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*Review scientific article***APPLICATION OF MEASURES OF DISINFECTION, DISINSECTION
AND RODENT CONTROL IN SLAUGHTERHOUSES****Ljiljana JANKOVIĆ^{1*}, Radislava TEODOROVIĆ¹, Milutin ĐORĐEVIĆ¹,
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Abstract: The responsibility of all food business operators is the prevention of conditions that can lead to the development and spread of foodborne diseases. Hazard Analysis and Critical Control Points HACCP (Hazard Analysis Critical Control Point) has been identified as the most effective standardized approach that reduces the risks of foodborne diseases and is therefore accepted by FAO (Food and Agriculture Organization) and WHO (World Health Organization). Disinfection, disinsection and deratization (DDD) is just one of the prerequisite programmes in the application of the HACCP system in the food industry. By implementing these measures, manufacturers are closer to their ultimate goal which is a safe product of high quality. Measures of disinfection, disinsection and deratization are carried out continuously and involve complex, carefully planned and complete procedures for destruction of microorganisms, insects and rodents. These measures require a combination of preventive and curative measures and they must be implemented in order to achieve the expected effects. Companies that implement DDD measures must have trained staff who understand the principles of HACCP and know how to apply these measures in a way that will not pose a risk to the end consumer.

Key words: disinfection, disinsection, deratization, slaughterhouse

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INTRODUCTION

The emergence of foodborne diseases can endanger not only the health of consumers, but also trade and tourism and lead to economic losses. The responsibility of the management of all food business operators is the prevention of conditions that can lead to the development and spread of foodborne diseases. Experiences of a large number of developed countries on the suppression and prevention of foodborne diseases indicate the importance of preventive action on hazards that can cause health problems in humans. The current volume of food trade calls for the establishment of a standardized approach to food safety around the world in order to assess whether a particular product carries the risk to health and to determine the level of that risk (Makiya and Rotondaro 2002). Hazard Analysis and Critical Control Points HACCP (Hazard Analysis Critical Control Point) has been identified as the most effective standardized approach that reduces the risks of foodborne diseases and is therefore accepted by FAO (Food and Agriculture Organization) and WHO (World Health Organization). Disinfection, disinsection and deratization (DDD) are just one of the prerequisite programmes in the application of the HACCP system in the food industry. DDD measures represent a unique entity that was created with the aim to combine efforts to protect the health of people, animals and material goods by specific measures. Disinfection,

disinsection and deratization measures must be carried out continuously and include complex, carefully planned and comprehensive procedures for the destruction of microorganisms, insects and rodents. These measures require a combination of preventive and curative measures and they must be systematically implemented in order to achieve the expected effects. Bearing in mind the problems encountered in the production and processing of foods, as well as in the storage, it must be emphasized that the mentioned DDD measures must be considered as part of the entire sanitation process, and not as individual operations. DDD measures are integral parts of every food production and therefore must be integrated as prerequisites in each HACCP plan. The best way to achieve all the goals set for obtaining healthy food is to set sanitation processes as sub-processes with their own critical control points and their own monitoring and control procedures (FAO / WHO, 2009). A company that most often as a contractor performs DDD measures must have staff who understand the principles of HACCP and knows how to apply DDD measures in a way without any risk to the end consumer.

In order to ensure the success of all measures aimed at obtaining healthy food, it is very important that the construction of the facility and

equipment meets all the veterinary and sanitary requirements and the construction-technical conditions prescribed by the regulations.

During the implementation of mandatory DDD measures for each type of facility and in each procedure, the contractor is obliged to:

1. Inspect the area and space.
2. Create the necessary documentation,
3. Make a plan for the implementation of mandatory DDD measures with proper content and
4. Make an assessment of the performed DDD measures.

