A STUDY ON INCIDENCE OF *SALMONELLA* CONTAMINATION ON THE SURFACE OF FEED MILL EQUIPMENTS

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Abstract

In the production of compound feed, contamination with undesirable substances may occur, which may come from the environment and/or the production process; compound feed and raw materials may be contaminated with these substances. In the production of compound feed, each unit operation can contribute to the threat to their safety. The aim of the work is to determine the contamination with Salmonella spp. of the equipment on the flow of production in a feed mill from Romania. Sampling for the determination of contamination with Salmonella spp. was done from different points of the production flow, depending on the predisposition to a potential contamination, namely from mixers, granulators, sieves, mills, hoppers, coolers, as well as from the hoppers of the machines with which feed is transporting. During 2019 (in March, July, October, and December) and 2020 (in March, May, August and December) 22 samples respectively 20 samples were taken and analysed to determine the contamination with Salmonella spp. The results of microbiological analyzes performed in the feed mill studyed, showed that all 22 respectively 20 samples were negative. The introduction of an appropriate system for monitoring and analyzing microbiological contaminants in a feed mill can help to control and prevent contamination, with a direct impact on food safety, animal and human health.

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

INTRODUCTION

In compound feed production, each unit process in production can contribute to feed safety. Equipment such as conveyors, separators, extractors, cells and hoppers, mills, scales, mixers, conditioners, granulators, extruders, coolers, dryers, could be considered as critical points in the production process from the safety aspect. Potential areas of contamination may occur as a result of improper equipment construction, malfunction, damage, or improper process performance (Đuragić et al., 2017; Verstraete, 2012).

The unnecessary or unintentional presence of pathogenic microorganisms is called microbiological contamination. Contagious microbes, including bacteria, fungi, protozoan yeasts, and even viruses, cause microbial contamination (Chatterjee & Abraham, 2018).

Animal feed is vulnerable to the introduction of bacteria throughout the production chain. The presence of pathogens in compound feed can occur due to the use of contaminated raw materials, during transport, in the production unit or in the farm. Because bacterial contaminants are not uniformly distributed in feed, the bacteria present may be damaged or injured and difficulties may arise during microbial analysis. The aim of feed pathogen control should be to ensure that feed pathogens are below a critical threshold to minimize the risk to human and animal health. Animals consuming contaminated feed could become infected and colonized with pathogens, leading to their spread in the farm environment, which poses a risk to the entire livestock population in that facility (Alali & Ricke, 2012).

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Compound feed production is an important link in the food chain, which should provide sustainable and safe food products. Compound feed manufacturers must ensure systematic control at all stages of production, processing and distribution in accordance with EU legislation, as well as good manufacturing practices and other quality systems (HACCP, GMP+, etc.) (Đuragić et al., 2017).

Salmonella is often a contaminant of compound feed at farm or feed mills, and consequently can lead to infection of animals and by implication humans who consume food of animal origin. The general source of Salmonella is the intestinal tract of a wide range of domestic and wild animals, and consequently a variety of food products of animal and plant origin result as sources of infection. The organism can easily spread between animals on a farm without being detected, and animals can become intermittent or persistent carriers (EFSA, 2009).

Regulation (EC) number 2160 of 2003 on the control of salmonella and other specific zoonotic agents present in the food chain aims to ensure that appropriate and effective measures are taken for their detection and control at all relevant stages of production, processing and distribution, including in food for animals, to reduce their prevalence and the risk they represent to public health. According to Article 5(3) of Regulation (EC) No. 183 of 2005 on feed hygiene, feed manufacturers must comply with specific microbiological criteria.

The data published by EFSA (European Food Safety Authority) showed that in 2015 the most analyzed feed raw 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 meal, with 290 tests, of which 16.7% were positive. For compound feed, the prevalence of positive units for Salmonella 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 samples tested for birds (EFSA, 2016).

MATERIALS AND METHODS

The research focused on the identification and monitoring of possible sources of contamination located on the entire technological process of the production of compound feed; these sources have been identified as prone to contamination of the technological process through the formation of a heterogeneous mixture, cross-contamination and microbial contamination.

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

The samples were taken from a feed mill in Romania during 2019 and 2020, and the tests were carried out in a specialized laboratory in Romania, accredited by RENAR (the Romanian Accreditation Association).

