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Brief of Preliminary Paper

Does sanitation best practice effectively minimize the risk of undeclared components in food products?

Elizaveta Kryuchenko[1,2], Zoya Yurchak[1], Darya Gustova[1], Irina Chernukha[1] and Oksana Kuznecova[1]*

[1] V.M. Gorbatov Federal Research Center for Food Systems, 109316, Moscow, Russia
[2] RUDN University, Agrarian and Technological Institute, 117198, Moscow, Russia

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ABSTRACT

In modern food production, food safety is one of the most important aspects that must be taken into consideration at all stages. Sanitization at food industry enterprises is a key procedure for the production of high-quality and safe food products. Successful implementation of this procedure protects the food products from any pollution and from the contamination with the undeclared components, which helps to increase the stability of the food product and increase its shelf life. This paper presents the results of a study to determine undeclared components in swabs taken from the equipment of a meat processing plant certified for compliance with the requirements of the FSSC 22000 certification scheme, after cleaning and disinfection.

1. Introduction

Currently, one of the most acute issues of quality and safety management in the food industry of the Russian Federation is the issue of food product falsification, which among other things, is caused by the detection of undeclared components (TR CU 022/2011). The current *Technical Regulations of the Customs Union* (2011a) "Food Products in Terms of Their Labelling" and *Technical Regulations of the Customs Union* (2011b) "On the Safety of Food Products" do not set up maximum permissible levels (MPLs) for undeclared components in finished food products. Thus, any detected amount of an undeclared component can be interpreted as a violation of the requirements of the relevant technical regulations, and the food product can be stipulated as non-compliant or falsified. As a result, when conducting research on food products, if regulatory authorities and public organizations detect, for example, insignificant amounts of DNA of various types of meat not declared in the composition on the food label, or genetically modified organisms (GMOs) in corn, they can transmit information to the mass media about the finding of compositional discrepancies without further analysis of the reasons, which causes heavy economic and reputational damage to the industry (*Kryuchenko & Kuzlyakina*, 2021). In addition, data on such studies are published spontaneously and unsystematically, which does not allow society to draw a general conclusion about the real situation (*Kuzlyakina et al*., 2023).

For example, starch, meat and some other ingredients can get into food products by accident, since traces of their DNA can be only completely removed

***Corresponding author:** Elizaveta Kryuchenko, *l.kryuchenko@fncps.ru*

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from equipment with hydrochloric acid. Regulatory authorities consider even a tiny share of another type of meat DNA in meat products to be a violation (*Minaev*, 2017). The presence of undeclared ingredients can be unintentional and related to the inclusion of residues from a previous batch of food products processed on the same line, but with proper sanitary and hygienic practices, those risks are reduced to a minimum (*Jackson et al*., 2008).

The aim of this study was to investigate the efficiency of sanitization aimed to minimize the risk of undeclared components occurring in the food products. Over six months in 2024, experts from the V.M. Gorbatov Federal Research Center for Food Systems of the Russian Academy of Sciences analyzed the swabs from the various facilities of a meat processing plant certified for compliance with the FSSC 22000 certification scheme in order to find the residual availability of recipe components after the washing of equipment. This plant has implemented best practices for cleaning and disinfection.

2. Materials and methods

The objects of the study were swabs from equipment, auxiliary inventory, and clothing of the personnel of a meat processing plant certified according to FSCC 22000 in order to find the residual presence of components of the recipe of sausages produced in the plant. Three swabs were collected from 20 control points. In total, 60 swabs from different objects were examined.

To understand the probable spots of the food product cross-contamination with undeclared components, it is important to note that some allergenic components specified in TR CU 022/2011 are ingredients in the plant's food product recipes. For example, mustard is included in the list of ingredients of the frankfurters "Adzharian frankfurter with spicy herbs for frying", milk is added into the frankfurters "Milky" and into frankfurters "Creamy". In addition, some complex food additives included in the sausage recipes contain mustard, soy, peanuts, or gluten, but these are not directly listed as recipe ingredients of those sausages.