PLAN FOR CLEANING AND SANITARY WASHING AND ITS IMPLEMENTATION IN SLAUGHTERHOUSES

In the planning phase of a slaughterhouse construction, it is mandatory to consider cleaning and sanitation processes that are integrated in the process of slaughtering and handling meat (Small et al., 2007a). The established plan of mechanical cleaning and sanitary washing ensures an adequate level of cleanliness of all parts of the building as well as cleaning equipment itself. For each facility a sanitary procedure plan is made individually, depending on the capacity of the building, the technical characteristics and the type of production (Guide to Good Hygiene Practice and the Application of the HACCP Principle in Meat Industry, 2012). The plan should be regularly and fundamentally implemented and documented on demand in order to establish the success and justification of the implemented procedures. If it is cleaned during work, it is necessary to protect the food from possible contamination. Employees must take care of personal hygiene. The hygiene plan should for each production segment and part of the equipment should contain the details of:

- hygienic requirements,
- responsible persons,
- preparations to be used,
- procedures and instructions,
- frequency of washing and disinfection and
- monitoring of procedures and corrective DDD measures.

Removing impurities from disinfecting surfaces is a prerequisite for successful disinfection, and therefore pre-disinfection, mechanical cleaning and sanitary washing should be carried out thoroughly and conscientiously. Mechanical cleaning and sanitary washing in slaughterhouses implies that after the completed production process loose dirt and food particles must be removed from all tools, accessories and surfaces. The goal of sanitation is to remove impurity invisible to the naked eye-organic matter (blood, fat) or inorganic matter (rust, scale) and thereby create better conditions for the disinfectant. For the successful implementation of sanitary washing, the water temperature, operating time of the washing agent, and water hardness are of great importance (Walia et al.,

2017). Washing control is performed by visual inspection - by observing residual mechanical impurities after washing. Whether the pre-disinfection steps have been successfully performed is based on a continuous film of water that completely covers a certain surface, i.e. when its continuity is nowhere broken by residues of grease or protein. Only by fully achieving this goal it can be considered that cleaning and washing was effective. Sanitary agents which react with water at lower temperatures should be used as this prevents excessive evaporation, condensation and growth of the mildew (Veljić and Rajković, 2012).

The mechanical cleaning and sanitation washing process consists of the following phases:

1. preparatory cleaning (brushing, scraping, wiping and removing impurities and food residues with rinsing with water),
2. sanitary washing (using surfactants to improve surface wetting properties and sequesters to improve the dissolution of any residual inorganic impurities from the surface as well as to prevent the formation of scale on the surface)
3. rinsing with water to remove detergent, uncleaned detergent and food residues.

Mistakes in hygiene procedures are:

- inadequate procedures during work,
- the water temperature is not high enough (higher temperatures are more efficient but they can cause condensation or coagulation of proteins on surfaces, which makes cleaning difficult)
- cleaning techniques or tools are not adapted to the conditions,
- there is no hygiene plan for a specific drive,
- there is no
- responsibility for maintaining hygiene has not been established.

Chemicals used for cleaning and washing should be kept in a secure place so that they do not pose a risk to the usability of food and human health. Cleaning equipment should be kept in a separate room, which should be regularly cleaned, monitored and disinfected, so as not to become a source of cross-contamination. Some cleaning equipment should be used only in certain rooms to prevent the spread of contamination. Coloring equipment is one of the simplest ways to ensure good control over the purpose and location of certain equipment. The success of the cleaning will be reduced if the surface of the rooms and equipment is not maintained in the proper condition, or if they are worn, damaged or porous.

DISINFECTION IN SLAUGHTERHOUSES

In slaughterhouses, a large number of different types of microorganisms are introduced through animals brought to slaughter, as well as through workers. Some technological processes in slaughterhouse production are designed in such a way that they can partially influence the elimination and reduction of possibly present microorganisms in the meat (high and low temperatures, salmurian, salting and smoking processes) However, it is necessary to implement the disinfection process in the production plant on a daily basis (Gun et al., 2003).

