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Facultatea de Științe Agricole, Industrie Alimentară și Protecția Mediului

Abstract of PhD Thesis

Research on chemical contamination of food and opportunities to reduce it

Coordinating teacher:

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Foreward

Scientific researches that led to this PhD thesis have been realized under the POS DRU project "Increasing the role of doctoral studies and PhD competitiveness in a united Europe", Project ID 7706. This project is conducted under the slogan Invest in people and is a project funded by European Social Fund.

I would like to bring special thanks to all those who helped me to complete what I have started in 2008. First I thank to my coordinating teacher, PhD Eng. Ovidiu Tița that during these three years directed and supported me in finding the best solutions and opportunities to achieve the proposed goals.

I thank also to the entire staff of the Meat Research Institute, Budapest, and especially to Mrs. Director, Ph.D Gabriella Zsarnóczay who received me and provide me the resources of the Institute during my three months transnational mobility.

I address special thanks to Professor Ph.D László Körmendy who supported me in statistical evaluation of data and to chemical engineer Ágnes Kovács who was my tutor during my internship and provided substantial support for the scientific efforts to complete all the researches.

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I Scientific objectives of the thesis[1]

The main objective of the research was to find methods to reduce chemical contamination of meat products with nitrite. To achieve this objective we have identified the following opportunities: reducing the amount of residual nitrite and replacement of chemical nitrite with a natural source of nitrite. The scientific approaches were:

1. conducting experimental simulations for bologna type sausage (pork parizer - Hungarian recipe) in which the Hurdle factors used were pH, water activity, temperature and amount of added nitrite;
2. use of lactic acid to reduce pH
3. assessing the influence of pH on the sensory characteristics of the product and the amount of residual nitrite;
4. reduction of water activity value by adding soy protein isolate;
5. assessing the influence of soy protein isolate on sensory characteristics of the product and on water activity value;
6. using a more intense heat treatment;
7. assessing the influence of heat treatment intensification on the sensory characteristics of the product and the amount of residual nitrite;
8. use different amounts of nitrite
9. assessing the influence of different amounts of nitrite used on sensory characteristics of the product and the level of residual nitrite;
10. using the Hurdle factors at the optimal level in order to reduce the residual nitrite without negative changes of sensory and microbiological characteristics of the product;
11. comparative evaluation of residual nitrite levels, of sensory and microbiological characteristics of the reference sample and those which were applied Hurdle factors;
12. replacing chemical nitrite with nitrite from a natural functional mix-based on celery powder and without changing any other parameter of the product or process;
13. Assessing the effect of functional mix on residual nitrite levels and on sensory and microbiological characteristics of the product.

[1] *The numbering of chapters, tables, figures, appendices and bibliographical indications of this summary is the same numbering of thesis*

Introduction

Food has a vital importance in our lives. It is necessary for our development beginning with the moment when we are conceived. A person consumes, in average, 30 tons of food during his life, under different versions of diet that varies locally, nationally and internationally. If we are referring to food in general, they are a mixture of chemicals that can be divided into four categories: nutrients, natural toxins, contaminants and additives. A food is safe when its consumption does not alter or put in danger the consumer's health.

The concept of food safety has no universally accepted definition. Food security can be defined as all activities that ensure that food does not cause any health problem to consumers. This simple definition covers a wide range of activities from the basic staff hygiene to the most complex technical procedures to remove contaminants from the process or processed foods and ingredients.

II. Documentary study

Chapter 1. Theoretical considerations on food safety and toxicity of chemicals

In chapter 1 are presented the theoretical aspects of food safety and toxicity of chemicals. Food safety is a primary aspect when it comes to production and comercialization of food. Responsibles for ensuring the food safety are all those involved in the food chain but mainly the producers.

The business tools necessary to ensure food safety in food processing units or those who comercialize them are food safety standards. Without the implementation of at least one such standard, the activities of these units is not permitted by legislative bodies. The most relevant standards are: ISO 22000: 2005, International Food Standard (IFS) and British Retail Consortium (BRC).

Regarding the toxicity of chemicals, it is the ability of these to induce an adverse effect in a living organism, an example being the human body. In general, information on the toxicity (risk) of chemicals in food is obtained through animal studies, in vitro studies, studies on volunteers or epidemiological studies.

Chapter 2. Current approaches to legislation regarding chemical contamination of food

Chapter 2 of the thesis is foccused on the current legislation on chemical contamination of food. I approched this issue by the European legislation and national legislation point of view as though we are a member of the European Union, legislation is not uniform for all states members. Each state must adopt EU laws but may have their own laws in force which must be in line with European ones.

