MCFAs as part of the ‘stable to the table’ control of Salmonella

Sector poultry / Fighting Salmonella

Salmonellosis is one of the most common and economically important foodborne zoonotic disease in humans. Infections of food animals play an important role in public health and particularly in food safety, as food products of animal origin (contaminated meat, eggs, milk and cheese) are considered to be the major source of human Salmonella infections. Because contaminated poultry products remain the most significant public health challenge, reduction of contamination levels in these products is a major focus of the commercial producers and processors.

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Public Health

Salmonella is a gram negative facultatively anaerobic bacteria belonging to the Enterobacteriaceae family, growing in a wide range of temperature and pH (from 8°C to 45°C, and at pH of 4 to 8). The members of the genus *Salmonella* are regarded as zoonotic or potentially zoonotic, and this group of bacteria has more than 2,500 different serotypes, but fewer than 100 cause the vast majority of infections in human.

The Center for Disease Control and Prevention (CDC) has estimated that Salmonella bacteria cause more than 1.2 million illnesses each year in the United States, resulting in more than 23,000 hospitalizations and 450 deaths. Moreover, according to the European Center for Disease Prevention and Control, people with weakened immune systems, and children under five have a higher risk for Salmonella infection (Figure 1). Infections in these groups can be more severe, resulting in long-term health consequences or death.

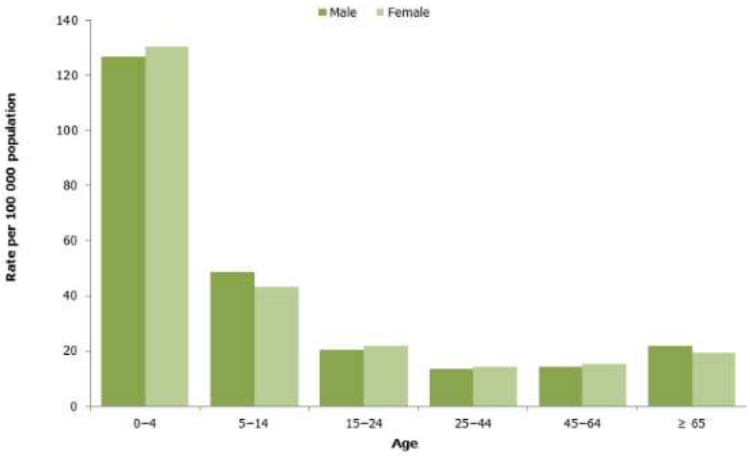

Figure 1. Reported confirmed non-typhoidal salmonellosis cases: rate per 100 000 population, by age and gender, EU/EEA, 2014. (source: European Centre for Disease Prevention and Control. Annual epidemiological report 2015)

Economic Impact

Human salmonellosis is one of the most common and economically important zoonotic diseases. The United States Department of Agriculture (USDA) has estimated the economic burden of human salmonellosis to cost 3,7 billion dollars per year (Figure 2).

From the fifteen pathogens causing more than 95% of the foodborne illnesses, hospitalizations and deaths, *Salmonella* is in the lead.

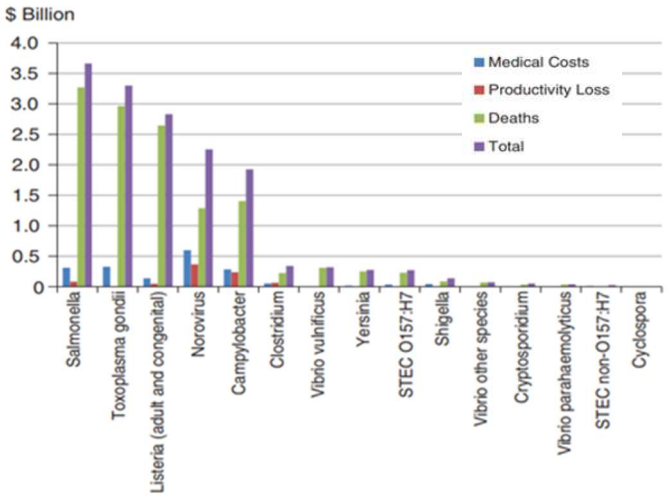

Figure 2. Total mean cost of foodborne illnesses in the United States (2013 $). (source: United Sates Department of Agriculture. Economic Burden of Major Foodborne Illnesses Acquired in the United States, 2015)

Total Approach

Prevention and control of *Salmonella* can be achieved by adopting Good Agricultural Practices and Hazard Analysis Critical Control Point (HACCP) principles. But producers, processors and consumers always need to take into account that no single measurement to be used alone will achieve effective Salmonella control.

