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Formulating Poultry Processing Sanitizers from Alkaline Salts of Fatty Acids

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Abstract

Some poultry processing operations remove harmful microbes from the carcass of broiler chickens during processing, but other processing operations can cause further contamination. Although commercial poultry processors use chemical sanitizers to reduce microbial contamination during processing, poultry is still recognized as a major cause of human foodborne diseases. Some naturally occurring fatty acids in plant and animal tissues possess antimicrobial activity that can kill bacteria, yeasts, and viruses. These microbicidal fatty acids such as, caproic, caprylic, capric, lauric, myristic, and oleic acids have little or no human toxicity; and soaps are formed when these fatty acids are combined with sodium hydroxide or potassium hydroxides. The soaps can act as cleansers that can wash debris and microorganisms from the surface of carcasses during processing while maintaining the antimicrobial activity of the fatty acids. Since these substances are safe for use on foods, they are ideal candidates for formulating new, effective sanitizers for poultry processing operations. Research focused on making new sanitizers from these fatty acids could produce new sanitizers that can be used produce safe, wholesome poultry meat.

Keywords: Fatty acids; Poultry processing; Sanitizers; Surfactants

Introduction

The microflora of live poultry entering processing facilities consists of human foodborne pathogens, spoilage microorganisms, and beneficial microorganisms carried on the feathers and feet, as well as in, the alimentary tract of the birds [1]. Though some processing operations remove a portion of these microorganisms from the carcass; other processing operations cause cross-contamination that spreads microorganisms between carcasses, processing water, and processing equipment. Human enteropathogens on processed poultry carcasses can cause foodborne illnesses or death, and spoilage microorganisms on the carcasses can cause significant economic losses.

One method used by commercial poultry processors to reduce microbial contamination during processing is the application of microbicidal, chemical sanitizers to kill microorganisms. However, despite the ongoing use of sanitizers such as chlorine, peroxyacetic acid, acidified sodium chlorite, cetylpyridinium chloride, and organic acids, poultry is still recognized as a major cause of human foodborne diseases [2]. More human deaths are attributed to the consumption of poultry contaminated by *Listeria* and *Salmonella* than to the consumption of any other meat [2]. Furthermore, consumption of poultry has been cited as a major risk factor associated with foodborne illnesses caused by *Campylobacter* [3]. The development of safe, effective sanitizers that can be used to reduce microbial contamination of processed poultry may reduce human illnesses currently associated with poultry consumption.

Naturally occurring fatty acids (FA) found in plant and animal tissues possess antimicrobial activity that can kill bacteria, yeasts, and viruses [4]. Those FA composed of 6 to 12 carbons are classified as medium-chained fatty acids (MCFA), while those with 13 to 21 carbons are defined as long-chained fatty acids (LCFA). The microbicidal MCFAs, caproic (C6:0), caprylic (C8:0), capric (C10:0), and lauric (C12:0) acids and the LCFA, myristic (C14:0) and oleic acid (C18:1) have little or no human toxicity and have been used extensively as food preservatives. Examples of sources of FA include coconut oil and palm kernel oil that contain high concentrations of capric, caprylic, lauric, and myristic acid, and goat's milk that contains high concentrations of caprylic, capric, and caproic acids. Also, high concentrations of oleic acid are found in olive oil and in the adipose tissues of chickens. Alkaline salts of MCFA and LCFA are produced by dissolving the fatty acids in solutions of potassium hydroxide (KOH) or sodium hydroxide (NaOH). Molecules of these alkaline salts of FA contain hydrophilic (water-soluble) and hydrophobic (oil-soluble) groups that make them effective cleansers (i.e. soaps) that maintain the microbicidal activity of the FA.

The antimicrobial activity of alkaline salts of FA has been demonstrated *in vitro*, on excised skin of processed poultry, and on processed poultry carcasses. Agar diffusion assays demonstrated that caproic, caprylic, capric, lauric, and myristic acids can inhibit the growth of several bacteria isolated from poultry [5]. Solutions of these FA dissolved in KOH inhibited the growth of *Acinetobacter calcoaceticus*, *Campylobacter jejuni*, *Enterococcus faecalis*, *E. coli*, *Listeria monocytogenes*, *Pseudomonas fluorescens*, *Salmonella Typhimurium*, and *Staphylococcus simulans* on agar media. Other *in vitro* tests determined that there were significant ($p<0.05$) decreases in the number of *A. calcoaceticus*, *Aeromonas sobria*, *Brochothrix thermosphacta*, *C. jejuni*, *Clostridium perfringens*, *Enterobacter cloacae*, *E. faecalis*, *E. coli*, *L. monocytogenes*, *Pseudomonas aeruginosa*, *Salmonella Enteritidis*, *Salmonella Typhimurium*, *S. aureus*, and *Staphylococcus chromogenes* recovered from cultures of these bacteria after suspension in solutions of KOH-lauric for 5 minutes [6]. This study also found that washing excised poultry skin in

KOH-lauric acid solutions reduced the number of *Campylobacter* spp., *E. coli*, *enterococci*, lactic acid bacteria, *pseudomonads*, *staphylococci*, and yeasts that were recovered from rinsates of the skin. Other research demonstrated that rinsing poultry skin in solutions of oleic acid reduced the number of total aerobes, Enterobacteriaceae, *Campylobacter*, and enterococci recovered from the skin and rinsates of the skin [7]. Furthermore, rinsates of poultry skin washed for multiple times in KOH-lauric acid contained significantly ($p<0.05$) fewer total bacteria, coliforms, lactic acid bacteria, and anaerobic spore-forming bacteria than skin washed in peptone water [8]. Finally, research has shown that fewer total bacteria, *Campylobacter* spp., and *E. coli* were recovered from whole broiler carcasses after multiple washings in solutions of KOH-lauric acid [9].

The combination of microbicidal activity and cleansing activity, in addition to the non-toxicity of alkaline salts of FA, make these substances ideal candidates for formulating novel, effective sanitizers for poultry processing operations. FA kill microorganisms by disrupting cellular membranes and producing leakage of cellular contents [10]. The protective lipopolysaccharide layer covering the cell wall of Gram negative bacteria makes these bacteria more resistant to the antibacterial activity of FA than Gram positive bacteria. Development of effective processing sanitizers from FA involves determining which combinations of FA are most effective in killing the wide range of microorganisms associated with poultry processing and determining the concentration of FA required to overcome the ability of fats and proteins found in poultry meat to reduce the microbicidal activity of these compounds. Newly developed sanitizers also should not produce undesirable organoleptic changes in the processed carcass meat. Since the microbicidal surfactants are formulated from GRAS compounds, several countries that currently prohibit the use of chemicals during poultry processing might consider the use of these sanitizers as processing interventions. Research focused on formulating novel sanitizers based on alkaline salts of FA could potentially produce a new class of sanitizers that can be used as part of a program to provide consumers with safer, wholesome poultry products.

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