Chapter 3. Chemical contamination of meat products with nitrite and nitrosamines

In this chapter I have discussed the chemical contamination of meat products with nitrite, nitrosamines respectively. Effect of nitrite on meat products is complex and not yet fully understood. Chemistry of nitrite in meat products is very complex and chemical reactions that occur between decomposition products of nitrite and meat components are bringing benefits in terms of colour, flavor, lipid oxidation and food safety. Effect of nitrite on meat colour is best understood and most obvious result of nitrite addition in meat.

Besides beneficial effects, nitrite has also negative effects that can affect human health and may be even fatal in people with hypersensitivity and children. These effects are detailed in the risk analysis.

Nitrosamines are formed when natural amines from protein interacts with nitrosating agents. If foods with optimal conditions for the formation of nitrosamines, are processed by a heat treatment the probability to their formation is increased.

Once activated in the body, nitrosamines can affect different organs and are considered to be carcinogenic compounds. Most nitrosamines are mutagenic and and a number of its are carcinogenics. The most common carcinogenic nitrosamines, found mainly in food are N-nitroso-dimetylamine (NDMA), N-nitroso-dietylamine (NDEA), N-nitroso pirolydine (N-Pyr) and N-nitroso-piperydine (N -Pip).

Chapter 4. Theoretical considerations who led to the scientific investigations

In this chapter are presented the theoretical considerations which were the base of the scientific investigations. The two directions approached have been reducing the amount of nitrite added to the bologna type sausage and replacement of chemical nitrite, with nitrite from natural sources. The final goal in both cases was reducing the amount of residual nitrite in the product.

Hurdle technology, known as combined methods, combined processes, combined conservation is originated in 1978 and is the intended use of several factors that have role of conservation, improve sensory and nutritional properties of products (Figure 10).

Figure 10. Combining hurdle factors (SOURCE: HEINZ şi HAUTZINGER, 2007)

The basis of this technology is the concept of homeostasis. Homeostasis is the organism property to maintain the internal environment constants in very appropriated limits. In food preservation, homeostasis of microorganisms is the key phenomenon which must be given special attention because if it is disturbed by hurdle factors then they will not be able to develop.

Also, in this section are found theoretical concepts and data from literature about the hurdle factors that I used, namely pH, water activity, heat treatment and the amount of nitrite, and the research carried out to replace chemical nitrite.

III. Studies and experimental results

Chapter 5. Analysis and evaluation methods used to achieve research

Chapter 5 contains the description of analytical and evaluation methods used in scientific approaches undertaken. The methods used were:

- *Analytical methods:* pH measuring by potentiometric method, measurement of water activity by cryogenic method, texture measuring by penetration method, colour measurement using CIE L*,a*,b* system, the determination of nitrite by spectrophotometric method, determination of moisture by oven drying, sodium chloride determination by Mohr method, determination of fat by Soxhlet method, determination of proteic substances by the Kjeldahl method;

- *Sensory analysis:* carried out by descriptive method and using for evaluation a hedonic scale of 1 to 9;

- *Microbiological methods:* Determination of the total number of germs by fast Compact Dry TC method and determination of the number of coliforms by Compact Dry CF method;
- *Risk analysis*;
- *Statistical methods of data evaluation:* analysis of variance and linear regression.

Chapter 6. Risk analysis for nitrite

Chapter 6 covers all stages of risk analysis for nitrite. In short, the information contained in this chapter is:

- nitrite toxicity, manifested by the production of methemoglobinemia, the production of lymphatic cancer, inhibition of thyroid function, inhibition of transformation of provitamins A in vitamin A, the production of nitrosamines in the presence of secondary and tertiary amines, strong vasodilator action;
- NOAEL level of nitrite, calculated after completion of chronic toxicity studies in mice is 10 mg $NaNO_2$ or 6.7 mg NO_2 per kg body;
- ADI values are 0,2 mg $NaNO_2$ per kg body respectively 0,13 mg NO_2 per kg body;
- average daily ingested nitrate is 1.25 mg/kg body for an adult over 65 years old and over 3.6 mg/kg body for 1-3 years children;
- nitrite intake was estimated to be 2.3 mg NO_2 per day;
- to avoid chemical contamination with nitrites, it is held in specially designed spaces, under key and access to it is limited;
- the presence of nitrite in meat products is known to consumers through its declaration on the label of the product.

