A Review on Quality Control Raw Milk

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ABSTRACT: ***The goal of quality control is to ensure that the milk supplied to the customer is of good quality and safe to drink. The characteristics of raw milk are affected by the nature and modification of the product, as well as the hygienic conditions on the farm and in the industry, the procedure to which it is exposed, and the storage circumstances. Milk quality is monitored at many levels, including by the farmer, the industry, and the government. To enhance and preserve the quality of the product supplied to the changing sector, the farmer must have control over the raw milk. To guarantee the safety and quality of the product going to market, the dairy industry must regulate the raw milk provided by farmers and implement controls on the process and/or the final product. Government authorities oversee the entire production process and prevent fraud and mislabelling by controlling raw milk, obtaining information on cleanliness and safety, and the final product.***

KEYWORDS: Bacterial Counts, Milk, Pathogens, Quality.

1. INTRODUCTION

The best method to make high-quality milk is to start with excellent basic materials. As a result, testing raw milk is necessary to guarantee its safety and purity. The existence of macroscopic abnormalities, the addition of water, the microbiological quality, the presence of milk from mastitic cows, the presence of residues, and the composition of raw milk are all examined. Microbial contamination is a significant problem because infections may affect food safety and spoilage bacteria can shorten shelf life. Poor udder preparation or milking conditions, inadequate cleaning, failure of milk chilling systems, or the presence of milk from mastitic cows may all lead to raw milk contamination on the farm. The existence of leftover veterinary medicines, plaguicides, or mycotoxins is another safety concern. The composition of raw milk is a critical component of its quality. Farmers and processors determine the dry matter, fat, and protein for payment. Other milk components may be examined by the industry to improve processing, labeling, and quality [1]–[3].

Drinking raw milk is legal in certain countries. Total bacterial counts (50 000 colony-forming units (cfu) mL1), Staphylococcus aureus, and Salmonella spp. are all subject to EU restrictions. Other infections or their toxins should not be present in sufficient quantities to pose a health risk. The quality of processed milk is controlled differently depending on the product. Pasteurization, high temperature short time (HTST), extended shelf life (ESL), sterilisation, ultra-high temperature (UHT), and other procedures such as microfiltration distinguish fluid milks. Because each kind of milk has its own set of limits when it comes to heating, heat load tests are used to identify inadequate or excessive heating. Post-heat treatment contamination, or spoiling by bacteria that enter milk after heat treatment, typically in the filling/packaging process, and thrive at refrigerator temperatures, is the limiting shelf-life factor in short-shelf-life milks. Total microbial count, coliforms, psychrotrophs, and pathogens are all routine tests. The presence of heat-resistant spore-forming bacteria, primarily Bacillus spp., which are common in raw milk and survive heating procedures and thrive at refrigerator temperatures, is a major cause of spoiling in short-shelf-life milk [4]–[6].

Living germs should not be present in long-shelf-life fluid milks (such as sterile and UHT milks). The presence of heatresistant enzymes, especially lipases and proteases, generated by psychrotrophs during refrigerated storage of raw milk, which induce age gelation and off-flavour, is the main shelf-life limiting issue for UHT milk. If the psychrotroph count in raw milk is high, a more severe heat treatment may reduce enzyme activity while also causing nutrients and organoleptic qualities to be lost. The high temperature of processing causes significant changes in color (Maillard reaction), odor, and taste, making organoleptic qualities a key quality trait of UHT milk (e.g. cooked flavour). Furthermore, the heat process may cause micellar caseins to destabilize and precipitate. An ‘accelerated' shelf-life test is conducted by incubating UHT milk in a closed container for 15 days at 30°C (or for 7 days at 55°C) following processing to determine the microbiological content, appearance, and organoleptic characteristics.