Disinfection of accessories, equipment, work surfaces and sanitary facilities in all facilities where food is prepared and manufactured must be carried out daily (FAO, 1985) Disinfection should be done as a continuous daily process by those who use surfaces, premises or facilities. Equipment and surfaces that come in contact with food should be made of disinfectant material. Also, it is important that the surfaces are in a satisfactory condition, ie undamaged. Surfaces that are rough, scratched or crushed, corroded parts and hard-to-reach spots (dead corners) are difficult to clean and disinfect, and these places have the optimal conditions for the creation and development of biofilm. Biofilm is formed when microorganisms attached to solid and damp surfaces form microcolonies. Biofilm is actually a mixture of microorganisms, food components, and

exopolysaccharide (EPS) substances produced by microorganisms attached to solid surfaces (Janković et al., 2009). Disinfectants, that will in the concentration and exposure time recommended by the manufacturer destroy the microorganisms possibly present in the plant, should be used. The requirements that must be met by disinfectants to be used in food production facilities are:

- a wide range of actions against various microorganisms,
- slight weakening of the effect due to the presence of impurities,
- constant composition and
- that it is not harmful to the materials to which it is applied.

Chlorinated preparations are found to be highly applicable in the meat industry, but may pose a potential health risk to consumers if they are not used in accordance with the instructions. They work better at lower pH and then exhibit virucidal, bactericidal and sporocidal effects. The lack of chlorine preparations is that organic matter reduces their disinfecting power, while the presence of bases neutralizes their effect. If the temperature is increased by 10°C, the chlorine efficiency increases by 60% -65%. In base-poor environments, the microbiocidal effect of chlorine increases. The optimum pH of the medium for the action of chlorine preparations ranges between 6 and 8 (Walia et al., 2017; Gosling et al., 2017).

Quaternary ammonium compounds are often used for disinfection in the food industry. These compounds have very pronounced bactericidal properties, very low odor, high stability, less susceptible to the presence of organic substances than chlorine preparations, do not cause corrosion and are poorly toxic. Quaternary ammonium compounds destroy micrococci and thermoresistant bacteria well, and somewhat weaker coliform bacteria and gram-negative psychrophiles (Walia et al., 2017).

The disinfection process consists of several stages:

- application of disinfectant ,
- basic rinsing with water and
- control of the conducted disinfection (microbiological testing – use of microbiological tests or fast tests for checking the effectiveness of sanitation procedures).

The most common failures during disinfection are:

- insufficient previous mechanical cleaning and sanitary washing (consequence: reduction of the effect of disinfection),
- the use of an inappropriate

disinfectant (consequence: insufficient activity of disinfectants, corrosion, discoloration),

- inadequate concentrations of the disinfectant (consequence: in high concentration the residue problem in food; in low concentration the formation of resistance
- biofilm remains which prevent penetration and the effect of the disinfectant;
- missing or incomplete rinsing of the disinfectant (consequence: residue in foods)
- incorrect operation (as a result: some surfaces are not disinfected).

Proper implementation of disinfection and rinsing of disinfected surfaces are constituent parts of each operation and each stage of the production process in the slaughter industry and one of the most important elements for food safety (Radenković et al., 2015). Problems arising from unprofessionally conducted disinfection are caused by the ignorance of the measure, its ineffective implementation, inadequate education of direct performers of these jobs, as well as the lack of standards for assessing the success and control of disinfection (Janković et al., 2012; Naglić, 2005).

DISINSECTION IN SLAUGHTERHOUSES

Insect control in slaughterhouses is one of the essential prerequisites for an integrated approach to health and food safety. The design, construction,

location and size of the food facility must be such as to enable good hygienic practice in handling food including protection against insect contamination

and insect entry points. Insects entering the facilities are a significant source of microbiological and physical hazards (eggs and larvae). Keener (2009) states that a housefly can carry over 3.6 million bacteria. Inadequately implemented insect control and eradication programs, as well as careless storage and use of insecticides can also cause chemical hazards, so it is imperative to establish procedures to minimize such risk. Persistent insect phenomena indicate serious hygiene and other failures (inadequate cleaning and maintenance). It is necessary to ensure adequate conditions for temporary storage and the disposal of inedible by-products and other waste. Successful control of insects in slaughterhouses should be based on an integrated, comprehensive approach that promotes preventive measures through the application of good hygiene, sanitary or production practices (Veljić and Rajković, 2012, Bogdanović and Stanković 2011). The most common preventive measures applied in order to prevent the insect entry into the production facility are : to control the exterior windows, doors and other openings and to equip them with mesh tape or strips. Insect light traps or "Insect-O-cutor" may be installed at the entrances, but it must be ensured that these devices are never placed above finished products, packers and other sensitive equipment (they are placed in those parts of production facilities that are less illuminated and without direct strong light).