Chapter 7. Research and discussion on the influence of Hurdle factors on product

In this chapter I studied the individually influence of each hurdle factor chosen. The simulation experiments were performed with a Bologna type sausage mix. Table 9 shows the formulation of the Bologna type sausage mix.

Tabelul 9. Formulation of the Bologna type sausage

Raw materials	**kg/100kg product**
Pork meat	60
Pork fat	12,5
NaCl (0,5% nitrite)	2
Poliphospahate ($Na_4P_2O_7$)	0,3
Black Pepper	0,2

Tap-water	25

pH-influence

In general, this type of product has a pH between 6,3 and 6,6. In the experimental simulations to decrease the pH of raw pasta it was used lactic acid. To decrease the pH of raw pasta to a value between 5,5 and 5,7 was added 0,409 g lactic acid and for a value of 5,8 – 6 0,178 g.

A day after fabrication, the samples were evaluated by the internal panel of Meat Research Institute in Budapest, using descriptive sensory evaluation method. Internal panel consisted of nine members, in 2010 four of them being certified by the Hungarian National Committee of the European Organization for Quality, as experts and five as consumers.

Figure 33 shows the influence of pH on the sensory characteristics of the product.

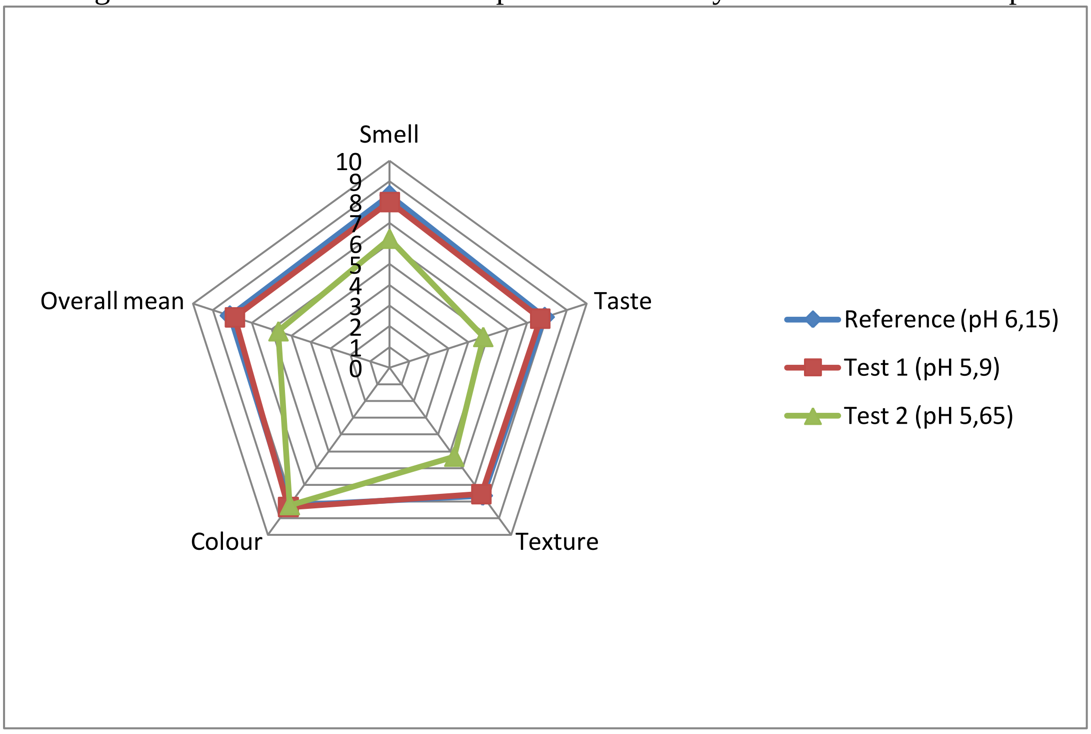

Figure 33. Assessment of the pH influence on the sensory characteristics of the product

Because pH can affect the color of meat products, it was measured by CIE L*a*b* method. Assessing the influence of pH on the texture of the product was made both in terms of sensory analysis and by measuring the penetration force. Results of determination of residual nitrite can be found in Figure 38.