The industry's examination of the final goods is not always adequate to guarantee product quality. Furthermore, adjustments on the manufacturing line are not possible at this time. As a result, the industry has shifted its focus from end-product assessment to process control via the implementation of hazard

analysis of critical control points (HACCP) and good manufacturing practice programs. Current EU law (EU, 2004a–e) does not require particular testing and instead relies on the producer to ensure product quality and safety by establishing a HACCP system. The efficacy of the process control is supported by testing the final product. As a result, in contemporary industry, the assessment of raw materials and/or suppliers, as well as constant monitoring of the processing line, are the two most important aspects of producing a safe and high-quality product. The traceability system, which has become obligatory in the EU, is another important aspect of milk management (EU, 2002). This method, which is based on a large database, allows users to trace milk back to its source using a bar code printed on the package. This enables processes to quickly detect issues and take action [7]–[10].

1.1. Methods of analysis:

Milk testing is done in a variety of ways by farmers, producers, and control labs. The analytical technique employed is determined by the analysis' goal, the requirement for a quick result, the equipment available, the availability of specialized people, and the cost. On the farm, techniques must be quick, simple, and low-cost, with no need for skilled people or sophisticated equipment. Dipsticks and lateral flow devices that provide a coloured visual indication are extremely useful, but online detection sensing technologies are becoming more common in automated milking systems. Physical sensors, spectroscopic sensors, and biosensors are examples of real-time online detection systems that are suitable for process control.

Fast online techniques often sacrifice sensitivity, accuracy, and/or precision in the sake of speed. Farmers and industry do not have the capability to conduct accurate measurements for certain tests, therefore they must submit their samples to control labs to do these duties. Control laboratory techniques must be exact and accurate at the price of money, specialized people, and costly equipment. It is strongly suggested that control labs be certified and accredited in order to establish legal claims. The main standard organizations, such as the Association of Official Analytical Chemists (AOAC), the International Standards Organisation (ISO), and the International Dairy Federation, have developed and published reference methods (IDF). Many reference techniques are sometimes thought to be outdated. They do, however, function well, are widely used, and most importantly, they are used to calibrate other regular techniques.

1.1.1. Abnormal milk analysis:

Milk with clots or blood should not be allowed to reach the bulk tank. To prevent this, milk may be visually checked for clots after filtering. Color sensors are used to detect blood online, while conductivity sensors are used to screen for bad milk. Conductivity sensors, on the other hand, produce false positives and negatives. As a result, many techniques have been suggested, including an optical sensor that can detect clots and flakes.

1.1.2. Microbial analysis:

Microbiological tests are used to assess the microbial quality of raw and processed milk, as well as to identify inadequate hygienic conditions. To get an overview of microbial contamination, total bacterial load is used; psychrotrophs are assessed to prevent potential spoilage; coliforms are used to evaluate the hygiene history of milk; specific pathogens (e.g. Salmonella spp., S. aureus, Listeria monocytogenes, Mycobacterium paratuberculosis) are used to avoid potential health hazards; and thermoduric bacteria are used to assess the hygiene of the production s

Physical techniques for estimating microbial concentration, like as conductivity and titratable acidity, are indirect yet quick sensing methods. In milk testing, measuring the pH is a standard procedure. Although convenient and simple to set up for online measurements, these techniques lack sensitivity and specificity.

Metabolite testing is also a quick, non-specific, and low-sensitivity technique that takes use of the presence of metabolites like ATP, which is a cofactor in numerous processes in live cell metabolism. This cofactor is used in the reaction between the enzyme luciferase and its substrate luciferin, producing in a bioluminescence product that can be detected. It is often employed in the field of hygiene testing.

The most common techniques have been counting methods. Because of its sensitivity, accuracy, and cheap cost, the standard plate count (SPC) has been effectively employed for a long time and is the reference method used to evaluate alternative methods. It is based on microorganisms' capacity to proliferate and form colonies, which may be counted visually or with automated colony counts. Only live cells are counted. Selective media and/or conditions are required to differentiate between various kinds of bacteria. Milk is incubated at 30°C on a non-selective medium for total counts. Preliminary incubation at 6°C is followed by SPC at 21°C to identify psychrotrophs. Coliforms are detected using selective media.