In order to control and eradicate insects, the following methods can be used:

1. Mechanical methods, which involve the use of:
 - sticky tape,
 - sticky traps for crawling insect (with self-adhesive paper, some chemical compounds or pheromones),
 - gels,
 - inert dust (silicon gel and diatomaceous earth that dries insects).
2. Physical methods, which include the use of:
 - insectocutors (for flying insects, it must be placed away from the area where it is handled with food),
 - ultrasound and
 - low temperatures.
3. Autocidal control of the insect means:
 - interruption of the reproductive cycle by the release of sterile males or genetically modified insects.
4. Behavioral control:
 - Behavior control involving the use of chemical attractants that attract insects into trap or interrupt and interfere with the development cycle of insects.

If all of the above methods and measures have not been successful it is necessary to do the disinfection of the slaughterhouse using a chemical disinfectant (Good Hygiene Practice Guide and HACCP Meat Industry Approach, 2012). When performing

disinfection, it is necessary to apply the appropriate precautionary measures and strictly respect the manufacturer's instructions. Insecticides used in the food industry must be approved for this purpose and should not be used during working hours or during active work operations. Treatment with chemical preparations is carried out after the end of the work shift, during the weekend or on other occasions when the production facility is closed. Before using insecticides, all products and all exposed material must be covered or removed from the area being treated. Insecticides of plant origin such as nicotine, rotenone,

permethrin (Veljić and Rajković, 2012) can be used. Corrective measures need to be taken when defects in procedures are identified or when the presence of insects is noticed. Corrective measures include:

- disposal of the product that is contaminated,
- determining the causes and ways in which it is possible to prevent the occurrence of similar contamination in the future,
- to improve the instructions and training of staff.

DERATIZATION IN SLAUGHTERHOUSES

Deratization is a very challenging task, and in order to achieve success, it requires expertise, good knowledge the target species biology and the right choice of measures and procedures during the destruction of the rodents in a particular area. Regardless of the degree of hygienic conditions and building technical solutions, certain types of mice are nevertheless present in the facilities (or their immediate vicinity) of the slaughter industry. Control of potential risks that may be caused by certain types of rodents is one of the most important aspects of controlling the safety of production in slaughterhouses. Rodents are one of the greatest dangers for food safety, as they can cause contamination of both raw materials and finished products, and thus contribute to the spread of various diseases that can endanger the health

of consumers. These pests can cause microbiological and physical or chemical contamination of food, and thus further jeopardize human health (Janković et al., 2015; Bogdanović and Stanković, 2011).

In slaughterhouses, the presence of harmful rodents is a risk due to the possibility of contamination of products, work space and equipment. The presence of rodents contributes to the loss of consumers' confidence in a particular company or product, the possibility for the company to be prosecuted and to pay large damages in the event of serious health problems in people (Bogdanović i Stankovic, 2011). An operational and effective program of controlling rodents is necessary in every segment of the production chain. Food business operators are responsible for the control of pests and they have to establish,

implement and maintain a permanent procedure. Rodent suppression can be successful only by using an integrated approach, ie, the joint application of preventive, mechanical, physical and chemical measures will yield the desired results, while any deviation will result in the creation of favorable conditions for the retention and reproduction of rodents (Janković et al., 2013, Krajcar, 2011;)

Deratization of larger facilities should be carried out according to the plan and program that is being developed for each facility separately. When designing a plan, it is necessary to take into account and take into account all the specifics of the object (location, construction, technological and production characteristics) and to provide for the coverage of all the surfaces of the building as well as the environment of the building (Krajcar, 2011). Requests and measures for combating harmful rodents in the slaughterhouse are:

1. Object inspection - in order to create a plan and a program of deratization, it is necessary to thoroughly inspect the object and the immediate environment to determine the actual condition. Apart from looking for traces of rodents (active holes, feces, traces of gnawing), all critical sites that are suitable for entering and retaining rodents in or around the facility should be registered. The survey is conducted by deratization contractors with the cooperation of employees and users of the facility.

