ANALYSIS OF *SALMONELLA* CONTAMINATION OF PROCESSING ENVIRONMENT IN A FEED MILL

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Abstract

In order to ensure food safety, it is necessary to consider all aspects of the food chain, from the primary agricultural production, including compound feed production, to the supply of consumers, as each of these can affect the safety of final products. In the production of compound feeds, each unit operation can contribute to threatening their safety. The paper aims to determine the contamination with Salmonella spp. of the equipment on the technological process of production from a feed mill from Romania. Sampling was done from different points of the production process, depending on the predisposition to a potential contaminant, respectively from mixers, granulators, sieves, mills, bunkers, coolers, as well as from the bunkers of the machines with which the feed is delivered to customers. During 2019 (in March, July, October, and December) 22 samples were taken and analyzed to determine the contamination with Salmonella spp. The results of microbiological analyzes performed in the feed mill under study, showed that all 22 samples were negative. The introduction of an appropriate system for monitoring and analyzing microbiological contaminants in a fee mill can help to control and prevent contamination, with a direct impact on food safety, animal and human health.

Key words: compound feed, feed safety, food safety, *Salmonella,* feed mill

INTRODUCTION

Feed is vulnerable to the introduction of bacteria throughout the production chain. The presence of pathogens in compound feed may occur due to the use of contaminated raw materials during transport, in the production unit or on the holding. Because bacterial contaminants are not evenly distributed in the feed, the bacteria present may be damaged and difficulties may occur during microbial analysis. The purpose of the control of feed pathogens should be to ensure that feed pathogens are below a critical threshold in order to minimize the risk to human and animal health. Animals that consume contaminated food could become infected and colonize with pathogens, leading to their spread in the farm environment, which poses a risk to the entire herd of animals in that unit [1].

Compound feed production is an important link in the food chain, which should provide sustainable and safe food. Compound feed producers must ensure systematic control at all stages of production, processing and distribution in accordance with EU law, as well as good manufacturing practices and other quality systems (HACCP, GMP + etc.) [4].

In compound feed production, each unit operation may contribute to the feed safety risk. Equipment such as conveyors, separators, extractors, cells, mills, scales, mixers, steam and mechanical treatment equipment (conditioners, granulators, extruders), coolers, dryers, could be considered from a safety point of view as sources of contamination in production process. Potential sites of contamination can be formed by improper construction of equipment, malfunction, damage or unprofessional process management [13].

Factors that influence the development of microorganisms are represented by:

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temperature, oxygen, relative humidity, water activity, pH, nutrients and different types of inhibitors [11].

Salmonella is one of the most important zoonotic pathogens of food origin, with a significant impact on the economy and health of both humans and animals [14]. Non-typhoid *Salmonella* is the world's leading cause of foodborne illness and is estimated to cause approximately 93.8 million cases of gastroenteritis globally each year due to *Salmonella*, with 155000 deaths. It is estimated that 80.3 million of these cases are transmitted through food [7]. *Salmonella* is often a contaminant of compound feeds on the farm or in feed mill, and consequently can lead to infection of animals and thus people who eat food of animal origin.

The general source of *Salmonella* is the intestinal tract of a wide range of domestic and wild animals, and as a result a variety of food of animal and plant origin as sources of infection. The organism can spread easily between animals on a farm without being detected, and the animals can become intermittent or persistent carriers [5].

Thermal inactivation of *Salmonella enteridis* and *Escherichia coli* O157: H7 was determined by temperatures between 54.3 - 64.5°C, pH values between 4.2 - 9.6 with HCl or NaOH, and a concentration of NaCl between 0.5 - 8.5% [2].

Data published by EFSA (European Food Safety Authority) showed that in 2015 the most analyzed feed materials were soy derivatives, with 3404 samples tested and an average prevalence of Salmonella of 3.7 %; also, a high prevalence was reported for meat flour, with 290 tests, of which 16.7% positive. For compound feeds, the prevalence of Salmonella-positive units in 2015 was low for all animal species: 1.20 % of 2240 samples tested for cattle, 0.51 % of 2754 samples tested for pigs, and 0.67 % of 7961 tested samples for poultry [6].