When the quantity of bacteria is too low, concentration/enrichment of microorganisms may be used. A concentration or a preceding incubation phase may be used to accomplish this. Filtering allows for the concentration of all germs, while immune magnetic separation allows for the concentration of a single microbe. To enhance the quantity of live bacteria over dead bacteria, preliminary incubation is beneficial. Selected bacterial kinds may be evaluated using selective circumstances (temperature, medium). When utilizing techniques that do not differentiate between live and dead cells, preliminary incubation is extremely helpful for identifying pathogens that are present in low quantities. It is also beneficial to enhance viable bacteria when using methods that do not distinguish between live and dead cells.

1.1.3. Mastitic milk – somatic cell count (SCC):

Pathogens and spoilage bacteria are found in mastitic milk, which is distinguished by an increase in Na+ and Cl, as well as leucocytes. Conductivity tests, which look for changes in ion composition, and the California mastitis test (CMT), which looks for an increase in leucocytes, are two examples of screening tests. More precise techniques rely on counting somatic cells, mainly leucocytes, which should not exceed 400 000 or 750 000 cells per milliliter (EU and US milk quality standards, respectively). Following DNA staining, direct microscopy (DMSCC) may be used to determine the SCC. Automatic counters are both quick and dependable. They utilize electrical sensors, such as the Coulter counter, or fluoro-optical sensors, such as the Fossomatic technique, to distinguish and count somatic cells, taking advantage of their enormous size and high DNA concentration (FSCC). Direct microscopy and FSCC are two techniques that have been standardised (IDF, 1995a). After a concentration stage, filtering and additional disruption of the cells, ATP assays may be conducted.

1.1.4. Testing for residues compounds:

Milk that contains substances that are possibly hazardous to human health should not be allowed to enter the tank. The vast variety of chemicals and tiny quantities to be identified provide a significant analytical difficulty for residue detection. Antibiotics are made up of many distinct compounds, such as -lactams (penicillins), sulphonamides, tetracyclines, aminoglycosides, and macrolides, which are all families of chemicals. - Lactams are extensively utilized, and most established techniques have focused on them. General screening tests based on the capacity to prevent the development of Bacillus stearothermophillus var. calidolactis spores are insufficient for detecting low doses of antibiotics or the present spectrum of antibiotics. Pesticides are divided into many categories, each of which contains a distinct chemical species. Organophosphates and carbamates are two kind of insecticides that are frequently employed. The acetylcholinesterase (AchE) inhibition test, which has developed over many years, may identify them as a whole by their impact. To improve test efficiency, recombinant AchEs have been created.

1.2. Major components analysis:

The main components of milk (dry matter, protein, fat, and lactose) are determined using traditional reference techniques based on classical chemistry. The dry matter content of a milk sample is determined by weighing the residue after it has been dried. The protein content is determined using a technique that calculates the total nitrogen content in the milk and then multiplies this number by a factor of 6.38 to get the protein concentration. The presence of other nitrogen molecules, such as urea, may affect protein levels. The difference between total nitrogen and non-protein nitrogen is used to determine real protein content. The latter is determined by measuring the nitrogen remaining in the supernatant following protein precipitation with trichloroacetic acid (TCA). The fat content of the milk sample is assessed using a gravimetric technique using the matter obtained via organic solvent extraction. The Gerber and Babcock techniques are two more common fat-testing methods. Furthermore, turbidimetry by light scattering for fat assessment is advantageous since it is mechanized and standardized techniques are accessible. Lactose determination methods have received little attention until lately, and there is currently no worldwide reference technique available. There are, however, gravimetric, polarimetric, and enzymatic techniques available. Enzymatic reactions and HPLC-based techniques are the greatest prospects for becoming reference methods. Enzyme assays are colorimetric techniques that use a cascade of enzymes to react, such as -galactosidase and glucose oxidase. This approach has led to the development of biosensors.