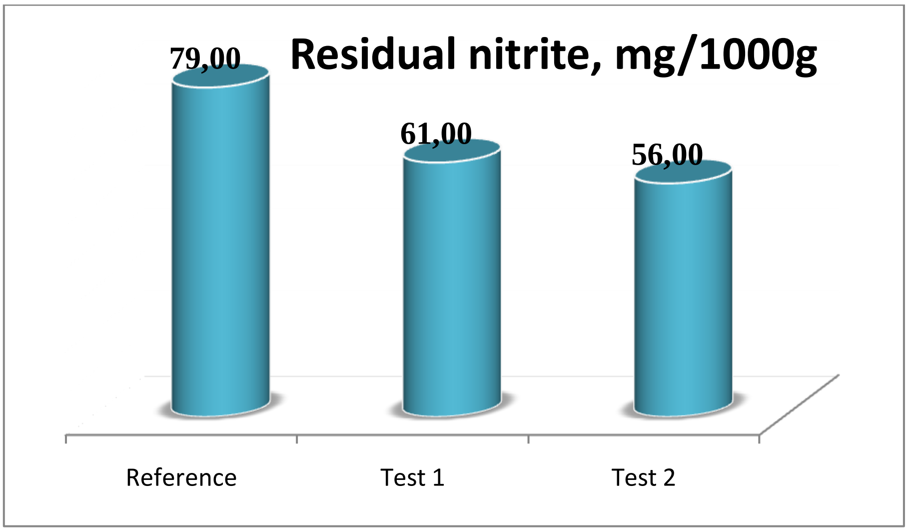

Figure 38. Comparative analysis of residual nitrite content of the three samples with different pH values

<u>Partial conclusions</u>

Test 2 with pH 5.65 was the one who received the lowest score in sensory evaluation. Between test 1 (pH 5,9) and reference test (pH 6,15), there were no significant differences in any of the sensory characteristics evaluated. Texture measurements have supported the assessment made by the panelists. Meat pH reduction did not result in significant changes of colour. The results showed that visual was not seen any major difference between the three samples. Regarding the amount of residual nitrite, if pH decreased also the residual nitrite decreased.

Water activity influence

To reduce the water activity value, the only opportunity which semed to be possible was using humectants, because other solutions are not suitable for this type of product. It were made two experimental simulations in which water was replaced with 2 kg isolated soy protein, respectively 3 kg isolated soy protein, ratio of replaced water : isolate soy protein beeing 1:1.

The result of sensory evaluation of these two tests comparing with the reference are shown in figure 40.

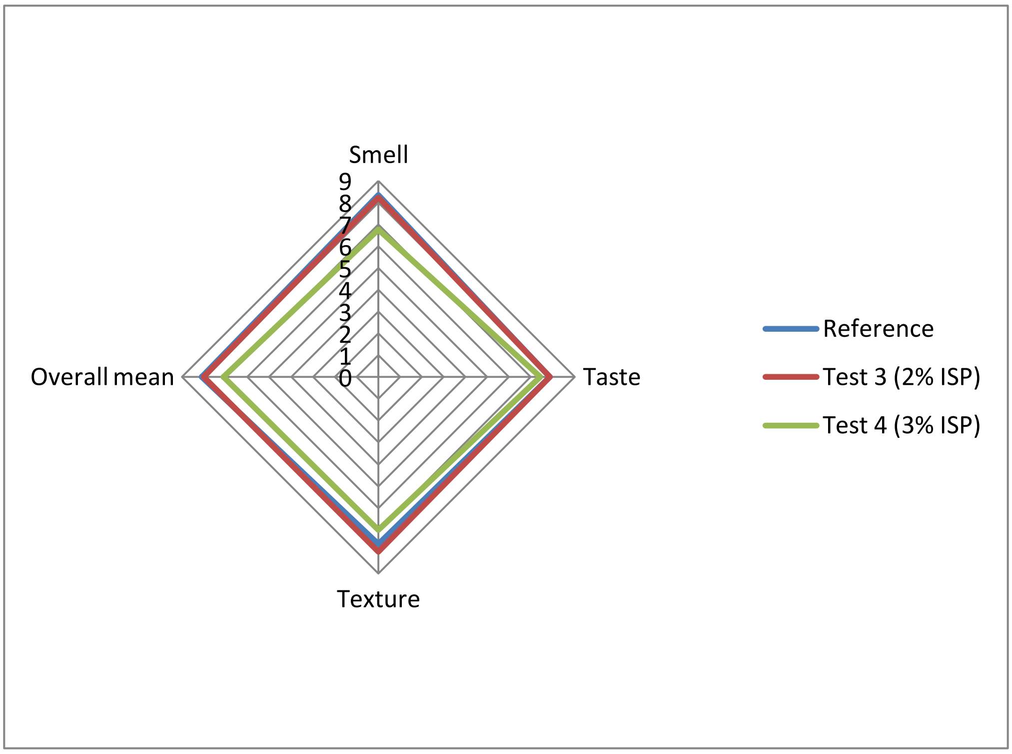

Figure 40. Influence of the addition of soy protein isolate (ISP) on the sensory characteristics of the product

