as milk, yogurt, and saturated dairy goods (e.g., cream, butter) in microbial procedures, (2) explore the possible application of dairy sector waste products for biometabolite manufacturing and waste therapy, (3) decide improved methods to utilize dairy waste in the biorefinery procedures, (4) create a bioprocess layout to enhance the being dairy/food manufacturing by recognizing new incorporated procedures, and (5) conduct techno-economic evaluate for the manufacturing of essential bacterial goods like bioethanol from and biohydrogen.

Agricultural Biotechnology Journal; Print ISSN: 2228-6705, Electronic ISSN: 2228-6500

References

Amiri S, Aghamirzaei M, Mostashari P, et al. (2021) The impact of biotechnology on dairy industry. J Microbiol Biotechnol 53-79.

Freitas LC, Barbosa JR, da Costa ALC, et al. (2021) From waste to sustainable industry: How can agro-industrial wastes help in the development of new products? Resour Conserv Recycl 169, e105466.

Galimberti A, Bruno A, Agostinetto G, et al. (2021) Fermented food products in the era of globalization: Tradition meets biotechnology innovations. Curr Opin Biotechnol 70, 36-41.

Gao J, Li X, Zhang G, et al. (2021) Probiotics in the dairy industry—Advances and opportunities. CRFSFS 20(4), 3937-3982.

Meftahi GH, Bahari Z, Zarei Mahmoudabadi A, et al. (2021) Applications of western blot technique: From bench to bedside. Biochem Mol Biol Educ 49(4), 509-517.

Nielsen J, Tillegreen CB, Petranovic D (2022) Innovation trends in industrial biotechnology. Trends Biotechnol 40(10), 1160-1172.

Nowosad K, Sujka M, Pankiewicz U, et al. (2021) The application of PEF technology in food processing and human nutrition. J Food Sci Technol 58, 397-411.

Preethi KA, Sekar D (2021) Dietary microRNAs: Current status and perspective in food science. J Food Biochem 45(7), e13827.

Sohrabi H, Majidi MR, Fakhraei M, et al. (2022) Lateral flow assays (LFA) for detection of pathogenic bacteria: A small point-of-care platform for diagnosis of human infectious diseases. Talanta 243, e123330.

Surti PV, Kim MW, Kailasa SK, et al. (2022) Progress on dot-blot assay as a promising analytical tool: Detection from molecules to cells. Trends Analyt Chem e116736.

Tabatabaei MS, Islam R, Ahmed M (2021) Applications of gold nanoparticles in ELISA, PCR, and immuno-PCR assays: A review. Anal Chim Acta 1143, 250-266.

Wang L, Liu Z, Jiang H, et al. (2021) Biotechnology advances in β-carotene production by microorganisms. Trends Food Sci Technol 111, 322-332.

مجله بیوتکنولوژی کشاورزی
شاپا چاپی: ۶۷۰۵-۲۲۲۸ شاپا الکترونیکی: ۶۵۰۰-۲۲۲۸

آینده پایداری صنایع غذایی با استفاده از مداخلات بیوتکنولوژیک در بخش لبنیات

دیپاک کومار ساهو

*نویسنده مسئول. استادیار، گروه داروسازی، دانشگاه کالینگا، نایا رایپور، چاتیسگار، هند. ایمیل: ku.deepakkumarsahu@kalingauniversity.ac.in

لاخان لعل کاشیاپ

استادیار، گروه داروسازی، دانشگاه کالینگا، نایا رایپور، چاتیسگار، هند. ایمیل: ku.lakhanlalkashyap@kalingauniversity.ac.in

تاریخ دریافت: ۱۴۰۲/۰۹/۲۱ تاریخ دریافت فایل اصلاح شده نهایی: ۱۴۰۲/۱۱/۱۱ تاریخ پذیرش: ۱۴۰۲/۱۱/۱۲