Good Start

It is important always to start working with eggs from *Salmonella* free breeding flocks, taking into consideration that *Salmonella* could be transmitted vertically via the egg. In just a few hours, a carrier chick can spread large amounts of *Salmonella* through the feces and consequently contaminate many other birds inside the hatchery. Chicks and poults of less than 1 week of age are highly susceptible to infection, and these animals are frequently colonized without detectable symptoms (healthy carriers).

Infection of flocks during pullet grow-out probably can occur via a previously contaminated environment. Therefore, cleaning and disinfecting all installations and equipment such as feeders and drinkers after each production cycle must be routinely performed, the elimination of *Salmonella* in the farm environment is difficult and residual contamination might be responsible for new infections. In this case a surveillance program together with an eradication strategy also should be stablished.

Safe Feed

Another point of attention is the contamination with *Salmonella* of the feed served to the animals. Although plant-based ingredients can also be a source of contamination for food, the use of animal meal such as meat-and-bone, fish and feather meal, if not treated properly, can become a crucial problem in the introduction of the pathogen in poultry stock. Environmental and storage conditions (temperature X humidity) plus control of diet processing procedures are important in blocking the agent cycle.

Biosecurity

Biosecurity and adequate management practices also play an important role in Salmonella control, avoiding the introduction and/or limiting the spread once the flock is contaminated. It is advisable that farms have a good pest control regimen in place to avoid the introduction of infection by this route, since wild birds and rodents can introduce and maintain the infection, acting as reservoirs.

Restricting access of non-essential vehicles and visitors is important because humans can also act as mechanical and biological vector, so they should not be allowed to enter into the clean areas of the farm. Preferably staff must wear protective clothing, and boots should be washed before dipping. Air temperature, and air humidity also represent a point of attention since bacterial growth is favorable in environments with high temperature and humidity.

Good End

Precautions should be taken in the transport, slaughter and processing of the birds. Feed should be withdrawn from the birds at least eight hours before the slaughter in order to reduce the amount of defecation, since a large numbers of broiler chickens are colonized by salmonella during grow-out. This practice is important to avoid the contamination of the carcass and the skin of the animals.

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Health and hygiene controls at slaughter are essential, and special precautions should also be applied when slaughtering potentially infected flocks. To avoid cross-contamination, the infected birds are slaughtered in a separate slaughter line or at the end of the day under highly hygienic conditions, followed by full cleaning and disinfection of the plant.

Consumer Education

A final essential element in the prophylaxis of human salmonellosis is consumer education. Special and simple care should be taken seriously, like washing hands before and after handling poultry meat, kitchen hygiene is also important. To avoid cross contamination, cooked or fresh food should never be placed to any surface that previously held raw chicken. Safe storage and proper cooking are also key factors to limit the risk of infection.

Nutritional Strategy

Whereas the feed is a potential risk factor for the transmission of *Salmonella*, it also provides an opportunity to counter *Salmonella*. Feed strategies that reduce early colonization may have an impact on overall flock carriage levels and may help to reduce product contamination. In this context a balanced mixture of medium chain fatty acids (MCFAs), C6 – C8 – C10 – C12, can act as a highly antibacterial substance, and also reduce pathogen virulence through their anti-invasive effect on pathogens.

A study performed by Evans *et al*., (2017) entitled 'Investigation of Medium Chain Fatty Acid Feed Supplementation for Reducing *Salmonella typhimurium* Colonization in Turkey Poults' evaluated the supplementation of MCFAs in day-of-hatch turkey diets at 0.4 kg, 0.9 kg, 1.2 kg, and 1.6 kg/MT. Birds were inoculated with 10^8 colony forming units (CFU) of bioluminescent *Salmonella Typhimurium*. Subsequently, gastrointestinal tissue samples were collected at 3 days post inoculation for imaging of bioluminescent Salmonella (Figure 3).