Swabs from equipment, auxiliary tools, clothing of the personnel were collected in accordance with the swab sampling plan for control of undeclared components.

2.1 Methods of study

The content of gluten, soy, peanuts, and mustard in the swabs was defined by:

a) PCR method;

b) ELISA (AgraQuant® Gluten test kit from Romer Labs) according to the test kit manual.

All laboratory analyses were conducted strictly according to the rules of averaged samples, so each sample was tested three times to facilitate calculation of the average value. The reliability of the obtained results was confirmed by threefold repetition of the experiments, as well as statistical processing of their results, carried out using Microsoft Excel 2019 and STATISTICA 10 software. The results of product studies were presented as mean ± SD, statistical significance was calculated using variance analysis (ANOVA) with the Tukey criterion. The probability of 0.05 was chosen as a significant level. The results of swab studies were presented as median ± SD and percentiles [P 25 - 75]. Statistical significance was calculated using the nonparametric Mann-Whitney U criterion. The probability of 0.1 was chosen as a significant level.

3. Results and discussion

Based on the conducted risk analysis, the swab sampling plan was developed, of which a representative part is shown below in Table 1.

The results of the study of swabs from the company's production line for the presence of DNA indicating soy, gluten, mustard, and peanut using the PCR method are presented in Figures 1 and 2.

Ct values for positive controls were 15.57 for gluten, 14.65 for mustard, and 13.24 for both peanut and soy. It is worth noting that both gluten and mustard DNA were found on the inner surface of the knackwurst stuffing hopper.

Since gluten and mustard DNA were found on the equipment used for food product manufacturing, and were also found in food products produced on the line (data not shown), we assume that cross-contamination of these products occurred because of the equipment. However, we cannot exclude the occurrence of the hazards via unintentional introduction of the undeclared components in the food additives included in the recipes of the above-mentioned food products.

The presence of gluten in the swabs taken from the manufacturing equipment was confirmed by us, including confirmation with the ELISA method. The results of detecting gluten in the swabs with the ELISA method are presented in Table 2 and Figure 4.

Table 1. Representative part of the swab sampling plan to detect undeclared components in cooked sausages.

Subdivision	Tested points – name of the object	Designated place for swabbing	Range of food products manufactured with the equipment
Department for mince stuffing and shaping	1. Unloading disc of the cutter for preparing minced meat for cooked sausages		Cooked sausages: “Veal” frankfurters “Milky” frankfurters “Creamy” knackwursts “Doctor” frankfurters
	2. Unloading disc of the cutter for preparing minced meat for cooked-smoked sausages		Cooked-smoked sausage “Cervelat”
	3. Scraper for cleaning the surfaces of the cutter for preparing minced meat for cooked sausages		Cooked sausages: “Veal” frankfurters “Milky” frankfurters “Creamy” knackwursts “Doctor” frankfurters
	4. Internal surface of the bin for minced meat in the frankfurter line of AL-system		Cooked sausages: “Milky” frankfurters “Creamy” knackwursts

