

IMPORTANCE OF ADEQUATE HAND HYGIENE OF FOOD HANDLERS IN SNAILS MEAT PROCESSING

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Abstract

The hand hygiene of the food handlers is a very important element in ensuring the microbiological safety of food. There are many cases of food poisoning in the world, in which microorganisms - the causes of poisoning in food - come through workers who manipulate with food. The package of frozen snail's meat in the shells is done completely manually.

In the period 2014 - 2017 were taken swabs from the hands of workers who have direct contact with snail's meat and tested for the presence of *Enterobacteriaceae* and *Staphylococcus aureus*. 1370 samples were analyzed. For the analysis is used the finished selective substrate of the 3M manufacturer, and after the incubation was done, colonies were counted according to the standard method. Measures have been undertaken in order that improving hand hygiene of workers and to prevent cross-contamination of finished meat products (setting disinfection barrier through which is not possible passage without the prescribed time hand disinfection, control of hands before entering the processing plant snail meat for the presence of possible wound as a possible source of *Staphylococcus aureus*, wearing of gloves and employee training programs in the field of hand hygiene). The efficiency of preventive measures is determined by the analysis of swabs from the hands of workers and work surfaces before deployment and after the implementation of certain preventive measures.

The number of positive findings prior to the implementation of preventive measures was 7.60% of the total number of analyzes carried out and after the implemented preventive measures 2.28%.

The results of the study showed that *Staphylococcus aureus* was the cause of food handlers hand contamination in most cases. Analysis of *Enterobacteriaceae* in a sample swab is a good indicator of the efficiency of the washing and disinfection of the workers.

Key words: Hand hygiene, Food safety, Food handlers, Bacteria.

1. Introduction

Adequate hygiene of the food handlers' hands is one of the most important preventive measures in ensuring food safety. There is a special importance of hand hygiene in cases when preparation of food is consumed without subsequent thermal treatment prior to use.

Human skin is the habitat of numerous microorganisms. Most of them are harmless, only a small number are pathogenic bacteria, and between these two extremes there are a significant number of permanently present bacteria relatively harmless, which in certain conditions can cause infections. These are the so-called conditionally pathogenic microorganisms (Tofant, [1]).

Legislation in Bosnia and Herzegovina prescribes the limit value for the number of colonies of bacteria from the *Enterobacteriaceae* family when it comes to the microbiological purity of the workers hands who handle food (Food Agency of Bosnia and Herzegovina, [2]).

In addition to the bacteria from the *Enterobacteriaceae* family, the bacterium of the genus *Staphylococcus aureus* is a significant factor in the overall hands hygiene.

Staphylococcus aureus are present in the nasal passages and throats, and on the hair and skin of 50% or more of healthy individuals. The incidence is even higher among those who associate with sick people and hospital environments. Contamination may be introduced into foods by direct contact with workers with hand or arm lesions caused by *Staphylococcus aureus*, or by coughing and sneezing, which is common during respiratory infections. Food handlers are frequently the source of food contamination in staphylococcal outbreaks; however, equipment and environmental surfaces also can be sources (FDA, [3]).

Hand washing is a fundamental precautionary measure which is a protection against the spread of disease and is one of the primary practices to reduce the transfer of bacteria, whether from person to person, or from person to food contact surfaces. Furthermore, it was established that a food workers unwashed hands can

transmit pathogens, especially fecal pathogens, to food products after a visit of a toilet (Lambrechts *et al.*, [4]). Hand washing during food production and consumption is one of the most important ways to prevent the transmission of harmful pathogenic microorganisms (Conover and Gibson [5]), and help in prevention of the infectious diseases spreading (Sickbert-Bennett *et al.*, [6]). It represents a key step in the prevention of disease. Factors that enable monitoring of hand washing efficiency are not always understandable. In practice, various methods are used to estimate these factors.

Hand washing is one of the FDA's recommended prevention methods, for it can significantly reduce transmission of pathogens from hands to food and other objects. The Food Code indicates that proper hand washing should take at least 20 seconds and include: running warm water, soap, friction between the hands for 10 to 15 seconds, rinsing, and drying with clean towels or hot air (Green *et al.*, [7]).

