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EVALUATING OF SPICES SUPPLIERS FOR MEAT PRODUCTION PLANTS[®]

Ocena dostawców przypraw do zakładów przetwórstwa mięsnego[®]

Key words: meat plants, spices supplier, suppliers evaluation.

The aim of the study presented in the article was to verify whether the suppliers of spices for the production of meat products meet all food safety requirements. For this purpose, 10 audits of spice suppliers were carried out using the audit method with a plant-specific questions checklist. It was found that monitoring the quality management system of suppliers allows for their good control and obtaining the appropriate quality, safe raw material for production. Based on the conducted audits, it was found that the suppliers of spices provide the meat plant with a safe products, produced in appropriate conditions and with full control of the production process. The research carried out in functioning meat plants is presented which have big implication importance to the theory and practice as well as for future studies.

Słowa kluczowe: zakłady mięsne, dostawcy przypraw, ocena dostawców.

Celem badań przedstawionych w artykule było sprawdzenie czy dostawcy przypraw do produkcji wyrobów mięsnych przestrzegają wszystkich wymogów bezpieczeństwa żywności. W tym celu przeprowadzono 10 audytów u dostawców przypraw, wykorzystując metodę audytu z opracowaną do specyfiki zakładu listą kontrolną pytań. Stwierdzono, że monitorowanie systemu zarządzania jakością dostawców pozwala na ich dobrą kontrolę i uzyskanie właściwej jakości, bezpiecznego surowca do produkcji. Na podstawie przeprowadzonych audytów stwierdzono, że dostawcy przypraw dostarczają do zakładu mięsnego produkty bezpieczne, wytworzone w odpowiednich warunkach i przy pełnej kontroli procesu produkcyjnego.

Przedstawione badania przeprowadzone w funkcjonujących zakładach mięsnych mają duże znaczenie dla teorii i praktyki oraz przyszłych badań.

INTRODUCTION

Despite the many beneficial properties of spices, they can pose a threat to human health. Spices as a product of agricultural practice can carry high numbers of microorganisms as well as mycotoxins. Microorganisms detected in herbs and spices have the potential to cause human illnesses. Among the most important microorganisms are *Bacillus cereus*, *Clostridium perfringens*, *Escherichia coli*, *Salmonella* spp., *Listeria*

monocytogenes, *Staphylococcus aureus* and bacilli of the family *Enterobacteriaceae* [5,10,11,15,30,32,36]. The most common fungi detected in spices are *Fusarium*, *Rhizopus*, *Penicillium*, *Aspergillus* (e.g. *Aspergillus* spp.), and bacteria of the genus *Bacillus* [25], and *Cronobacter* species bacteria [15].

The degree of contamination of spices depends on factors such as: growing, harvesting, storage and transport conditions.

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Based on research results, it is known that contaminated spices have been the causes of certain food-borne illnesses and food spoilage [2]. Poor quality of spices causes a variety of food hazards, including pathogens, chemical contaminants, and pests [1, 33, 38, 50, 51].

Prevention of microbial contamination in dried herbs and spices lies in the application of good hygiene practices during production cycle i.e. growing, harvesting and processing from farm to fork, and effective decontamination [35]. Effective control and knowledge about the methods of quality assurance at the producers and suppliers of spices and about the quality management systems used by them is a prerequisite for the use of spices in the food sector [31]. Spice producers have to ensure food safety [34], and also have certified quality management systems such as ISO 9001, ISO 22000, BRC, IFS. Whereas, the recipients of spices, e.g. meat plants, monitor the quality of the spices supplied, and the quality management systems used in their production. Supplier monitoring is a requirement of the standards they have implemented [7, 17, 19, 20]. Various

methods of supplier evaluation are described in the literature, and the most frequently used method is audit [21, 46, 52].

The aim of the study was to verify whether the suppliers of spices for the production of meat products meet all food safety requirements.

MATERIAL AND METHODS

The study examined the results of audits carried out in 2021 by one of the largest meat processing plants in Poland. The audit methodology was based on the guidelines given in ISO 19011 [18] and the plant's own internal audit procedure. The research is a continuation of the evaluation of spice suppliers in terms of the assessment of compliance with food safety requirements in the years 2007–2019 [22].