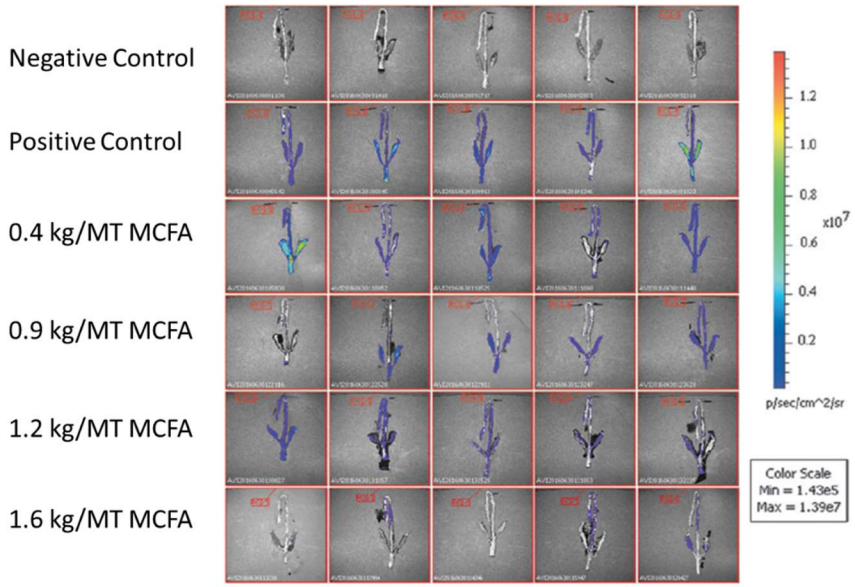

Figure 3. Images of gastrointestinal samples (Merckel's diverticulum to cloaca) with pseudocolor overlays representing the amount of light produced by luminescent Salmonella Typhimurium (3 days post inoculation). The color bar indicates the amount of bioluminescence (surface radiance: p/s/cm^2/sr) detected during imaging.

The authors found a progressive reduction of bioluminescence as the MCFA concentration increased (Figure 4) revealing a significant decrease for both the 1.2 and 1.6 kg/MT MCFA groups compared to the positive control group. In view of the very high infection pressure (10^8 CFU) this shows the powerful capacity of MCFAs to counter *Salmonella*.

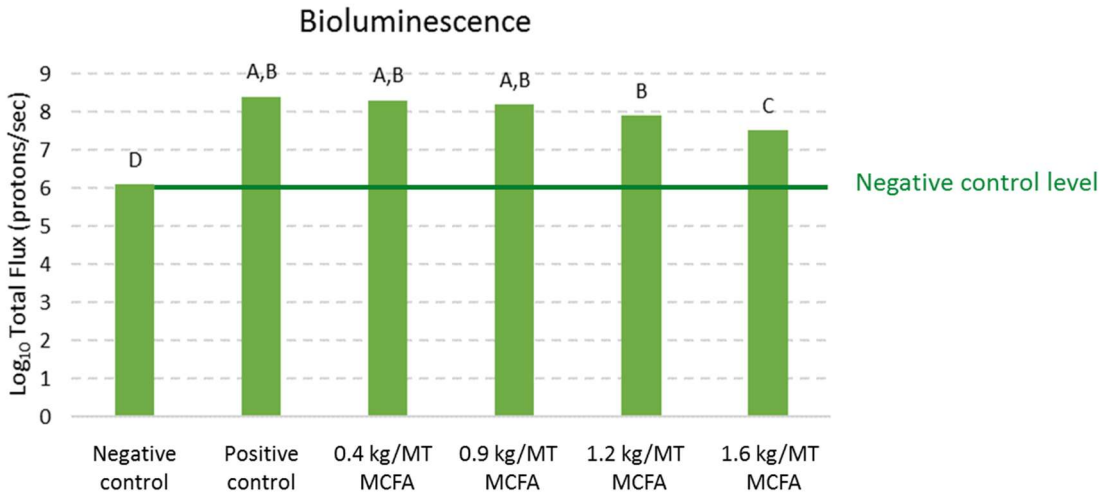

Figure 4. Salmonella bioluminescence in gastrointestinal samples (Mercle's diverticulum to cloaca) from control and MCFA treated poults (3 days post inoculation). Treatments not connected by the same letter are significantly different ($p \leq 0.05$).

MCFAs are a powerful tool as a functional feed ingredient in poultry feed to reduce early *Salmonella* colonization. However *Salmonella* control policy for public health purposes should cover all stages from 'the stable to the table'. Therefore, prevention requires control measures at all stages of the food chain, from agricultural production, to processing, manufacturing and preparation of foods in both commercial establishments and at home, making integrated intervention strategies necessary along the food chain.

More information

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