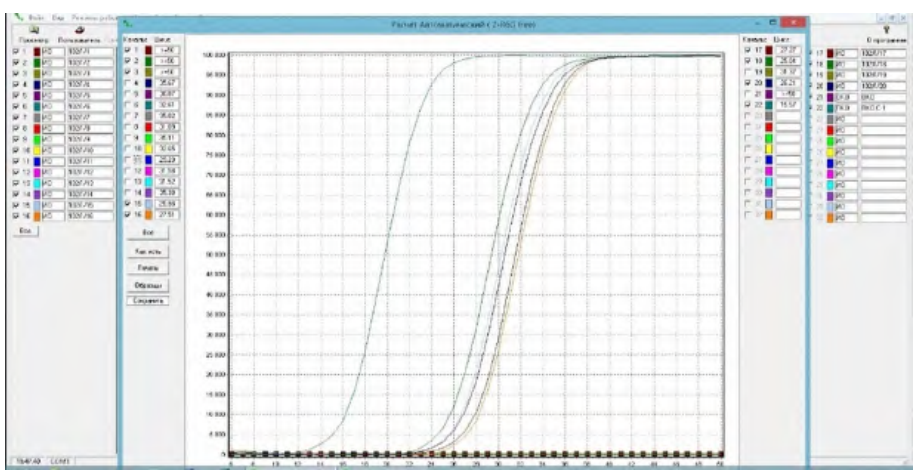

Figure 1. DNA amplification curves of the positive control and the swab samples that were positive. Gluten was regularly detected in the swabs from the inner surface of the horn of the AL-system frankfurter line (< 0.01%, Ct=39.35), the hopper for minced meat of the knackwurst forming stuffer (< 0.01%, Ct=30.12), the inner surface of the horn of the cooked-and-smoked sausage forming stuffer (< 0.01%, Ct=33.16), the inner surface of the horn of the cooked sausage forming stuffer (< 0.01%, Ct=33.14), the inner surface of the horn of the cooked sausage forming stuffer (< 0.01%, Ct=32.18).

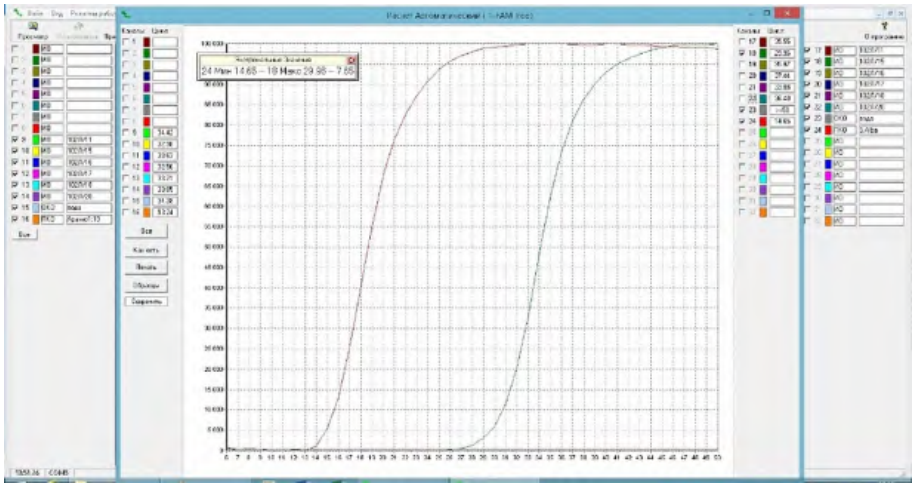

Figure 2. Typical DNA amplification curves of positive control and a swab samples that was positive. Mustard was regularly detected in the swabs taken from the inner surface of the knackwurst stuffing hopper (< 0.001%, Ct=37.18).

Table 2. Results of swab analysis to quantitatively detect the presence of gluten via the ELISA method.

Swab sample		Gluten content, ppm
1 Inner surface of the mince hopper in the knackwurst stuffer	Mean ± SD	9.565±1.074
	Median± SD	**9.697±1.074б***
	[P25 – P75]	[8.431 – 10.566]
2 Inner surface of the inner surface of the stuffer horn for shaping the cooked-and-smoked sausages	Mean ± SD	50.515±6.3981
	Median± SD	**48.474±6.3981**
	[P25 – P75]	[45.387–57.685]
3 Inner surface of the mince hopper for the stuffer for shaping the cooked sausages	Mean ± SD	177.689±121.608a
	Median± SD	**181.886±121.608**
	[P25 – P75]	[54.037–297.145]
4 Inner surface of the stuffer horn for shaping the cooked sausages	Mean ± SD	4.237±0.453 б*
	Median± SD	**4.366±0.453**
	[P25 – P75]	[3.734–4.612]
5 Inner surface of the horn in the sausage line of the AL-system	Mean ± SD	46.412±50.219
	Median± SD	**32.441±50.219**
	[P25 – P75]	[4.671–102.147]

Legend: a-b – significant difference between the sampling locations (ANOVA, Tukey, P<0.05), * – significant difference between columns (nonparametric test, Mann-Whitney U, P<0.1)

It is noteworthy that the gluten concentration varied significantly in different areas of the inner surface of horn on the AL-system sausage line, from which it can be concluded that residual quantities of the components were distributed unevenly along the equipment surface. Naturally, this undoubtedly complicates the process of managing the undeclared components, since an uncontrolled yet high concentration of an undeclared component could show up in one piece of the food product only.