Another useful spectroscopic method is Raman spectroscopy, which combines the specificity and optical convenience required for milk composition testing and process management, making it a viable option to FTIR tests. Even though it is not well recognized or frequently utilized, nuclear magnetic resonance (NMR) spectroscopy is a method that should be remembered. This method is very flexible, and it has advanced significantly in recent years, with the development of more sensitive probes, automated flow injection

sampling systems, and the integration of chromatographic techniques. For many years, low-resolution bench equipment like as Minispec (Bruker) have been used to differentiate solid from liquid fats in dairy products. Many components in milk may be detected using high-resolution equipment.

2. DISCUSSION

Heating milk changes the physico-chemical state of its constituents, causing denaturation of some protein fractions (enzymes, whey proteins), as well as the production of Maillard reaction products. Only enzymes, lactose-derived chemicals, Maillard reaction-derived compounds, and whey proteins are acceptable as chemical indicators of heat treatment intensity. Enzyme assays are common testing for goods with a limited shelf life. Pasteurized milk is made by heating it to 72°C for 15 seconds, or any other temperature–time combination that produces the same result. Because alkaline phosphatase, a milk native enzyme, is inactivated during pasteurization, it is used as a measure of pasteurization efficiency. Lactoperoxidase, a natural enzyme, is more heat-stable than alkaline phosphatase. Following pasteurization, it retains its activity, but after HTST processing, it loses it. As a result, the lactoperoxidase test is used to differentiate between the two therapies. Spectrophotometry and fluorimetry are two common techniques for alkaline phosphatase and lactoperoxidase testing. Other natural enzymes, such as -fucosidase, phosphodiesterase, and -mannosidase, may also be used to assess heat load in milk, although their practical use is limited. Lactose-derived chemicals may be utilized to assess more intense heat treatments, such as sterilisation and direct and indirect UHT treatments. Lactulose is produced when lactose is isomerized during milk heating and has been suggested as an analytical indicator for distinguishing UHT from sterilised milk. The maximum amount of lactulose in UHT milk should be 600 mg L1. Lactulose is not present in pasteurised milks, but it has been discovered in commercial samples up to 82 mg L1. Lactulose has been measured using a number of techniques, including GC, HPLC, and CE, enzyme approaches, colorimetry, and continuous flow amperometry. A fast enzymatic technique and an HPLC method are now used as standard procedures.

Heating produces Maillard reaction products such lactuloselysine, which is then converted to furosine by acid hydrolysis. Raw milk has 3–5 mg 100 g1 protein of furosine, whereas pasteurised milk contains 5.2–7.5 mg 100 g1 protein of furosine. The amount of furosine in sterile milk samples varies widely, although it is typically greater in milk processed by indirect UHT treatment than in milk processed by direct UHT treatment. When utilizing furosine as a chemical indicator to differentiate between commercial sterilised milks, the major problem found is overlapping of values in milk subjected to various heat treatments. Furthermore, the amount of furosine in UHT milk may rise with storage. It is established in certain countries where HTST milk is extensively eaten (e.g., Italy) that this kind of milk should produce negative phosphatase and peroxidase tests, as well as a furosine level of 20 mg per 100 g of milk. A variety of RP-HPLC techniques utilizing various columns, anion-exchange chromatography with pulsed amperometric detection, CE, and GC may all be used to quantify furosine. This technique cannot be recommended for regular analytical use since furosine is partly destroyed during gas chromatography analysis. An ion-pair RP-HPLC apparatus is used in the worldwide standard technique.