The analysis of the monitoring results showed that not all requirements were fully met. In the previous research, a forecast was calculated that indicated that all the requirements of supplied spices would be met in 2021. The authors

Table 1. Checklist of spices suppliers audit

Tabela 1. Lista kontrolna audytu dostawców przypraw

No.	Question	Abbreviation	Score (1-4)
1	Is a qualifying questionnaire employed and is the information so obtained verified and monitored?	Supplier assessment	
2	Is there an established organisational policy and a process of continuous improvement?	Organisational policy	
3	Are the (GMP, GHP, HACCP) principles understood, and are the relevant procedures, internal audits, training programmes established, implemented and functioned?	HACCP	
4	Is monitoring of raw material purchasing (quality, delivery, origin) taking place?	Purchasing	
5	Is the specification of products (ingredients, recipe, packaging) checked and controlled?	Specification of products	
6	Is product design and development taking place and does this result in product and process modification?	Product design and development	
7	Is the release of the products is carried out properly?	Product release	
8	Are proper procedures in place to ensure traceability, particularly of allergens and GMO?	Traceability	
9	Are corrective actions and correction undertaken; occurrences of non-compliance managed and non-compliant products processed?	Corrective actions	
10	Is the location and immediate environment of the plant appropriate?	Location	
11	Is the layout of the plant, and workflow appropriate?	Plant layout	
12	Is the equipment in production and storage areas kept in a good state?	Equipment	
13	Are measuring and monitoring devices maintained, repaired, calibrated and controlled?	Monitoring devices	
14	Are utilities (water, ice, air, gases, and other services) professionally procured and controlled?	Utilities	
15	Is equipment for personnel hygiene provided and are suitable social facilities available?	Personnel hygiene facilities	
16	Are appropriate hygiene practices, medical examinations, procedures for infectious diseases and work injuries in place?	Personnel hygiene procedures	
17	Is protective clothing for the use of personnel and visitors available and appropriate?	Protective clothing	
18	Is hygiene maintained in the plant and immediate surroundings; are appropriate processes in place for washing, disinfection, waste management, and pest control?	Plant hygiene	
19	Is the production process properly carried out, and are all the necessary parameters monitored and controlled?	Production	
20	Are supplies properly stored with rotation and control of stock?	Storage	
21	Is shipment and transport properly organised and controlled; is product delivery properly supervised?	Shipment and transport	
22	Is adequate control of the product during processing and after completion properly undertaken?	Product control	
23	Are allergens under supervision?	Managing allergens	
24	Is monitoring and control of foreign body contamination in place?	Foreign body contamination	
25	Is plant access controlled and are suitable supervision and monitoring procedures implemented?	Food defence	

Source: [22]

Źródło: [22]

of this study set themselves the goal of verifying whether the forecast has come true. For this purpose, two years after the previous research, ten audits of spice suppliers were carried out in 2021. The same methodology was used in this study. The audits were carried out based on a checklist with 25 audit questions (Table 1). All audits were performed by the same auditor as in the previous work, i.e. the first author of the paper.

Each requirement was assessed a score of four, three, two, one, or zero points depending on the degree of the supplier's compliance with the requirements, according to the following rules: 4 points – full compliance, 3 points – one minor noncompliance, 2 points – two minor non-compliance, 1 point – three minor non-compliances, 0 points – more than three minor non-compliances or one major non-compliance. The points obtained influenced the audit result. The total number of points that could be scored was 100 [22].

DATA ANALYSIS

Descriptive statistics were used to characterize the obtained results, i.e. mean, median, minimum, maximum and standard deviation. To compare the results of the audits from 2021 and 2019, the student's T-test was calculated [26]. The calculations were performed using Statistica 13.3 software (StatSoft, Inc., Krakow, Poland). Significance was identified when $p \leq 0.05$.

A forecast to when the spice suppliers achieve 100% compliance was calculated using the third order polynomial [41]. The probability of meeting the forecast was determined by the coefficient of determination R^2 . The coefficient of determination R^2 was calculated using Excel Microsoft Office Professional v.2016 in order to predict the year in which full compliance with food quality and food safety standards will be achieved.

RESULTS

As a result of audits carried out in 2021, it was found that the average score was 97.7 points (97.70% compliance with requirements). This result was significantly higher than the average number of points obtained in the previous study in 2019, i.e. 95.40% (Table 2).