2. Construction measures - are

undertaken with the aim of preventing the entry, retention, feeding and reproduction of rodents in or around an object.

The construction measures include:

- proper and high quality foundation of facilities,
- installation of protective nets on ventilation and other openings,
- installation of correct siphons and barriers in the sewerage system, etc.

Procedures and measures to prevent the entrance of the crown in the building (RAT-PROOF-SISTEM) are proposed by the deratization contractor (in written form) and are carried out by the owner of the facility.

3. Hygienic measures - procedures for timely and hygienically correct removal and disposal of waste, so that rodents can not use them for food, shelter or habitat. These measures play a major role in organized suppression, as they reduce the ability to choose food, and thus make the exposed bait boxes more acceptable and vice versa.

4. Employees should be informed about the issue of health safety related to the occurrence of rodents, the need to respect the instructions should be emphasized, as well as the importance of up-to-date reporting of the rodents occurrence and ineffective control measures.

The contractor who will perform the control of rodents should have the authority to carry out activities issued

by the competent ministries and a copy of the register of the Court Register for performing activities. Rodenticides must be approved for intended use, label instructions must be followed, including requirements relating to the removal of food or equipment overlay prior to the application. All hazardous chemicals must be stored in accordance with the Ordinance on permits for the performance of traffic, ie permits for the use of particularly hazardous chemicals "Official Gazette of RS", No. 94/2010) Rodent extermination- If it is a minor number or cases where rodenticides pose a risk of contamination, depending on whether there are mice or rats present in the facility, traps or glue (placed in deratization boxes) can be used. If the number of rodents is high, it is recommended to carry out the deratization using baits with rodenticides, and it is necessary to make a precise plan for placing the boxes with the poisoned bait.

- positions of baits and traps in the facility (production plants),
- positions of traps in the immediate environment
- positioning of traps in the sewer system.

Installation, control and replacement of bait are carried out exclusively by trained workers of the authorized contractor. The bait must not be placed in rooms where the food is exposed / unpacked, and the dead rodents should be removed quickly and safely.

For the purpose of successful pest control, it is necessary to determine the schedule for the implementation of regular controls. The checklist helps to ensure checking of all areas, provides the possibility of recording the appearance of rodents as well as taken measures.

At certain time intervals it is necessary to check:

- possible ways of entering
- possible sources of food, water and shelter for rodents,
- signs of the appearance of rodents, including faeces or nests, and
- baits at checkpoints and rodenticide efficacy.

The most common mistakes in the implementation of pest control are due to:

- insufficient knowledge of the terrain that is covered
- insufficient coverage of the whole field of interest and skipping facilities,
- processing only objects, and not the surrounding environment,
- the wrong choice of the formulation of the bait and the incorrect exposure of the bait,
- exposure of insufficient quantities of bait and a lack of pest control boxes,

Mistakes during the implementation of pest control can be corrected only if during the implementation and after the completed action there is an internal and professional supervision of the

deratization (Krajcar, 2011; Janković et al., 2013). In that case most of the detected errors can be easily removed during the action. All other mistakes

detected in the final analysis are eliminated by repeating measures in the facility or in objects where failures are detected.

CONCLUSION

The number of people suffering from foodborne diseases is constantly increasing. Therefore, in factories where food is produced every day, more and more requirements are established in order to achieve and maintain the hygienic conditions for obtaining a safe product. Hazard Analysis System and Critical Control Points HACCP has been identified as the most effective standardized approach to reducing food safety risks. Disinfection, deratization

and disinsection are part of the prerequisite programs of the unique HACCP system in food production. These measures involve complex and carefully planned comprehensive procedures for the destruction of microorganisms, insects and rodents and must be carried out continuously. If these measures are not implemented programmatically, its expected effects are reduced, and their significance is impaired.

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