چکیده

هدف: صنعت لبنیات، تولید کننده پرکار ضایعات و محصولات جانبی، دارای مجموعه متنوعی از کالاها است که سهم قابل توجهی در رژیم غذایی روزانه ما دارد. با این حال، ضایعات فراوان تولید شده در این فرآیند، که با تقاضای اکسیژن شیمیایی بالا (COD) و مشخصات غنی از مواد مغذی شامل لاکتوز، پروتئین ها و چربی ها مشخص می شود، نیاز به کاوش در کاربردهای بیوتکنولوژیکی جایگزین دارد. این اکتشاف به ویژه هنگام در نظر گرفتن هر دو روش پردازش هوازی و بی هوازی بسیار مهم است. اقلام غذایی پروبیوتیک با استقبال گسترده مصرف کنندگان، رشد قابل توجهی را در صنایع غذایی تغذیه‌ای تجربه می کنند. با شناخت این روند، صنایع غذایی به طور فعال در حال گسترش دامنه وعده‌های غذایی پروبیوتیک فراتر از محصولات لبنی سنتی است. این گسترش نویدبخش ارائه مزایای سلامتی متعدد به مصرف کنندگان است. در نتیجه، این تحقیق به بررسی طیف گسترده‌ای از محصولات لبنی در دسترس می‌پردازد و راه‌هایی برای مهار ضایعات محصولات جانبی از صنایع لبنی را روشن می‌کند.

مواد و روش‌ها: سی و پنج نمونه شیر غیر پاستوریزه از شترهای شیرده سالم در مناطق مختلف پنجاب هند به دست آمد. نمونه‌ها در یک ظرف استریل جمع آوری شدند. سپس نمونه‌ها در جعبه‌های یخ نگهداری شدند تا به آزمایشگاه منتقل شوند. نمونه‌ها به طور کامل (۱۰٪ وزن / حجم) در محیط قلیایی استریل با فسفات با یک همزن مخلوط شدند. پس از انکوباسیون، کلنی‌هایی با مورفولوژی متمایز انتخاب شدند و برای خالص‌سازی بر روی صفحات آگار قرار گرفتند.

نتایج: ایزوله‌های پروبیوتیک A1، A3 و A8 افزایش معنی‌داری ($p < 0.05$) در حذف کلسترول (به ترتیب ۶۲، ۵۶، ۷۸ و ۵۲ درصد) پس از ۱۲ ساعت انکوباسیون نسبت به نمونه‌های دیگر نشان دادند. ایزوله A7 با نرخ ۳۳٪ کمترین ظرفیت حذف کلسترول را داشت، در حالی که ایزوله A4 دارای میزان کمی بالاتر از ۳۹٪ بود. کارایی حذف تری گلیسیرید متناسب با طول مدت انکوباسیون بهبود یافت.

نتیجه‌گیری: در نتیجه، مدیریت ضایعات صنایع لبنی یک فرصت دوگانه را ارائه می دهد: کاهش اثرات زیست محیطی از طریق دفع مسئولانه زباله و استخراج مواد مغذی ارزشمند برای کاربرد در حوزه‌های مختلف بیوتکنولوژیکی. این اکتشاف جامع به درک ما از پتانسیل محصولات جانبی ضایعات لبنی کمک می‌کند و روش‌های پایدار و برنامه‌های کاربردی نوآورانه را که با چشم‌انداز در حال تحول صنایع غذایی تغذیه‌ای همسو هستند، روشن می‌کند.

کلیدواژه‌ها: صنایع غذایی، بیوتکنولوژی، لبنیات، پایداری

نوع مقاله: پژوهشی.

استناد: ساهو دیپاک کومار، کاشیاپ لاخان لعل (۱۴۰۳) آینده پایداری صنایع غذایی با استفاده از مداخلات بیوتکنولوژیک در بخش لبنیات. *مجله بیوتکنولوژی کشاورزی*، ۱۶(۱)، ۳۱۹-۳۳۶.

Publisher: Faculty of Agriculture and Technology Institute of Plant Production, Shahid Bahonar University of Kerman-Iranian Biotechnology Society.