Water activity determination was made by cryogenic method. The results are the following:

- reference: 0,964
- test 3: 0,9636
- test 4: 0,9612

<u>Partial conclusion</u>:

The results obtained by measuring water activity showed that water activity didn't had a significant decreasing but the addition of 3% soy protein isolate resulted in a negative change of texture, smell and taste of the product. As it can be seen from figure 40 the addition of 2% did not negatively influence the product.

Heat treatment influence

To see the influence of heat treatment on the characteristics of the product were applied to the basic recipe (Table 9) the following two heat treatments: low pasteurization - 75°C external temperature until the core product temperature reaches 72°C (treatment A) and a high pasteurization - 91°C external temperature in the boiler until the core product temperature reaches 88°C (treatment B). Influence of heat treatment on the sensory characteristics of the product is found in figure 45.

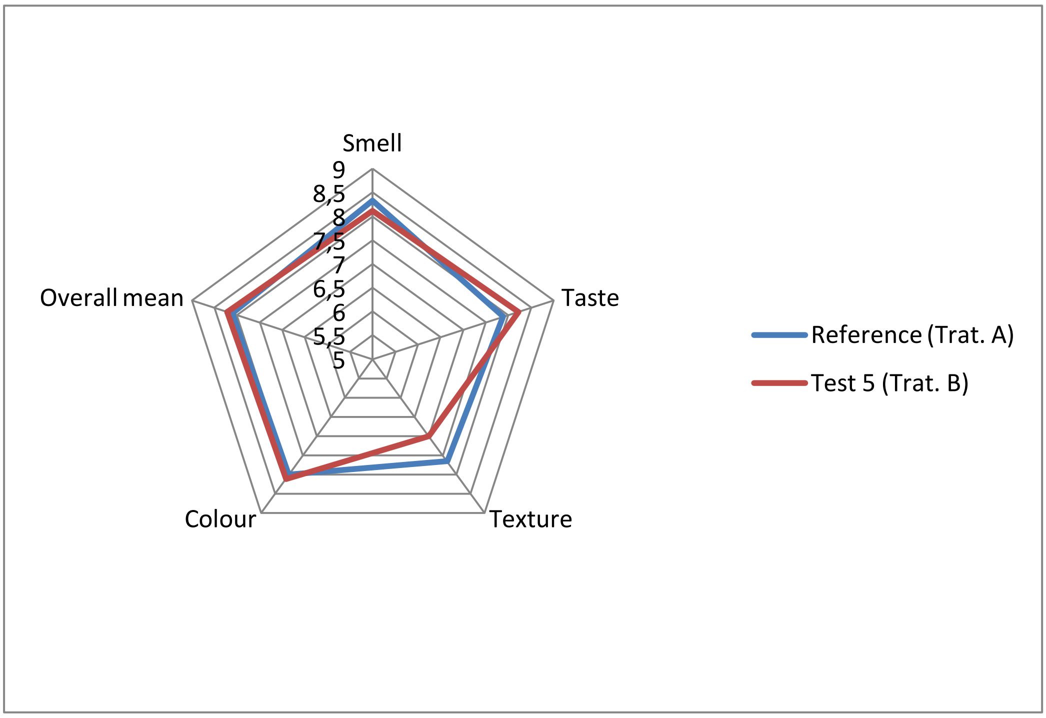

Figure 45. Influence of heat treatment on the sensory characteristics of the product

Heat treatment influences the behavior of nitrite in meat products and residual nitrite was determined from the two experimental simulations by spectrophotometric method. The results are the following:

- reference : 79 mg $NaNO_2$ /1000 g
- Test 5: 42 mg $NaNO_2$ /1000 g.

Partial conclusions:

Applying a more intense heat treatment led to a favorable assessment of the product. Nitrite was consumed in greater proportion and the product had a more intense colour (MÂNDREAN and TIȚA, 2011b). According to statistical analysis, there was a significant difference between the colour components of the two samples. Colour of test 5 was improved. The taste was not negatively changed due to the intense heat treatment. Product texture was softer for this treatment but the difference was not major.