Regulation (EC) No 2160 of 2003 on the control of salmonella and other specific zoonotic agents present in the food web [10] aims to ensure that appropriate and effective measures are taken to detect and control them at all relevant stages of production, processing and distribution, including in animal feed, in order to reduce their prevalence and the risk they pose to public health. In accordance with Article 5 (3) of Regulation (EC) No 183 of 2005 on the hygiene of feeding stuffs [9], feed manufacturers must comply with specific microbiological criteria.

MATERIALS AND METHODS

Research was focused on identifying and monitoring possible sources of contamination located on the entire technological process of compound feed production; these sources have been identified as being prone to contamination of the technological process by the formation of a heterogeneous mixture, cross-contamination and microbial contamination.

Samples that were collected in sterile test tubes, taken from the technological equipment on the production feed of the compound feed, were microbiologically analyzed to determine the contamination with *Salmonella spp*.

The samples were taken from a compound feed factory from Romania during 2019, and the tests were performed in a specialized laboratory in Romania, accredited by RENAR (Romanian Accreditation Association). Sampling was done from different points of the production flow, depending on the predisposition to a potential contamination. The samples were taken from mixers, granulators, sieves, mills, bunkers, coolers, as well as from the bunkers of the machines with which the fodder is delivered to the customers.

The microbiological analysis of the production spaces was performed in accordance with the standard SR EN ISO 6579-1: 2017 Microbiology of the food chain. Horizontal method for the detection, counting and serotyping of *Salmonella*. Part 1: Detection of *Salmonella spp.* [12]. The tests were collected from surfaces in sterile test tubes, on an area of 100 cm^2.

RESULTS AND DISCUSSIONS

The results of the analyzes of the contamination with *Salmonella spp.* of the production sites in a feed mill were presented in Table 1. The equipment from which

samples were taken for analysis were located on the entire feed production flow. In order of technological flow, samples were collected from the surfaces of the following equipment: grain sieving screens, raw material storage hopper walls, mills, microdosing mixers, macrodosing mixers, batch mixers, granulators, coolers, and from inside the hoppers of the trucks with which the fodder was delivered.

During 2019, 22 samples were taken and analyzed to determine the contamination with *Salmonella spp*.; the samples were collected in March, July, October and December. In March 2019, five samples were collected from five surfaces of the technological equipment (microdosing and macrodosing mixer, granulator, cooler and from the feed transport machine), all results being negative. In July, six samples were taken from the equipment in the compound feed mill (grain sieve, raw material storage hopper wall, mill, mixer, granulator, and feed delivery machine), all results being negative.

Table 1 Results of microbiological analysis of processing environment

No.	Month	Sampling surface	*Salmonella spp.* (/100 cm^2)	Observations according to Order MAFF 249/2003
1.	March 2019	Microdosing mixer	undetected	according
2.		Macrodosing mixer	undetected	according
3.		Granulator	undetected	according
4.		Cooler	undetected	according
5.		Feed delivery machine	undetected	according
6.	July 2019	Grain sieve	undetected	according
7.		Bunker wall raw materials	undetected	according
8.		Mill	undetected	according
9.		Batch mixer	undetected	according
10.		Granulator	undetected	according
11.		Feed delivery machine	undetected	according
12.	October 2019	Macrodosing mixer	undetected	according
13.		Batch mixer	undetected	according
14.		Granulator	undetected	according
15.		Cooler	undetected	according
16.		Feed delivery machine	undetected	according
17.	December 2019	Bunker wall raw materials	undetected	according
18.		Microdosing mixer	undetected	according
19.		Batch mixer	undetected	according
20.		Granulator	undetected	according
21.		Cooler	undetected	according
22.		Feed delivery machine	undetected	according

In October 2019, five analyzes were performed to determine the contamination with *Salmonella spp.* of the surfaces of technological equipment (microdosing mixer, batch mixer, granulator, cooler and feed delivery machine), all results being negative. In December, samples were collected for analysis on the wall of a raw material storage hopper, from the micro-dosing mixer, from the load mixer, granulator, cooler and from the hopper of the feed transport machine, all results being negative.