Sampling to determine contamination with *Salmonella* spp. was done from different points in the production flow, depending on the susceptibility to potential contamination; samples were taken from mixers, granulators, sieves, mills, hoppers, coolers, as well as from the hoppers of the machines used to transporting feed.

The microbiological analysis of the production premises was carried out in accordance with the SR EN ISO 6579-1:2017 Microbiology of the food chain standard. Horizontal method for the detection, enumeration and serotyping of Salmonella. Part 1: Detection of *Salmonella* spp.

RESULTS AND DISCUSSIONS

Table 1 shows the results of the sanitation tests carried out in order to determine the contamination with *Salmonella* spp./100 cm^2 for the samples taken from the processing environment of the unit under study; the frequency of applying sanitation tests was four times a year in both years of the study; in 2019, 22 samples were analyzed, and in 2020, 20 samples were analyzed.

Regarding the proportion of the samples taken and analyzed, in 2019 (Fig. 1) of the 22 samples, it was revealed that 18% were taken from inside the granulator and from inside the

feed transport machines, 14% from inside the coolers, from the mixer microdosing and from the batch mixer, 9% from inside the raw material bunkers, 5% from inside the macrodosing mixer, 4% from the grain sieve and inside the mill.

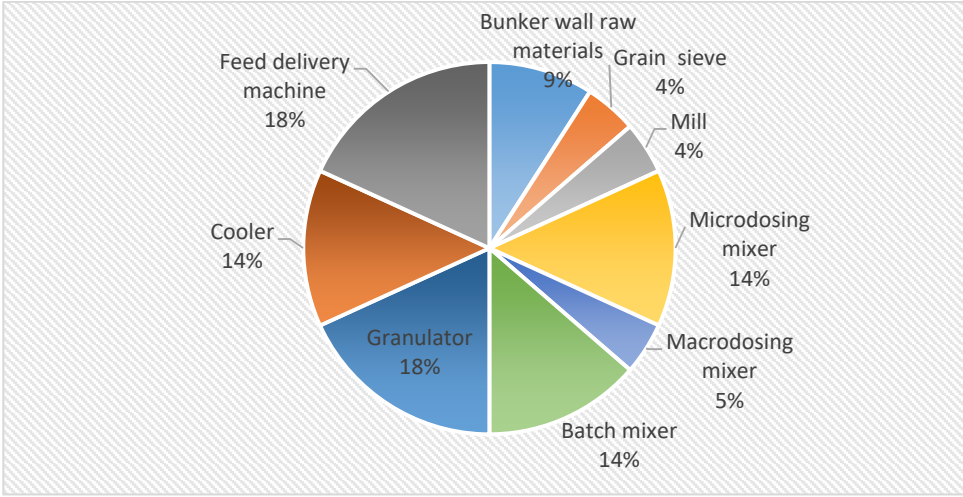

Fig. 1 Distribution of samples analyzed (2019)

Table 1 Results of microbiological analysis (2019 and 2020)

2019 year			2020 year		
Date	**Sampling surface**	***Salmonella* spp. (/100 cm²)**	**Date**	**Sampling surface**	***Salmonella* spp. (/100 cm²)**
03.19	Feed delivery machine	undetected	03.20	Feed delivery machine	undetected
	Cooler	undetected		Cooler	undetected
	Microdosing mixer	undetected		Microdosing mixer	undetected
	Macrodosing mixer	undetected		Macrodosing mixer	undetected
	Granulator	undetected		Supply bunker	undetected
07.19	Grain sieve	undetected		Feed conveyor	undetected
	Mill	undetected	05.20	Grain sieve	undetected
	Batch mixer	undetected		Macrodosing mixer	undetected
	Granulator	undetected		Granulator	undetected
	Bunker wall raw materials	undetected		Cooler	undetected
	Feed delivery machine	undetected		Feed delivery machine	undetected
10.19	Cooler	undetected	08.20	Cooler	undetected
	Granulator	undetected		Granulator	undetected
	Batch mixer	undetected		Feed conveyor	undetected
	Microdosing mixer	undetected		Feed delivery machine	undetected
	Feed delivery machine	undetected		Bunker cover	undetected
12.19	Feed delivery machine	undetected	12.20	Feed delivery machine	undetected
	Cooler	undetected		Cooler	undetected
	Microdosing mixer	undetected		Microdosing mixer	undetected
	Granulator	undetected		Granulator	undetected
	Batch mixer	undetected			
	Bunker wall raw materials	undetected			

In 2020 (Fig. 2), of the 20 samples taken and analyzed, it was found that 20% were taken from inside the coolers and inside the feed transport machines, 15% from the inside of the granulator, 10% from inside the mixers of micro-dosing, macro-dosing and from feed conveyor and 5% each from the supply bunker, grain sieve, and bunker cover.

