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Hazard analysis and risk assessment in meat production practice in Russian Federation

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Abstract

Animals are carriers of biohazards including foodborne pathogens *Clostridium perfringens, Campylobacter jejuni, Salmonella*, enterohaemorrhagic *Escherichia coli*. Chemical and physical hazards can be present in meat and ingredients or occur during processing. Food safety management system is of particular importance with implementation of the Customs Union documents, TR CU - 021/2011, 022/2001 and 034/2013. HACCP is obligatory in Russia since July 2014. The meat industry is the most prepared for HACCP implementation because scientific research on hazard analysis and risk assessment have been conducted since 2005. The results of assessments for chemical hazard, PAHs, and microbiological hazard, *S. aureus*, are presented.

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Keywords: risk assessment; hazard analysis; meat production chain

1. Introduction

In the meat production chain, processors have to face up with the consumers. It is the processor who has to answer to all complaints from the consumer. Consumer expectations about meat product quality can be shortened to several criteria: it should be safe, delicious, juicy, fresh, healthy and easy to prepare.

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One of the tools to give the consumer meat product with the qualities they expect is quality management system (QMS). HACCP has been obligatory for Russian food production since July 1, 2014, including other novel requirements such as allergen labeling and product traceability. Meat industry is the most prepared for HACCP implementation because scientific research on hazard analysis has been done since 2005. However, risk management has not been studied. We have just started to implement science-based risk management to the Russian meat industry. Risk profiling is needed at the first step. That is noted by the Codex Alimentarius Commission as a necessity to describe the problems in food safety assurance procedure[1].

In many countries, the strategy of risk analysis is used for risk assessment and even to connect "hazard" – "a particular type of food".

As part of the construction and development of a new system of technical regulation in Russia, a procedure has been launched to harmonize local, RF, food legislation with European and international standards. The basic requirements for food safety have been established and fixed in Technical regulations of the Custom Union 021/2011 "Of food product safety" and 034/2013 "Of meat and meat product safety". A general description of obligations for HACCP implementation (Fig. 1) shows that the research institutions are obliged, for risk management, to: (1) develop safety limits, (2) create hazard analysis methodology, (3) create hazard database.

The aim of this paper is to describe some results of risk management application to meat processing in RF: identification, control and management of hazards at each stage of the production chain, namely transportation, processing, storage, sale and consumption, producer responsibility for the output of hazardous products for human health and life.

2. Materials and methods

To study and analyze the causes of potentially dangerous phases at each stage of a meat production chain – breeding, farming, transporting to slaughter, preslaughter harvesting, slaughter; processing, storage, retail, the FMEA technique (failure modes and effects analysis)[2] was used. Characteristics of a product, ingredients, raw materials, procedures at each stage of the production process, which may lead to a hazard occurrence; hazards which may come from personnel, equipment, retail, were analyzed.

3. Results and discussion

To identify the critical hazard, it is necessary to include all significant failure modes for each contributing element or part in the system limit. The limit for a Risk Priority Number for meat processing was established by experts as 140±10. Risk Priority Numbers for each stage were calculated. The most unstable are breeding (Risk Priority Number = 226) and processing (Risk Priority Number = 245).

Hazard analysis and risk assessment were done for each part of meat production chain (Fig. 2), with average ratio of (micro)biological, chemical and physical hazards of 60:24:16 ranging from 30 to 86 for (micro)biological hazards; from 12 to 60 for chemical hazards and from 2 to 33 for physical hazards at different stages in production chain.

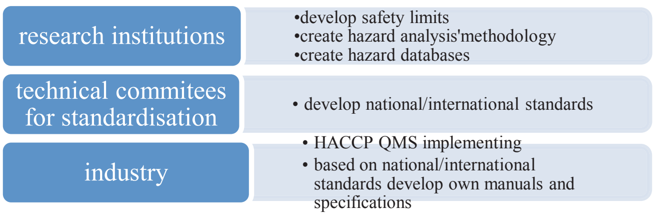

Fig. 1. Obligations for good quality management implementation in the RF meat industry.

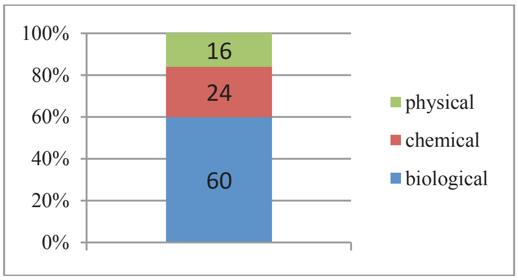

Fig. 2. Hazard profile for a meat processing chain.

