CRIMSON PUBLISHERS
Wings to the Research

Approaches in Poultry, Dairy & Veterinary Sciences

ISSN: 2576-9162

Mini Review

Recent Trends in Milk Processing-A Short Review

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Submission: September 11, 2017; **Published:** December 04, 2017

Abstract

Nutritious milk needs to be processed soon after milking to increase its shelf life and make it safe for human consumption. One major factor responsible for milk spoilage is microbial contamination. Freshly drawn milk contains some internal anti-microbial defense mechanism, but for longer storage, some other external anti-microbial preservation steps needs to be initiated to arrest or decontaminate the microbial growth. Different methods of preservation had have been discussed in this review paper, from naturally occurring defense mechanism to thermal and even non-thermal processing methods. This paper aims to provide a short review on conventional milk processing and recent advancements in terms of non-thermal processing.

Keywords: Milk processing; Natural anti-microbial mechanism; Thermal and non thermal processing

Introduction

Milk can be defined as the fresh lacteal secretion, obtained by complete milking of healthy cow or other milch animal. During milking of milch animals, the milk is all most in sterile state but as milk comes in contact to open atmosphere, chances of microbial and foreign particles contamination increases. Major changes taking place in milk after milking are caused by microbial activities, i.e. changes in flavour, taste and even in appearance [1-3].

Beside the nutritional content of milk, various other reasons are responsible as well, which favors microbial growths, i.e. high moisture content (more than 80% moisture), pH (6.6-6.8), surrounding temperature etc [2,4]. Raw milk spoilage may be prevented by subjecting milk to specific treatments. Number of publications in the form of books, reviews and research articles are available on this topic [1,2,5-8], but this manuscript targets to provide a compressed and brief review to the readers both from technical and non-technical domain to get scientific understanding about conventional milk processing and recent processing trends.

Natural anti-Microbial Mechanism

Freshly drawn raw milk has its own anti-microbial defence mechanism i.e. lactoferrin, lactoperoxidase, lysozyme, and possibly N-acetyl-ß-D-glucosaminidase (NAGase) [9]. But this anti-microbial defence mechanism of milk is temporary, which with time gets weaker, making milk prone to microbial spoilages.

Thermal operations and limitations

Conventionally milk processing is done by heating of the milk to certain temperature for fixed duration of time, which causes significant reduction in microbial population. Various levels of thermal treatments are practiced for processing milk based on the thermal harshness of treatments, i.e. thermization, pasteurization, and sterilization [1,2]. Thermal processing has been widely adopted as the treated product is recognized safe for consumption with longer storage life. But with advancement of understanding, particularly in the domain "Dairy Science", some undesirable changes were reported during heating of milk, such as, browning, development of a cooked flavor, loss of nutrients, inactivation of bacterial inhibitors and impairment of rennet ability etc., [1]. Therefore the need of non-thermal processing was realized and its practical applicability in milk processing was considered as an alternative to conventional heat treatment.

Non-thermal processing of milk

The term non-thermal processing is a novel concept of processing which is not only limited to milk but also to other food products. Non-thermal food processing targets elimination of microorganisms or any other biological entities without causing significant rise in temperature, which prevents chain of undesirable reactions in foods. Some widely acceptable non-thermal processes and their applications in milk processing are discussed in brief.

High pressure processing (HPP): HPP is the method of deactivating microorganisms by the application of high pressure, which was utilized by Hite for milk preservation. Generally HPP for food processing refers to the application of pressure range between 100 and 1200 Megapascal (MPa) [10,11]. HPP technology can be successfully applied to milk processing for microbial deactivation without causing significant changes in quality. Under higher pressure, microbial cellular membranes suffer irreversible damage due to changes in membrane protein and others, causing microbial inactivation [12]. Recent findings have shown light on the applicability of HPP to modify the functional properties of milk and pressure induced molecular changes were reported [13,14].

Pulsed electric field (PEF): This non thermal method of processing involves flowing of short pulses of high electric field through fluid or semi-fluid foods, which causes break down of microbial cell membrane, causing cell rapture and eventual microbial cell death [15]. Milk being a fluid food, is a good product eligible for PEF treatment. Bendicho et al. [16] reported occurrence of fewer undesirable changes in milk properties, undergoing PEF treatment, with reduction of bacterial load present in milk. Effects of PEF treatment was found to increase with increase in treatment temperature [17]. Sharma et al. [18] reported microbial stability of PEF treated milk similar to thermally treated pasteurized milk, but without any thermal induced damages.