Table 2. Comparison of the average results of spice producers' audits (2019 and 2021)

Tabela 2. Porównanie średnich wyników audytów u producentów przypraw (rok 2019 i 2021)

Year	2019	2021	T-student p value
Average audit result	95.40	97.70	0.020
Degree of compliance with the requirements	95.40%	97.70%	–

Source: Own study

Źródło: Badania własne

In 2021, the implementation of 17 out of 25 audit questions received the highest score, i.e. 4.0 (median 4.0) (Table 3). The rating of 4 was the maximum rating for the audit question. Regarding the answers to the remaining 8 questions, full compliance with requirements was not achieved and they

were scored slightly lower, i.e. 3.40 – 3.80 (Table 3). The lowest average score was obtained for the equipment (mean = 3.40, median 3.00, question 12) and plant hygiene (mean = 3.60, median 4.00, question 18). The lowest minimum rating was 2.0 and it was awarded for answers regarding monitoring devices (question 13) and plant hygiene (question 18). The results of answers to these audit questions had the highest SD values, which proves the greatest diversification of the degree of their fulfillment in the audited plants.

Table 3. Audit assessment results for spice suppliers in 2021

Tabela 3. Wyniki oceny pytań audytowych u dostawców przypraw w roku 2021

No	Audit question	Mean \pm SD	Median	Min.	Max.
1.	Supplier assessment	4.00 \pm 0.00	4.00	4.00	4.00
2.	Organisational policy	4.00 \pm 0.00	4.00	4.00	4.00
3.	HACCP	4.00 \pm 0.00	4.00	4.00	4.00
4.	Purchasing	4.00 \pm 0.00	4.00	4.00	4.00
5.	Specification of products	4.00 \pm 0.00	4.00	4.00	4.00
6.	Product design and development	4.00 \pm 0.00	4.00	4.00	4.00
7.	Product release	4.00 \pm 0.00	4.00	4.00	4.00
8.	Traceability	4.00 \pm 0.00	4.00	4.00	4.00
9.	Corrective actions	4.00 \pm 0.00	4.00	4.00	4.00
10.	Location	3.80 \pm 0.42	4.00	3.00	4.00
11.	Plant layout	4.00 \pm 0.00	4.00	4.00	4.00
12.	Equipment	3.40 \pm 0.52	3.00	3.00	4.00
13.	Monitoring devices	3.70 \pm 0.67	4.00	2.00	4.00
14.	Utilities	4.00 \pm 0.00	4.00	4.00	4.00
15.	Personnel hygiene facilities	3.70 \pm 0.48	4.00	3.00	4.00
16.	Personnel hygiene procedures	4.00 \pm 0.00	4.00	4.00	4.00
17.	Protective clothing	3.80 \pm 0.42	4.00	3.00	4.00
18.	Plant hygiene	3.60 \pm 0.70	4.00	2.00	4.00
19.	Production	4.00 \pm 0.00	4.00	4.00	4.00
20.	Storage	4.00 \pm 0.00	4.00	4.00	4.00
21.	Shipment and transport	3.90 \pm 0.32	4.00	3.00	4.00
22.	Product control	4.00 \pm 0.00	4.00	4.00	4.00
23.	Managing allergens	4.00 \pm 0.00	4.00	4.00	4.00
24.	Foreign body contamination	3.80 \pm 0.42	4.00	3.00	4.00
25.	Food defence	4.00 \pm 0.00	4.00	4.00	4.00

