Dairy Foods Symposium: Technological Advancements in the Reduction of Pathogens and Spoilage Organisms in Milk

209 Technological advancements in the reduction of pathogens and spoilage organisms in milk—Introduction and challenges. D. R. McCoy*, *Dairy Research Institute, Rosemont, IL.*

The introduction of pasteurization in 1886 improved both the safety and keeping quality of milk and milk products. Newer methods like ESL and UHT treatments have further increased the safety and the shelf-life of modern dairy foods as well as allowing non-refrigerated distribution. However, there are still challenges such as further widening the distribution opportunities for milk, reducing energy requirements, and improving the flavor of longer life products. As new technologies are explored, it is important to recognize not only the science but also the regulatory requirements for successful implementation. Well-designed experimental approaches can expedite both scientific discovery and regulatory review. Finally, it should be recognized that many plant operations reduce microbial load but do not need to meet the high safety standard inherent in being an alternative to pasteurization, which may allow implementation earlier in the regulatory process.

Key words: pasteurization, milk, processing

210 Reduction of cooked and oxidized flavors in UHT milk. D. G. Peterson*, *University of Minnesota, St. Paul.*

Fluid milk is thermally processed to reduce the microbial load for both product safety and stability. Multiple thermal treatment options are available, such as pasteurization, extended shelf-life (ESL), and ultra-high temperature (UHT) processing. UHT techniques provide the longest shelf-life and allow non-refrigerated distribution. Despite these notable benefits, UHT processing negatively influences milk flavor quality due to the generation of thermally catalyzed off-flavor compounds, primarily by Maillard chemistry. This presentation will focus on the application of common food phenolic compounds (i.e., in cocoa, tea, and soybeans) to suppress off-flavor development and improve acceptability in UHT products. Optimization of the phenolic structure-reactivity to suppress Maillard-type off-flavor development in UHT milk will also be reviewed.

Key words: UHT, off-flavor, reduction

211 CHIEF/pulse electric field technology—A unique processing system. R. Ruan*[1,3], S. Deng[1], Y. Cheng[1], X. Lin[2,3], P. Chen[1], and L. Metzger[4], *[1]University of Minnesota, St. Paul, [2]Fuzhou University, Fuzhou, Fujian, China, [3]Nanchang University, Nanchang, Jiangxi, China, [4]South Dakota State University, Brookings.*

Consumers are increasingly aware of the taste, flavor, color, nutritional value, as well as safety of the foods they eat. They demand safe foods that are both fresh and natural. Therefore, food processes must be designed to render minimal adverse effects on food quality and nutrition values while ensuring safety. Conventional thermal processing not only kills spoilage and pathogenic microorganisms but also degrades the taste, color, flavor, and nutrients of the food. Non-thermal methods are alternatives which offer possibilities of preparing fresh-like, minimally processed safe foods. Among all emerging non-thermal processes, high intensity pulsed electric field (PEF) is considered the best. Nonetheless, the PEF process has few large scale industrial applications to date chiefly because PEF equipment and process are very specialized and costly. Concentrated high intensity electric field (CHIEF) developed at the University of Minnesota is a technology similar to PEF. Both of them use high intensity electrical field to inactivate the bacteria through the well accepted electroporation and other mechanisms. Compared with traditional PEF technique, CHIEF uses much cheaper power supply, and does not have electrode erosion and contamination issues. Our research on juice and milk indicates that CHIEF has a great potential of becoming a commercial process for non-thermal pasteurization of fresh liquid foods. The advantages and disadvantages of the two technologies will be compared and the potential commercialization applications in milk processing will be discussed.