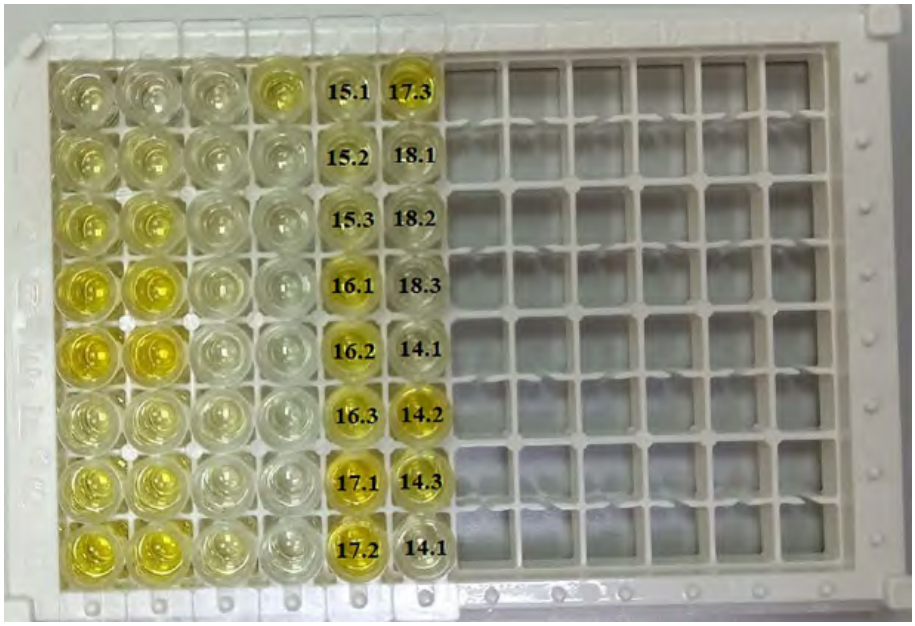

Figure 4. Representative ELISA detection of the presence of gluten in swabs taken from the of AL-system sausage production line. Gluten was regularly detected in the swabs taken from the inner surface of the stuffer horn on the sausage line, the mince hopper of the stuffer for sausage shaping, the inner surface of the stuffer horn for shaping the cooked-and-smoked sausages, the inner surface of the mince hopper of the stuffer for shaping the cooked sausages, and the inner surface of the stuffer horn for shaping cooked sausages.

4. Conclusion

This study shows that the implementation of food safety management systems—including those in accordance with the requirements of the FSSC 22000 certification scheme, which provides for extended and more complex requirements—cannot be considered as efficient methods for reducing or even eliminating the residual amounts of undeclared components from the surface of equipment and auxiliary tools. In this regard, it is necessary to develop and introduce more advanced practices targeted at eliminating the very risk of cross-contamination of the food product with undeclared ingredients after cleaning. This is especially important given that a number of components are allergens, even a minor amount of which can be harmful to a consumer's health.

In conclusion, it should be noted that cleaning of the process equipment is one of the most important stages in food production, and must be done regularly and thoroughly. Each processing method features its own advantages and disadvantages, so it is necessary to choose a method depending on the specific type of the particular equipment.

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Authors info

Elizaveta Kryuchenko, https://orcid.org/0000-0002-5805-3055
Zoya Yurchak /
Darya Gustova, https://orcid.org/0000-0002-0881-3861
Irina Chernukha, https://orcid.org/0000-0003-4298-0927
Oksana Kuznecova, https://orcid.org/0000-0002-7474-485X