3. CONCLUSION

The quality of market milks has greatly improved in recent decades, providing customers with superior goods. This improvement has been made possible by the way milk is treated in dairy plants and the quality control procedures used throughout the milk supply chain. Quality control methods have improved in recent years to offer better instruments for evaluating various milk quality indicators at various stages of production. It has been critical to establish method performance by having access to standardised techniques and harmonised guidelines established by specialized international organizations. Although traditional methods of analysis are still extensively employed for quality control, analytical techniques have progressed significantly. Molecular methods have significantly aided in the identification of infections as well as the creation of quick and simple devices. Automated techniques, such as those used to determine microbe counts, have made it feasible to get findings in considerably less time, a major development for the business. For automated milking and processing systems to move towards real-time control, online detection systems based on biosensors or physical sensors have proven critical. Advanced equipment and techniques employed by specialized labs for milk quality control have resulted in significant improvement in the regulation of milk authenticity and the production process. This is made more difficult by the industry's constant creation of new goods, which presents the analyst with fresh difficulties on a regular basis. Furthermore, modern computer resources offer strong tools for data analysis, making vast quantities of data valuable for raw material management, processing control, and end-product control.

REFERENCES:

[1] N. Soleymanzadeh, S. Mirdamadi, and M. Kianirad, "Antioxidant activity of camel and bovine milk fermented by lactic acid bacteria isolated from traditional fermented camel milk (Chal)," *Dairy Sci. Technol.*, 2016, doi: 10.1007/s13594-016-0278-1.

[2] L. M. Beltrán-Barrientos, A. Hernández-Mendoza, M. J. Torres-Llanez, A. F. González-Córdova, and B. Vallejo-Córdoba, "Invited review: Fermented milk as antihypertensive functional food," *J. Dairy Sci.*, 2016, doi: 10.3168/jds.2015-10054.

[3] Z. Hafeez, C. Cakir-Kiefer, E. Roux, C. Perrin, L. Miclo, and A. Dary-Mourot, "Strategies of producing bioactive peptides from milk proteins to functionalize fermented milk products," *Food Research International*. 2014, doi: 10.1016/j.foodres.2014.06.002.

[4] H. Beheshtipour, A. M. Mortazavian, R. Mohammadi, S. Sohrabvandi, and K. Khosravi-Darani, "Supplementation of spirulina platensis and chlorella vulgaris algae into probiotic fermented milks," *Compr. Rev. Food Sci. Food Saf.*, 2013, doi: 10.1111/1541-4337.12004.

[5] F. B. Ahtesh, L. Stojanovska, and V. Apostolopoulos, "Anti-hypertensive peptides released from milk proteins by probiotics," *Maturitas*. 2018, doi: 10.1016/j.maturitas.2018.06.016.

[6] C. Jans *et al.*, "African fermented dairy products – Overview of predominant technologically important microorganisms focusing on African Streptococcus infantarius variants and potential future applications for enhanced food safety and security," *International Journal of Food Microbiology*. 2017, doi: 10.1016/j.ijfoodmicro.2017.03.012.

[7] V. K. Shiby, & H. N. Mishra, and H. N. Mishra, "Critical Reviews in Food Science and Nutrition Fermented Milks and Milk Products as Functional Foods—A Review Fermented Milks and Milk Products as Functional Foods—A Review," *Crit. Rev. Food Sci. Nutr.*, 2013.

[8] V. K. Shiby and H. N. Mishra, "Fermented Milks and Milk Products as Functional Foods-A Review," *Critical Reviews in Food Science and Nutrition*. 2013, doi: 10.1080/10408398.2010.547398.

[9] M. L. Marco *et al.*, "Health benefits of fermented foods: microbiota and beyond," *Current Opinion in Biotechnology*. 2017, doi: 10.1016/j.copbio.2016.11.010.

[10] L. M. Beltrán-Barrientos *et al.*, "Randomized double-blind controlled clinical trial of the blood pressure–lowering effect of fermented milk with Lactococcus lactis: A pilot study2," *J. Dairy Sci.*, 2018, doi: 10.3168/jds.2017-13189.