The primary contamination of snail meat processed by the process of cooking and freezing certainly comes from raw materials, that is, the snails themselves and the environment in which they live and grow. In the second place are sources of contamination, such as the hands of workers handling manure with snails and equipment and the tool used in the product process (Temelli *et al.*, [8]). This paper presents an examination of the efficiency of hand hygiene maintenance of workers working in the meat processing plant for snails. The test relates to workers who are engaged in the final meat processing and packaging. The effectiveness of hand hygiene maintenance is monitored by determining the presence of *Staphylococcus aureus* and *Enterobacteriaceae*.

2. Materials and Methods

Monitoring of the effectiveness of hand hygiene was carried out at the processing plant for snail meat (*Helix pomatia*, *Helix lucorum*), in the part of the process where the final processing treatment of snails meat is performed. The key stages in the technological process in this part of the plant relate to: storing frozen snails meat, cooking of snail's meat with a mixture of spices, cooling meat, packing cooked meat into snails shell, packing and deep freezing of packaged snails shell with meat.

As an indicator of the hand hygiene effectiveness, swabs were taken from the hands of workers who

manipulate the snail's meat, and we determined the number of *Staphylococcus aureus* and *Enterobacteriaceae* colonies. The results presented in this paper refer to the percentage of defective samples compared to the total number of samples taken.

For the determination of these bacterial colonies, prepared substrates were used: 3M Petrifilm Staph Express Count Plate, and 3M Petrifilm *Enterobacteriaceae* Count Plate, (3M, USA). Principles of count *Enterobacteriaceae* on a Petrifilm is based that red indicator dye in the plate colors all colonies and the top film traps gas if it is produced by the bacteria. The acid producing bacteria are seen as red colonies surrounded by a yellow zone associated with acid production by the pH indicator in the medium. *Enterobacteriaceae* colonies have the following characteristic on Petrifilm *Enterobacteriaceae* count plate: *Enterobacteriaceae* can produce colonies which are associated with gas bubbles only; *Enterobacteriaceae* can also produce red colonies with acid zones only or *Enterobacteriaceae* produce red colonies which are associated with an acid zone and gas bubbles. The count of colonies on the Petrifilm *Enterobacteriaceae* substrate according to the manufacturer's recommendation was made for the number of colonies at maximum 100. If the number of colonies is very large, such results are expressed as too numerous to count (TNTC) (3M [9]).

Determination *Staphylococcus aureus* was done on 3M Petrifilm Staph Express Count Plate, producer 3M, USA, that is a sample-ready culture medium system which contains a cold-water-soluble gelling agent. The chromogenic, modified Baird-Parker medium in the plate is selective and differential for *Staphylococcus aureus*. Red-violet colonies on the plate are *Staphylococcus aureus*. For identification *Staphylococcus aureus* is used Staph Express Disk whenever colonies other than red-violet are present on the plate. Staph Express Disk contains a dye and deoxyribonucleic acid (DNA). *Staphylococcus aureus* produces deoxyribonuclease and they reacts with the dye to form pink zones. When the disk is inserted into the plate, *Staphylococcus aureus* produce a pink zone. The count of colonies on the Petrifilm Staph Express Count Plate substrate according to the manufacturer's recommendation was made for the number of colonies at maximum 150. If the number of colonies is very large, such results are expressed as too numerous to count (TNTC) (3M [10]).

The internal acceptability criteria for the presence of bacteria on the hands of workers are established and shown in Table 1.

Table 1. Internal acceptance microbiological cleaning criteria for hands of food handlers

Bacteria	Criteria		
	Satisfactory	Acceptable	Not acceptable
<i>Staphylococcus aureus</i>	n = 0	/	n ≥ 1
<i>Enterobacteriaceae</i> (after hand washing and disinfection)	n = 0	/	n ≥ 1
<i>Enterobacteriaceae</i> (on hands during work)	n ≤ 10	10 < n < 30	n ≥ 30

3. Results and Discussion

Testing the effectiveness of hand hygiene in the snails processing plant was done for a period of four years, from 2014 to 2017. The testing included employees working in the final processing of snails meat. The number of workers who are worked in the final processing of snails meat in years when the testing varied, depending on the volume of snails processed, and ranged from 80 to 120 workers. Operations carried out in the final processing of snails meat relate to the: cooking of frozen meat of snails with various spices, cooling the snails meat, manual packing of snail meat into prepared snails shell, deep freezing of snails shell with meat and storage of deep-frozen snails shell with meat.

Surely the most critical operation in this process is the manual packing of thermally processed snails meat into the snails shell from the aspect of microbiological contamination and the entire work is done manually with the participation of a large number of workers.