Source: Own study

Źródło: Badania własne

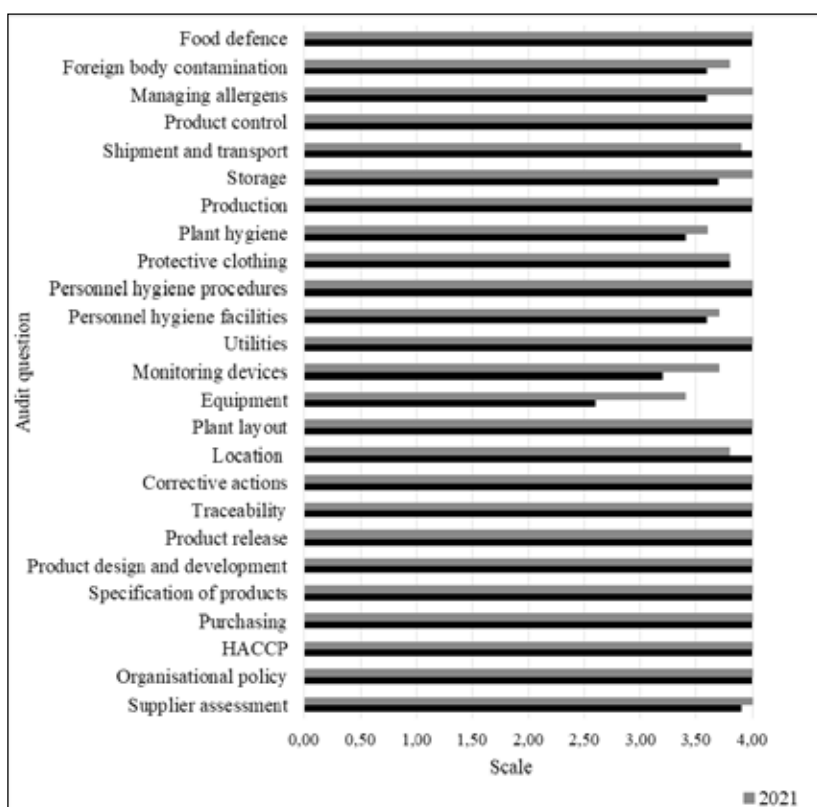


Fig. 1. Comparison of compliance with audit requirements at spice producers (2019 and 2021).

Rys. 1. Porównanie spełnienia wymagań audytowych u producentów przypraw (rok 2019 i 2021).

Source: Own study

Źródło: Badania własne

Differences and similarities in the implementation of audit requirements between 2019 and 2021 were shown (Fig. 1). In 2021, the implementation of 17 out of 25 audit questions received the highest average score (4.0), which represents 100% compliance with the requirements, while in 2019 it concerned 16 questions.

In the case of 8 audit questions, a significant improvement in compliance with audit requirements was found. They were: Q1 – Supplier assessment (T – student p value, $p = 0.330$), Q12 – Equipment ($p = 0.159$), Q13 – Monitoring devices ($p = 0.216$), Q15 – Personnel hygiene facilities ($p = 0.660$), Q18 – Plant hygiene ($p = 0.323$), Q20 – Storage ($p = 0.176$), Q23 – Managing allergens ($p = 0.330$), Q24 – Foreign body contamination ($p = 0.355$). At the same time, in the case of two requirements, a slight and statistically insignificant deterioration of the implementation of the requirements was observed. These were requirements such as Location (Q10) and Shipment and transport (Q21).

The study verified the forecast of compliance with all requirements in 2021, calculated based on the results of audits carried out in 2007–2019 [22]. Audits carried out in 2021 revealed non-compliance with audit requirements that were not fully complied with, as predicted in the previous study. Therefore, the forecast of compliance with

all requirements was re-calculated, supplementing the previous data with the results of audits from 2021 (Fig. 2). According to the forecast, spice suppliers will achieve the expected maximum points in 2024. The probability of meeting the forecast is at the level of approximately 57% ($R^2 = 0.5722$).

DISCUSSION

As the researchers [3, 4], point out, the selection of suppliers is a multi-criteria decision problem in which criteria have different relative importance, and in practice, many input information is not exactly known. Therefore, despite the selection of suppliers, it is important to further improve the supplier evaluation system to better manage costs, quality, and service, including delivery time performance and after sales performance of the supply chain. Many authors [8, 12, 16, 23, 29] propose complicated models of supporting the decision-making process for various types of producers. In this paper, we propose, based on the experience of meat plants, supplier assessment audits, which can be easily modified when situations changed in the food market, e.g. during a pandemic.

The use of audits made it possible to assess the application of the requirements of quality management systems by suppliers of spices to meat industry plants. This method was the most frequently chosen method of supplier evaluation declared by 85% of meat industry companies [21].

The popularity of the audit is due to the fact that it can be used to evaluate many processes, such as: customer service, research and development, processes, product quality, quality system management, packaging, shipping, etc. [43]. During audits, attention is also paid to the documents used and the safety of work places [46]. The quality of the raw materials supplied to the meat industry is very important for the safety of meat products and therefore was often used in the evaluation of suppliers [37, 39].

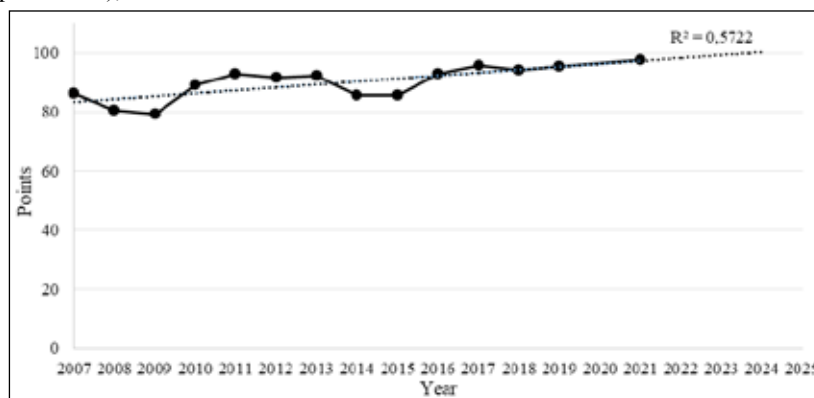


Fig. 2. Forecast of compliance with the audit requirements by spice producers.