The presence of hazardous contaminants or other undesirable substances in food is often unavoidable as these substances may (1) occur ubiquitously; (2) be unable to be avoided technologically (nitrate, phosphates); (3) be of natural origin (plant alkaloids). Hazard identification and risk assessment is a good tool to get sufficient knowledge on hazard occurrence, human exposure and the absence of genotoxic potential. Many substances show genotoxic potential (e.g. aflatoxins, or polycyclic aromatic hydrocarbons (PAHs)[4]. PAHs are of concern because some compounds have been identified as carcinogenic, mutagenic, and teratogenic. PAHs are found in meat cooked at high temperatures.

According to the RF legislation only benzo[a]pyrene has to be identified in meat products with the approved level of 1 μm/kg or less. Our research shows that benzo(a)pyrene comprise 6% of the total PAHs detected in a meat product while 8 PAHs comprise about 80% of them (Fig. 3). As a result, it was decided that benzo(a)pyrene is not a suitable hazard to assess to estimate the occurrence of PAHs in meat (meat products) and that a system of eight PAHs would be the most suitable indicator. These PAH will be included in the new RF standard.

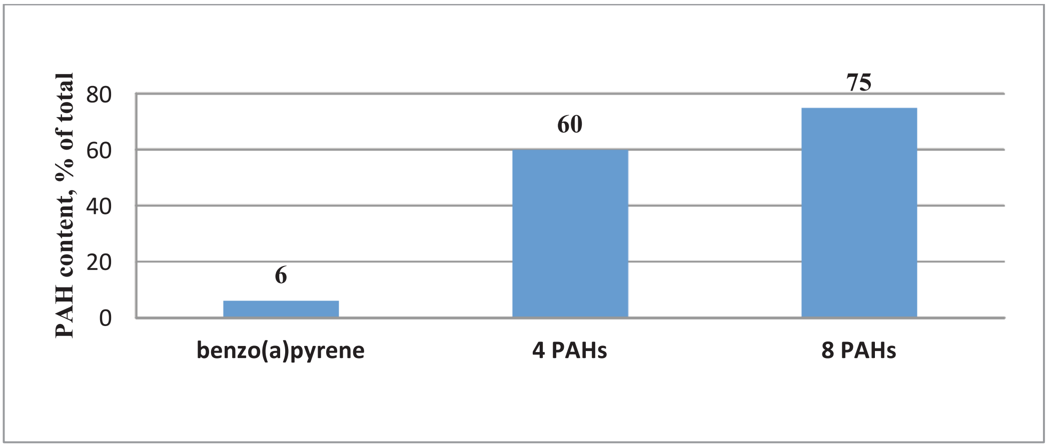

Fig. 3. PAH content, % of total PAH detected, where **4 PAHs** are benzo[a]pyrene, chrysene, benz[a]anthracene and benzo[b]fluoranthene. **8 PAHs** are the 4 PAHS plus benzo[k]fluoranthene, benzo[ghi]perylene, dibenz(a,h)anthracene and indeno(1,2,3-cd) pyrene

Raw fermented meat products were declared to be low risk items[6] if they are the result of controlled fermentation process. If a process is partly out of control, the risk of *Salmonella*, enterogaemorragic *Escherichia coli* occurrence is high.

The key requirement for traditional Russian raw fermented sausage production technique is low positive temperature (4±2^{o}C) during the process (except smoking). Low temperature, two weeks of curing and low sugar content help to avoid growth of *Staphylococcus aureus* during the process. Modern rapid technologies which are used in Russia nowadays include fermentation at 20^{o}C with starter cultures. Those starter cultures may contain *Lactobacillus* spp., *Pediococcus* spp., *Staphylococcus* spp., *Micrococcus* spp. According to Russian state standard GOST R 55456-2013 "it is allowed to use starter cultures which contain *Lactobacillus* spp, *Pediococcus* spp *Micrococcus/Kocuria* spp". Some of these microorganisms could negatively influence the fermentation process (e.g. *Leuconostoc*), or mask the presence of pathogens (e.g. *Staphylococcus* spp).

According to the current Russian legislation, *S. aureus* in meat and staphylococcal enterotoxin B are not determined in smoked meat products because this hazard was not critical for the traditional technology of smoked products. To assess the possible occurrence of *S. aureus* in products, each step of the raw fermented sausage production line was analyzed. Results showed that in 16 out of 27 samples, coagulase-positive *S. aureus* and in 2 samples enterotoxigenic *S. aureus* were found. Five samples after the end of fermentation process were positive for *S. aureus*. Reliable methods should be implemented to identify fermented sausage and starter culture microbiota.

4. Conclusion

As the range of hazards broadens and new meat processing techniques are implemented in the Russian meat industry, it is likely that there will be an increasing demand for risk assessments.

Science based approach to risk identification and risk assessment should be implemented in the Russian food processing industry to meet the WTO/EU requirements for food safety assurance, objectivity and transparency.

It is important to implement new processing techniques (when traditional hurdles are changed) after proper risk assessment.

It is advisable to divide the responsibility between the people carrying out the risk assessment process, and those who conduct risk management.

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