Based on the displayed number of unsatisfactory results in certain years when the test was performed, as can be seen from Table 2, it is noticeable that the increased number of unsatisfactory results is determined in 2014 and 2015. If we look at the period from 2014 to 2015, the average number of unsatisfactory results is 7.60%.

In the observed period, the highest number of unsatisfactory results were because of determined presence of *Staphylococcus aureus*.

Of the total number of analyzes carried out on *Staphylococcus aureus* in 2014 and 2015, the number of unsatisfactory results was 9.64%, which is shown in Table 3. Also it's evident that biggest percentage of unsatisfactory results in determining *Staphylococcus aureus* was in 2014 and it was 10.63% as it is shown in Table 3.

In the same period (2014 - 2015), the number of unsatisfactory results for the examination of *Enterobacteriaceae* after washing and hand disinfection amounted to 5.77% of the total number of analyzes, as shown in Table 4, and the number of unsatisfactory results of the examination of *Enterobacteriaceae* on the hands of workers during work was 3.88% of the total number of analyzes carried out, as shown in Table 5.

Although it has been established that food handlers understand the importance of hand washing, the question arises as to why they are not consistently complying with this obligation, or why the results of the examination of the swabs from the worker's hand are unsatisfactory. Some researchers listed as the most significant barriers to the right and efficient conduct of hand washing: availability of detergent and other hand washing materials, availability of sinks, lack of time to wash hands between tasks, high volume of work, stress, lack of accountability, insufficient and inadequate training on the significance of safe food handling (Pragle *et al.*, [11]).

Table 2. Number of hand swab analysis per year in snail's meat processing facilities

Year	Total number of hand swab testing	Number of satisfactory results	Number of unsatisfactory results	% of unsatisfactory results
2014	326	301	25	7.67 %
2015	213	197	16	7.51 %
2016	352	342	10	2.84 %
2017	479	470	9	1.88 %
Total	1370	1310	60	4.38 %

Table 3. Results of hand swab analysis of *Staphylococcus aureus* in snail's meat processing facilities

Year	Total number of hand swab testing <i>Staphylococcus aureus</i>	Number of satisfactory results	Number of unsatisfactory results	% of unsatisfactory results
2014	160	143	17	10.63 %
2015	120	110	10	8.33 %
2016	180	173	7	3.88 %
2017	255	248	7	2.75 %
Total	715	674	41	6.08 %

Table 4. Results of hand swab analysis of *Enterobacteriaceae* on clean and disinfected hands in snail's meat processing facilities

Year	Total number of hand swab testing <i>Enterobacteriaceae</i> on clean and disinfected hands	Number of satisfactory results	Number of unsatisfactory results	% of unsatisfactory results
2014	90	85	5	5.56 %
2015	66	62	4	6.06 %
2016	106	105	1	0.94 %
2017	157	157	0	0.00 %
Total	419	409	10	2.39 %

Table 5. Results of hand swab analysis of *Enterobacteriaceae* on hands during work in snail's meat processing facilities

Year	Total number of hand swab testing <i>Enterobacteriaceae</i> on hands during work	Number of satisfactory results	Number of unsatisfactory results	% of unsatisfactory results
2014	76	73	3	3.95 %
2015	27	26	1	3.70 %
2016	66	64	2	3.03 %
2017	67	65	2	2.99 %
Total	236	228	8	3.39 %

Based on these results from 2014 and 2015, certain preventive measures were taken that included the following:

- Clear definition of hygiene rules and behavior rules for workers that are engaged with operations in final snails meat processing facilities.
- Defining rules for washing and hand disinfection.
- Ensuring efficient resources for washing and disinfecting of workers hands.
- Conducting regular training activities for workers engaged in final snails' meat processing operations to ensure a high level of hygiene.
- Introducing a new workplace hygiene controller in final snail's meat processing facilities.