Throughout 2019, the distribution of samples taken and analyzed (Fig. 1) was as follows: 18 % from the surface of the granulator, 18 % from inside the feed transport machines, 14% from inside the coolers, 14 % from the microdosing mixer, 14 % of the batch mixer, 9 % of the raw material hopper, 5% of the macrodose mixer, 4 % of the grain sieve, and 4 % of the mill surface.

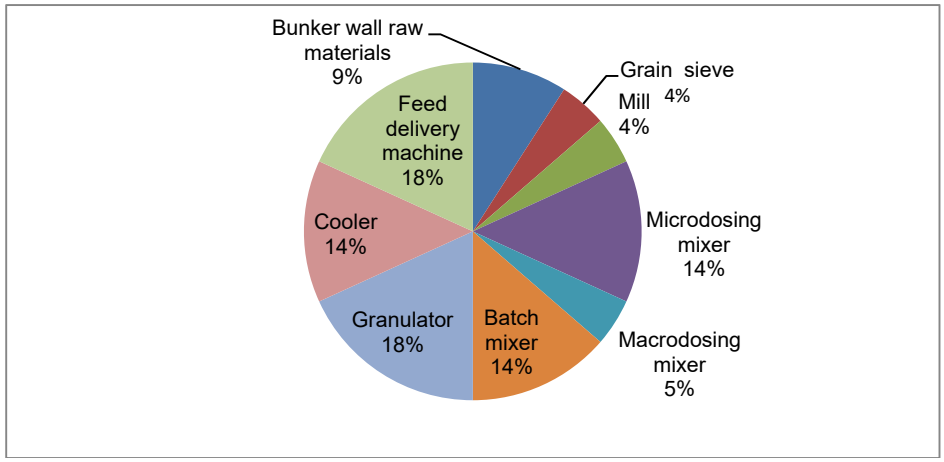

Fig. 1 Distribution of samples taken and analyzed

Davies and Wray (1997) [3] undertook a study in nine feed mills; the isolation rate of *Salmonella* ranged from 1.1% to 41.7% of the samples, and the most contaminated factories were those in which the inside of the coolers was colonized by *Salmonella*. A wide range of *Salmonella* serotypes have been isolated, including *Salmonella typhimurium* and *S. enteridis*. In four factories, *Salmonella*-containing contamination of raw material unloading tanks and unloading ports was identified in bird droppings.

Đuragić et al. (2017) [4] undertook a study in which they monitored the hygiene of 12 feed mills, by performing analyzes to determine contamination with *Salmonella spp*., *Escherichia coli* and *Staphylococcus aureus*. Samples were taken from mixers, elevators, conditioners, granulators and coolers. The results of the analyzes showed that 7 % of the samples were positive for Salmonella spp. And even 50 % of the samples were positive for other bacterial contaminants.

CONCLUSIONS

In the stages of production, transport and distribution of compound feed, due to deviations from their quality safety rules, accidental or deliberate contamination may occur, with an undesirable impact on animal health and the safety of food for human consumption.

There is an impressive diversity of *Salmonella* serotypes (many of which can coexist on the same animal), with different degrees of pathogenicity. Rats and mice, which are common carriers of *S. typhymurium* and *S. enteridis*, play an important role in the spread of the infection. Salmonella eliminated by these animals through feces remains viable, multiplies in the environment and thus contaminates the soil, fodder and drinking water, becoming secondary sources of infection, which spread over long distances.

Were performed 22 analyzes in order to determine the contamination with *Salmonella spp*. of the equipment from the technological process of production of a feed mill. Based on the results of microbiological analyzes performed in the feed mill under study, it was found that all 22 samples were negative, in accordance with Order No. 249 of March 31, 2004, issued by the Ministry of Agriculture, Food and Forestry [8] from Romania.

It can be concluded that the introduction of an appropriate system for monitoring and analysis of microbiological contaminants in a feed mill can contribute to the control and prevention of contamination, having a direct impact on food safety, animal and human health.

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