All the results of the sanitation tests carried out in order to determine the contamination with *Salmonella* spp. of the production environment, carried out during both years of the study, were negative.

In a study undertaken by Davies & Wray (1997) in nine compound feed plants, it was found that the isolation rate of *Salmonella* varied from 1.1% to 41.7%, the most contaminated plants being those where the interior the coolers were colonized by *Salmonella*; a wide range of *Salmonella* serotypes were isolated, which included *Salmonella typhimurium* and *S. enteridis*.

Đuragić et al. (2017) conducted a study in which they monitored the degree of hygiene in 12 combined feed factories, by carrying out analyzes to determine the contamination with *Salmonella* spp., *Escherichia coli* and *Staphylococcus aureus*. Samples were taken from the processing environment (mixers, elevators, conditioners, granulators and coolers) and the results showed that 7% of the samples were positive for *Salmonella* spp. and 50% of the samples were positive for other bacterial contaminants.

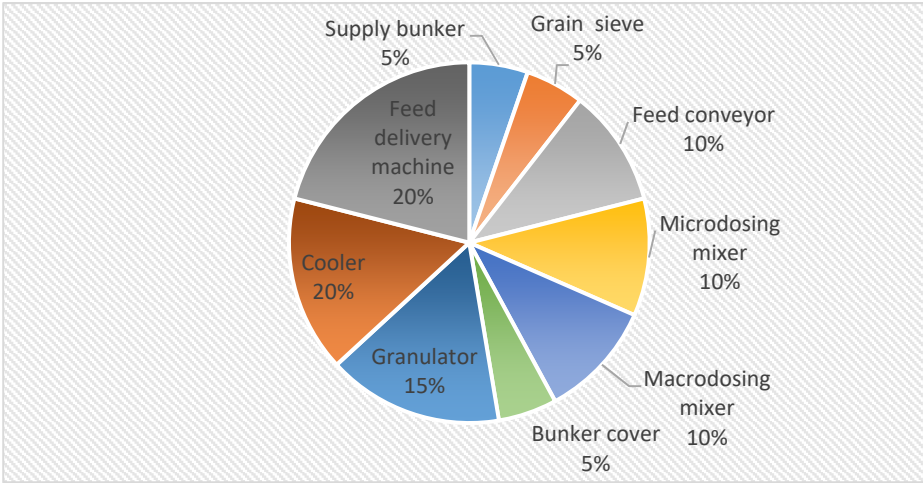

Fig. 2 Distribution of samples analyzed (2020)

Torres et al. (2011) undertook a study in 144 compound feed factories in Spain, *Salmonella* being identified in 28% of them; of the samples taken, *Salmonella* was isolated in 3.5% in raw materials, 3.2% in feed and 12.5% in dust from the processing environment.

CONCLUSIONS

In the stages of production, transport and distribution of compound feed, due to some deviations from their safety norms, accidental or deliberate contamination can occur, with an undesirable impact on the health of animals, as well as the safety of food intended for human consumption.

Regarding the analyzes carried out to determine the contamination with *Salmonella* spp. of the equipment in the production space, the frequency of applying sanitation tests was four times a year in both years of the study; in 2019, 22 samples were analyzed, and in 2020, 20 samples were analyzed. All the results of the sanitation tests carried out in order to determine the contamination with *Salmonella* spp. of the production environment, carried out during both years of the study, were negative.

According to some studies, in the compound feed industry there may be a high probability of microbiological contamination in the different production sectors, caused by the handling of raw materials and finished products (Coradi et al., 2011).

It can be concluded that the introduction of an adequate system for monitoring and analyzing 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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