Rys. 2. Prognoza spełnienia wymagań audytowych przez producentów przypraw.

Source: Own study

Źródło: Badania własne

Supplier's activities monitoring is a requirement of management systems and is essential to the quality of meat products. If non-compliances are identified during supplier audits, the results may indicate needed areas of improvement for suppliers. The audits carried out revealed non-compliances that were already indicated in the literature on the subject, such as plant hygiene, staff hygiene, foreign body contamination, allergen management and plant equipment [6, 14, 24, 26, 42, 44, 48,].

There has been a significant improvement in fulfilling the requirements of food safety management systems compared to previous studies [22], although the calculated forecast for 2021 has not been met. The reasons can be found in the pandemic SARS-CoV-19, which changed the situation on the food market, limited the frequency of internal audits, the employment of specialists, and made it necessary to deal with various economic and financial problems [13, 27]. The implementation of the forecast has been postponed by 3 years until 2024. It is worth emphasizing that the obtained average number of points 97.70 out of 100 possible to be scored turned out to be very satisfactory. Therefore, despite the failure to meet the previously calculated forecast, it is necessary to positively emphasize the activities of spice producers to improve the functioning of food safety management systems in their plants. Efforts of spices suppliers regarding the areas indicated in previous studies as sources of non-compliance deserve a positive emphasis. For example, many non-compliances were identified in traceability operations, HACCP, product release, corrective action, product specification, plant layout [9, 28, 40, 41, 45, 47, 49]. In the current research, they have been assessed as maximum points.

The presented study has some limitations. They concern the conduct of audits among suppliers of one large meat processing plant in Poland. Suppliers of other or smaller plants, as well as in other countries may meet the food safety requirements at different levels.

CONCLUSIONS

The authors want draw attention to monitoring of suppliers quality management system. It is important to guarantee the appropriate quality of raw materials and semi-finished products used in the production, in the discussed case of the production of meat and its products. These are the key elements to obtain high-quality and food safety industry products.

Supplier evaluation by means of an audit has proved to be a useful tool for assessing compliance with the requirements of quality and food safety management systems in the supervision of spice suppliers. In 2021, there was a significant improvement in the audit compliance with the producer's requirements compared to the previous research conducted among spice suppliers in 2019. However, the calculated forecast of meeting all, i.e. 100%, requirements of the food quality and safety management system has not been met. The forecast calculated in previous studies was to come true in 2021. Most likely, the forecast was not fulfilled due to the SARS-CoV-2 pandemic, and the new calculations point to 2024. However, the significant improvement in the implementation of audit requirements and the achieved result are fully satisfactory. Spice suppliers can be considered to deliver a safe product to the meat processing plant, produced under appropriate conditions and with full control of the production process.

WNIOSKI

Autorzy publikacji chcą zwrócić uwagę na monitorowanie systemu zarządzania jakością dostawców. Istotne jest, aby zagwarantować odpowiednią jakość surowców oraz półproduktów wykorzystywanych w produkcji, w omawianym przypadku, produkcji mięsa i jego przetworów. Są to kluczowe elementy do uzyskania wysokiej jakości i bezpieczeństwa produktów przemysłu spożywczego.

Ocena dostawców za pomocą audytu okazała się użytecznym narzędziem do oceny spełnienia wymagań systemów zarządzania jakością i bezpieczeństwem żywności w zakresie nadzoru nad dostawcami przypraw. W roku 2021 nastąpiła istotna poprawa spełnienia wymagań audytowych w porównaniu do poprzednich badań wykonanych wśród dostawców przypraw w roku 2019. Nie spełniła się jednakże obliczona prognoza spełnienia wszystkich, tj. 100% wymagań systemu zarządzania jakością i bezpieczeństwem żywności. Obliczona w poprzednich badaniach prognoza miała spełnić się w roku 2021. Najprawdopodobniej nie została ona zrealizowana z powodu pandemii SARS-CoV-2, a nowe obliczenia wskazują rok 2024. Istotna poprawa realizacji wymagań audytowych i osiągnięty wynik są jednak w pełni satysfakcjonujące. Można uznać, że dostawcy przypraw dostarczają do zakładu mięsnego produkt bezpieczny, wytworzony w odpowiednich warunkach i przy pełnej kontroli procesu produkcyjnego.

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