Key words: PEF, CHIEF, electric field

212 UV light inactivation of bacteria and spores in milk to enhance shelf-life. J. S. Cullor*, P. V. Rossitto, J. Crook, and J. Parko, *University of California at Davis, Tulare.*

Thermal pasteurization of milk achieves safe and high quality product that is acceptable to consumers. Thermo-tolerant spoilage organisms though do survive pasteurization restricting the shelf-life of products as evidenced by code dates of 14 to 18 d. Spoilage organisms include gram-positive, gram-negative and aerobic spore-forming bacteria of the genera *Bacillus*, *Paenibacillus*, and *Geobacillus*. These spores can and do survive pasteurization, germinate, multiply and cause spoilage in milk, milk products and UHT products after processing. Delivery of germicidal UV light at 254 nm inactivates microbes in milk. Though UV light inactivation of microbes in water is an established technology that currently has many commercial applications, utilization of this technology in foods is somewhat new. Introduction of the alternative technology of UV germicidal light in milk has been validated in laboratory studies on milk with 3.5% and 2% fat and shown to increase microbial shelf life. UV log killing values or D-Values have been established for gram-positive spore forming bacteria and the pathogens *E. coli* O157:H7, *Salmonella enterica* serovar Senftenberg, *Yersinia enterolitica*, *Staphylococcus aureus*, *Campylobacter jejuni*, *Serratia marcescens*, *Aeromonas hydrophila*, and *Listeria monocytogenes*.

213 Electrical resistive heating versus conventional UHT technologies. D. J. McMahon*[1], B. Ganesan[1], M. Qian[2], and C. Brothersen[1], *[1]Western Dairy Center, Utah State University, Logan, [2]Food Science and Technology Department, Oregon State University, Corvallis.*

Electrical resistive (ER) heating involves release of heat as an electrical current is passed through a conductor such as milk. This induces very rapid volumetric heating without exposure of the milk to hot steam or metal heat transfer surfaces. Such heating provides opportunities for processing of heat-sensitive materials as well as fluids containing particulates and these are briefly reviewed. Current ultra-high temperature (UHT) processing of milk uses indirect plate (or tube) heat exchanger (PHE) or direct steam injection or infusion (DSI). In USA, pasteurized milk is preferred over UHT milk because of flavor development induced by UHT heating and exacerbated by long ambient temperature

storage. Milk was UHT-processed (140°C, 4 s) by ER, DSI and PHE and stored for 8 mo at room temperature (22°C) for flavor attributes and consumer preferences. Fresh pasteurized milk acted as control for sensory evaluation and was most preferred by consumers. The ER milk was liked more than DSI or PHE milks initially and at 1 mo. All UHT milks were equally liked at 4 mo, while at 8 mo the ER and DSI milks were liked more than PHE milk. After 8 mo, DSI and PHE milks were considered more bitter than pasteurized or ER milks, while all UHT milks were more brothy than pasteurized milk. Overall, ER milk was preferred more than DSI or PHE milks. SPE gas chromatography-mass spectrometry analysis of volatile compounds showed that volatile sulfurs generally decreased during storage, while dimethylsulfide increased by 0.5-fold in DSI milk. Dimethylsulfide was the most abundant volatile sulfur compound and was found 2 to 4-fold higher at 1 wk in PHE milk than others. Methanethiol, dimethyldisulfide, and dimethyltrisulfide highly varied over time in UHT milks. Carbonyls other than hexanal increased in ER milk during storage but remained low in DSI and PHE milks. In conclusion, we found that ER produced better-flavored UHT milk than current UHT processes, but the flavor changes did not correlate with changes in known volatile sulfur or carbonyl compounds. ER heating also has potential to rapidly heat milk to higher temperatures for UHT heating with shorter required hold times.

Key words: ultra-high temperature, milk, electrical resistance

214 Continuous flow microwave heating for pasteurization and sterilization of dairy products. J. Simunovic*, *North Carolina State University, Raleigh.*

Over the last dozen years, continuous flow microwave heating of foods has progressed from a bench top concept to an industrial scale technology used commercially in thermal sterilization and aseptic packaging of low acid vegetable purees. Feasibility testing protocols have also been developed and implemented for sterilization of a variety of dairy products ranging from milk to sour cream and cream cheese. Developed equipment, procedures and processes will be presented and anticipated future applications discussed.