Microfiltration (MF): The MF may be used to reduce the microbial load in liquid milk and increase the shelf life without any changes in its composition and sensorial qualities [19]. Using modified membrane structures, microbial load can be reduced significantly without affecting the milk composition [20]. A study was conducted by García & Rodríguez [21], where process was developed for extended shelf life (ESL) of milk for 33 days, using a combination of microfiltration and thermal treatment. There is least change in the main composition of the ESL milk compared to raw untreated milk. For microfilteration processing, low fat milk is more preferred, though slight change in protein, calcium and lactose was observed after the treatment [20].

Ultraviolet light (UV): The UV light radiation used for food processing has wavelength varying from 100 to 400 nm. Raw milk has UV radiation absorption coefficient of 290cm^{-1} at 253.7nm wave length of UV radiation. Due to the photosensitive nature of milk, UV light radiation tends to have negative impact on milk [22]. However, Krishnamurthy et al. [23] reported pulsed UV light's potential in inactivation of pathogenic microorganisms present in milk showing complete inactivation of Staphylococcus aureus, a milk pathogen. Altic et al. [24] reported the breaking of *M. avium subsp. paratuberculosis* cell clumps present in milk while passing the milk through UV chamber. Short wavelength UV light may be utilized for Vitamin D synthesis. Some sensory and nutritional changes were reported by Matak et al. [25].

Cold plasma: This is an emerging technology, which was earlier used in the field of bio-medical devices, textiles and water sterilization. Recently this cold plasma technology is finding its applicability in food preservation due to its capacity of decontaminating microorganisms. Plasma is defined as 4th stage of matter, which is in electrically charged or ionised form, but without any fixed shape or volume [26-28]. Korachi et al. [29] reported that cold plasma was suitable to inactivate milk from *E. coli*, but changes in biochemical composition was observed during the study, i.e. changes in aldehyde composition were reported.

Conclusion

Non thermal methods of processing of milk and foods are smarter alternatives of conventional thermal processing. However, there are some limitations associated with these non thermal processes, which sometimes prove to be inadequate to affect a desired level of microbial inactivation. This calls for the need of resorting to, what may be termed as a hybrid technology, combining more than one method of non-thermal processing and sometime even coupling these with mild heat treatment to increase the efficiency of processing.

Cost is another major drawback, since these technologies are still in growth phase and it would require further development for commercial adoptability of the technology which would eventually reduce the cost of the machineries rendering them affordable as well as economical. Lack of awareness as well as apprehensions among the consumers in adopting the newly developed processed food would be a challenge for the entrepreneurs and regular processors to market their products in competition to the conventionally processed regular products. Beside this, consumer's safety approval by competitive agencies would be another challenge to be faced in the open market.

Acknowledgement

The authors are thankful to Centre for Incubation, Innovation, Research and Consultancy (CIIRC), Jyothy Institute of Technology, Bangalore (Karnataka, INDIA) and Agricultural and Food Engineering Department, Indian Institute of Technology-Kharagpur (West Bengal, India) for their infrastructural support.

References

1. Walstra P, Geurts TJ, Noomen A, Jellema A, van Boekel MAJS (1999) Heat Treatment, Dairy Technology-Principles of Milk Properties and Processes pp. 189.
2. De S (2002) Market milk, Outlines of Dairy Technology. Oxford University Press, India, pp. 6-10.
3. Ledenbach LH, Marshall RT (2009) Microbiological spoilage of dairy products. In Compendium of the microbiological spoilage of foods and beverages, Springer, New York, USA, pp. 41-67.
4. FDA (2017) Food and Drug Administration (US). Department Of Health And Human Services, Subchapter B-Food For Human Consumption (Part 131 - Milk and Cream).
5. Wiley RC (1994) Preservation methods for minimally processed refrigerated fruits and vegetables. Minimally processed refrigerated fruits and vegetables, pp. 66-134.
6. Saha BK, Ali MY, Chakraborty M, Islam Z, Hira AK (2003) Study on the Preservation of Raw Milk with Hydrogen Peroxide (H2O2) for Rural Dairy Farmers. Pakistan Journal of Nutrition 2(1): 36-42.
7. Ndambi OA, Kamga PB, Imelé H, Mendi SD, Fonteh FA (2008) Effects of milk preservation using the lactoperoxidase system on processed yoghurt and cheese quality. AJFAND 8(3): 358-374.
8. Pal M (2017) Pulsed electric field processing: an emerging technology for food preservation. Journal of experimental food chemistry 3(2): 126.
9. Ekstrand B (1989) Antimicrobial factors in milk-a review. Food Biotechnology 3(2): 105-126.
10. Rastogi NK, Raghavarao KS, Balasubramaniam VM, Niranjan K, Knorr

D (2007) Opportunities and challenges in high pressure processing of foods. Crit Rev Food Sci Nutr 47(1): 69-112.