The following basic rules of good hygiene practice have been defined to ensure effective hand hygiene:

- It was not allowed to carry jewelry on hands such as rings or watches because they prevent proper washing and hand disinfection.
- It was not allowed to wear artificial nails, as it creates the possibility of developing bacteria under artificial nails, and there is a danger of physical contamination, as nail can be broken and contamination of product can occur.
- The nails had to be properly cut and shaped according to the shape of the finger; they had to be not longer than the finger, as this creates the possibility of accumulating dirt and the development of bacteria.
- Nail cuts had to be properly performed to avoid creating hangnails that represent ideal growth sites for *Staphylococcus aureus*.
- Workers who had open hand injuries were not allowed to work in the facility for final processing of snails meat.
- In the event of symptoms in workers such as: vomiting, elevated temperatures, diarrhea, skin rash, skin diseases, leakage from the nose or ears, such workers were not allowed to work in the final snails processing facilities.
- All workers who had hangnails or similar small wounds on their hands had to wear gloves while working in direct contact with snail's meat. Gloves were changed after each re-entry, and in case of drowsiness the replacement is done during operation.

Procedures of washing and hand disinfection were clearly defined. The obligation of washing and disinfection hands was defined as follows:

- Before coming to work place or before starting work.
- Before and after use of the toilet and rooms for workers break.
- After coughing.
- Before and after meals.
- After removal of protective gloves.
- During work and especially after changing a certain batch of product with which it is working.
- After touching mouth, nose or ear.
- After contact with washing and disinfecting agents.
- After contact with waste material.

The necessary resources were needed for hygienic washing and hand disinfection, which includes:

- Supply with hot water that is microbiologically correct, in sufficient quantity and with adequate temperature.
- Ensuring the contactless hand-washing equipment as shown in Figure 1.
- Ensuring a sufficient number of faucets in relation to the number of engaged workers in the final snail's meat processing facilities (maximum 10 workers on 1 faucet).
- Ensuring liquid soap disinfectant so that washing and hand disinfection can be adequately carried out.
- Disposable paper towels for dry of hands.
- Waste bins for collecting paper towels.



Figure 1. Contactless equipment for hand washing in final snails meat processing facilities

Hand disinfection equipment was installed especially as automatic disinfecting equipment for both hands, equipped with light signals that give a signal when the disinfection is completed and let the worker enter the work space, as shown in Figure 2.

A new position in organization structure has been introduced, a hygiene controller, a person who is responsible for monitoring the procedure of hand washing and disinfection, the condition and adequacy of working clothes and footwear, and also performs an overview of the condition of the hand of workers working on manual packing of snails meat into the snails shell.

A defined training program for workers in the area of good hygiene practice has been established and its innovation is being continuously carried out in order to be adequate and it is periodically carried out testing of employees for the purpose of confirming effective training.



Figure 2. Hand disinfection station in final snails meat processing facilities

After the implementation of the mentioned preventive measures and the monitoring of the total number of unsatisfactory test results during 2016 and 2017, it is evident that the number of unsatisfactory results in these two years amounted to 2.28%, which is a significant decrease from the period 2014 to 2015 when it was 7.60%. There is a downward trend in the percentage of unsatisfactory results, because in 2017 it was 1.88% compared to 2016 when it was 2.84%.

From the obtained results, it is also evident that there has been a decrease in the percentage of unsatisfactory results in the presence of *Staphylococcus aureus* (Table 3), *Enterobacteriaceae* after washing and disinfection of the hands (Table 4) and *Enterobacteriaceae* on the hands during the work after implementation preventive measures mentioned above.

4. Conclusions

- From the results obtained in this study, it is evident that most of the cases of unsatisfactory results of workers' swabs are related to the presence of *Staphylococcus aureus*.

- Ensuring adequate preconditions leads to reduction of the risk for contamination of finished products with bacteria that are transmitted from workers' hands. There is a visible decrease in the number of unsatisfactory results of swabs testing of hands workers working for the final treatment of snails' meat in the presence of *Enterobacteriaceae* after implementation of preventive measures related to the provision of adequate resources for hands washing and disinfection.

- Training of workers in the field of hand hygiene, proper hand washing, proper behavior during work, and also proper food handling is very important. It is necessary that the company's management is working to raise the overall food safety culture in companies to avoid incidents of food-related illness or cases of withdrawal and recall of products.

- Company management in the food industry must use different ways to motivate and train employees in order to change their behavior and increase responsibility for the way and level of proper hand hygiene (Pellegrino *et al.*, [12]).

- It is clearly evident from the results of the study that the effectiveness of hand hygiene maintenance is at a significantly higher level when adequate resources like equipment is provided and when workers through training receive the required knowledge that is necessary. Certainly the awareness of workers in production has a great impact on the efficiency of all measures taken, and it is raised primarily by the clear commitment of the company's leadership in the production of health-care food.

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