Risk assessment in production of baked minced meat products

J. Pivoňka*, R. Ševčík, M. Čeřovský, M. Voldřich & P. Pipek
Institute of Chemical Technology Prague, Department of Food Preservation and Meat Technology,
Technická 5, 166 28 Praha 6, Czech Republic.
*E-mail: jan.pivonka@vscht.cz

Abstract

The recent approaches to the hazard analysis and risk assessment according to the GFSI standards are demonstrated in the case study of the production of baked minced meat and similar products.

The microbial risk was evaluated with the respect to contamination of raw material from environment, survival through the process of thermal treatment and contamination and growth after thermal treatment and throughout the shelf live of the product.

The spaces with the risk of microbiological contamination of the raw material and product were indicated in the representative factory producing baked minced meat. The needed parameters of raw material, semi product and baked product were analyzed and predictive microbiological model was used to calculate the risk of spoilage and pathogen growth in the case of contamination. The risk of microbial growth in the period after sanitation on the surfaces in direct contact with the food was evaluated with the help of the model as well. The thermal treatment process in the production of baked minced meat products was verified with respect to the dimension of the product and its form. The results of predicted parameters and new limits were verified by microbial tests.

Introduction

The food safety is in GFSI standards identically to the EU legislation based on the risk assessment. This process allows food business operators to look for different solutions of problems. It of course strengths the competitiveness on the market but otherwise it needs more scientific support for the operators and more responsible approach. The support of scientists should be as understandable and simple as possible, but it should not be deceptive or skip important parameters or information. From this point of view it is important to find out simple case studies and show them to the operators. This work is in its essence a case study showing possible approach to the risk assessment in the production of baked minced meat products and scientific approach to establishing production criteria.

Baked, grilled or fried minced meat products are traditional in many European countries. Different varieties of hamburgers are well known in the whole Europe. In many Mediterranean countries is common production of grilled spits or fried meatballs made of minced meat. Even in Central Europe is the production of baked minced meat products important.

The main goal was to demonstrate practical case of approach to the risk assessment. If the assessment has to be simple and useful for industry it should finally generate real numbers which can be used as critical limits or which can demonstrate if the process is under control. From this point of view are predictive microbiology and theoretical models very useful tools.

Materials and methods

The process of risk assessment was performed in the real company located in the Czech Republic. All samples were collected directly from the production where hazards were identified and predictions were performed.

The most important parameters from the point of food safety were measured directly in the product sample. The parameters which only help to establish the processing limits were identified in the literature and databases.

The risk assessment process was compiled on main fundaments:

1. Raw material characteristics (incl. microflora)
2. Product characteristics
3. Process characteristics

The places with significant risk of contamination were identified during the audit, which was performed by the authors. The hazards were collected with respect to the contamination from environment, from employees, cross contamination, contamination of raw material. The possible steps with the risk of microbial growth were identified. For the purposes of this work only several steps were chosen to demonstrate the approach to risk assessment.

Results

Raw material characteristics: The product composition is based on many different materials, which are supplied in frozen, fresh or dried form. For the purposes of the risk assessment raw materials were segmented into tree groups (Table 1).

In the raw material was identified the most common pathogenic microfloora: *Campylobacter spp., Salmonella spp., Listeria monocytogennes, Clostridium perfingens,* pathogenic serotypes of *Escherichia coli, Yersinia enterocolitica and Bacillu cereus* in the breadcrumbs.

Table 1. Groups of raw material sorted by risk

Supporting growth	Source of contamination	No risk
Minced pork meat	Mixture of spices	Water
Minced chicken meat	Raw onion	Salt
Chicken skin	Breadcrumbs	Additives (E250)

Product characteristics: The product is very sensitive from the microbial point of view. The pH values and a_w were measured to obtain basic product characteristics (Table 2). Results are shoving that the product will support growth of many microorganisms. On the other hand it is containing the preservative sodium nitrite, which is a good barrier for the germination of *Clostridium botulinum*. The risk of botulism is due to presence of this preservative significantly decreased.

Table 2. Average water activity and pH value at 20 °C

	a_w	pH
Surface	0,96	6.06
Bottom	0,97	6,12
Core	0,96	6,15

Process characteristics: The process flow chart was developed to identify all steps of the production. During the audit the most important microbiological hazards were identified:

1. Survival of pathogenic microflora during the heat treatment
2. Contamination from environment after the heat treatment
3. Growth of microorganisms after the heat treatment

Assessment of the heat treatment process: Microbial quality of raw foods depends on the breeding conditions as well as on the contamination during preliminary processing steps. Good manufacturing practices are important to protect food from further contamination during processing. Moreover, an adequate choice of cooking conditions should be done in order to destroy the contaminant microflora.

The time-temperature curves were recorded and the correspondent F_{70} was calculated for the core of the product and different places in the oven. The results were compared to the total microbial count in the core of the product after 24 hours of cooling (Table 3).

Table 3. End point core temperature, calculated F_{70} and the total bacterial count of final product

	Place in the oven	End point core T (°C)	F_{70} (min)	Total bacterial count (CFU/g)
0,5 kg	Top	74	35	<10
	Middle	72	15	<10
	Bottom	71	8,5	<10
1,0 kg	Top	72	18	<10
	Middle	65	0,3	$5x10^2$
	Bottom	68	4,5	10^2

I the case of 1,0 kg product, the thermal treatment process was evaluated as insufficient. The correction in the size or form is needed.

Contamination from the environment after heat treatment: Assessment of microbial contamination from the environment due to the long period between sanitations. The prediction was calculated for different temperatures in the production area. It was speculated that the safe period is depending on lag phase duration

in the case of continual production or on formulation of biofilm in the case of long lag between sanitations. The formulation of biofilm normally occur if the case when count of *Listeria* reach up 10^4 CFU/100 cm^2. The results (Table 4) are showing how long can be safe period between two following sanitations in different temperature conditions in the production area.

Table 4. Characteristics of microorganism growth in the production area

	Time to log (h)		Time to increase 4 log (h)	
Temperature	10 °C	15 °C	10 °C	15°C
Listeria monocytogennes	84	43	211	102
Salmonella spp.	86	23	279	76
Escherichia coli O157:H7	165	65	379	152

Growth of microorganism after heat treatment: The time temperature history of the cooling process was recorded and growth of *Listeria monocytogennes* was predicted during the cooling process and storage in the producers' premises. The results were summarized and prediction of the shelf life with respect to the *Listeria monocytogennes* growth (2 log increase) was proposed. (Table 5).

Table 5. Shelf life prediction

Temperature (°C)	4	6	8	10	12
Shelf life (days)	21	15	10	7,5	5,5

Conclusions

The increase in production amounts of baked minced meat products is significant in the recent time. Foretime these products were produced at home or at restaurants and were suitable only to the direct consumption. The industrial production raised up new hazards for this type of products. This work demonstrates that the traditional baking process does not ensure the sufficient decrease of microflora in all cases. In combination with long shelf life or interruption of the cooling chain it can present significant risk for final consumer.

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