11. Chawla R, Patil GR, Singh AK (2011) High hydrostatic pressure technology in dairy processing: A review. Journal of food science and technology 48(3): 260-268.
12. Datta N, Deeth HC (1999) High pressure processing of milk and dairy products. Australian Journal of Dairy Technology 54(1): 41-48.
13. Orlien V (2017) Utilizing High Pressure Processing to Induce Structural Changes in Dairy and Meat Products. In Reference Module in Food Science.
14. Cadesky L, Walkling RM, Kriner KT, Karwe MV, Moraru CI (2017) Structural changes induced by high-pressure processing in micellar casein and milk protein concentrates. Journal of Dairy Science 100(9): 7055-7070.
15. Abinaya V, Banerjee S, Palati M (2017) Experimental validation on effects of pulsed electric field treatment on the sensory quality of vegetable juices. Journal of Food Technology and Preservation 1(1): 56-60.
16. Bendicho S, Barbosa CGV, Martín O (2002) Milk processing by high intensity pulsed electric fields. Trends in Food Science and Technology 13(6): 195-204.
17. Sharma P, Bremer P, Oey I, Everett DW (2014) Bacterial inactivation in whole milk using pulsed electric field processing. International Dairy Journal 35(1): 49-56.
18. Sharma P, Oey I, Bremer P, Everett DW (2017) Microbiological and enzymatic activity of bovine whole milk treated by pulsed electric fields. International Journal of Dairy Technology, doi: 10.1111/1471-0307.12379.
19. Pafylias I, Cheryan M, Mehaiab MA, Saglam N (1996) Microfiltration of milk with ceramic membranes. Food Research International 29(2): 141-146.
20. Hoffmann W, Kiesner C, Clawin R, Martin D, Einhoff K (2006) Processing of extended shelf life milk using microfiltration. International journal of dairy technology 59(4): 229-235.
21. García LF, Rodríguez FR (2014) Combination of microfiltration and heat treatment for ESL milk production: Impact on shelf life. Journal of Food Engineering 128: 1-9.
22. Koutchma T (2009) Advances in ultraviolet light technology for non-thermal processing of liquid foods. Food and Bioprocess Technology 2(2): 138-155.
23. Krishnamurthy K, Demirci A, Irudayaraj JM (2007) Inactivation of Staphylococcus aureus in milk using flow-through pulsed UV-light treatment system. Journal of food Science 72(7): M233-M239.
24. Altic LC, Rowe M, Grant I (2007) UV light inactivation of *Mycobacterium avium* subsp. Paratuberculosis in milk as assessed by FASTP laque TB phage assay and culture. Applied and Environmental Microbiology 73(11): 3728-3733.
25. Matak KE, Sumner SS, Duncan SE, Hovingh E, Worobo RW, et al. (2007) Effects of ultraviolet irradiation on chemical and sensory properties of goat milk. Journal of Dairy Science 90(7): 3178-3186.
26. Mishra R, Bhatia S, Pal R, Visen A, Trivedi H (2016) Cold Plasma: Emerging As the New Standard in Food Safety, International Journal of Engineering and Science 6(2): 15-20.
27. Patra F, Patel A, Shah N, Shukla DA (2017) Application of Cold Plasma Technology in Milk and Dairy Products-Current Status and Future Prospective, National symposium on "Non-thermal technologies for improvement of safety quality of foods" at college of Food Processing Technology and Bioenergy, AAU, Anand, Gujarat, India.
28. Bourke P, Zuizina D, Han L, Cullen PJ, Gilmore BF (2017) Microbiological Interactions with Cold Plasma. Journal of Applied Microbiology 123(2): 308-324.
29. Korachi M, Ozen F, Aslan N, Vannini L, Guerzoni ME, et al. (2015) Biochemical changes to milk following treatment by a novel, cold atmospheric plasma system. International Dairy Journal 42: 64-69.