Influence of the amount of added nitrite

For this purpose were performed three experimental simulations with different nitrite level, respectiveley 100 mg $NaNO_2$/kg, 75 mg $NaNO_2$/kg and 50 mg $NaNO_2$/kg. Since the intensification of the heat treatment was considered by the panel of consumers to be beneficial, this treatment was used at the manufacturing of these three tests. The result of the sensory evaluation are shown in figure 51.

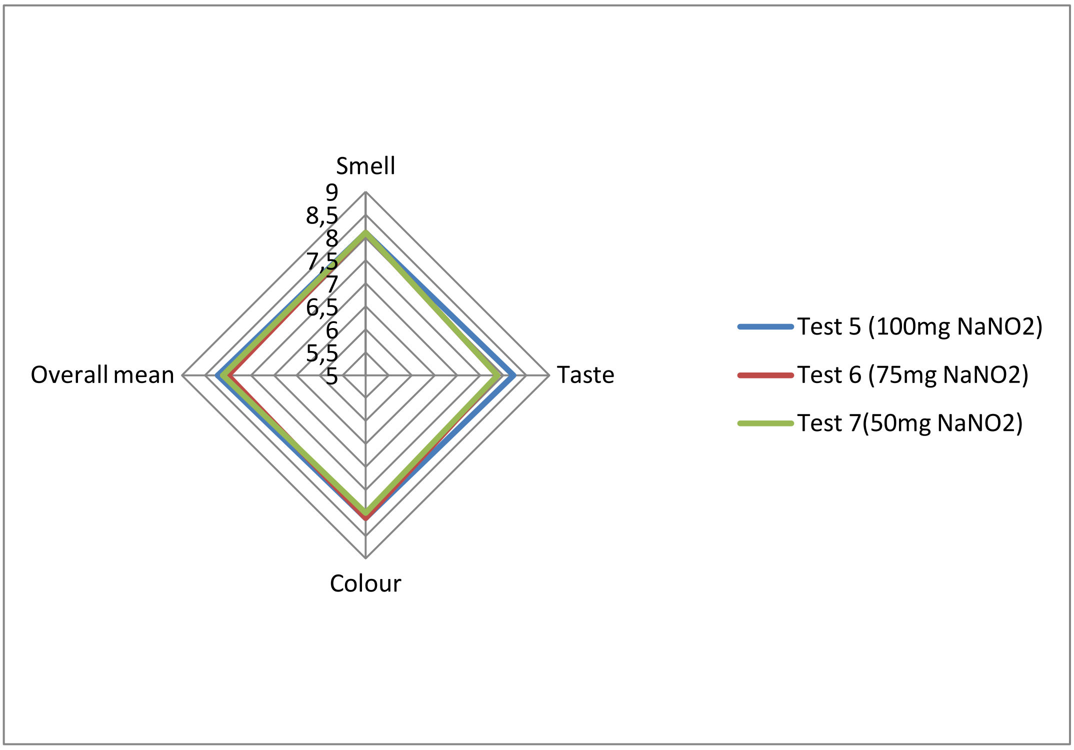

Figure 51. Influence of the amount of nitrite on sensory characteristics of the product

Determination of residual nitrite was made by spectrophotometric method and the results are as follows:

- test 5: 42 mg/1000g
- test 6: 23 mg/1000g
- test 7: 15 mg/1000g

<u>Partial conclusions:</u>

Reducing the amount of nitrite did not alter the flavor of the product. Expressed as a percentage, the amount of residual nitrite is not much different between the three experimental simulations and the fact that it were used different amounts of nitrite didn't had a major influence on colour. Consumers panel said that the colour of the three tests is almost similar.

Measurements have shown that colour component a* of the three experimental simulations showed no significant statistical difference. Between the other two components colour, L * and b * there was a significant difference according to statistical evaluation. Differences existed between test with 100 mg/1000g nitrite and 50 mg/1000g but consumers did not perceive this difference, because for meat products is specific a pink - red colour so the basic component that influence the sensoarial evaluation is a* (MÂNDREAN and TIŢA, 2011b).

Chapter 8. Simultaneous application of Hurdle factors and evaluation of their effectiveness

Following the above evaluation it was decided to apply as hurdle factors: the pH, the temperature and the amount of nitrite used. The experimental simulations performed are shown in table 30.

Table 30. Formula of experimental simulations and heat treatments applied

Raw Materials	Sample 1, Heat Treatment A	Sample 2, Heat Treatment B
Pork (shoulder), kg	60	60
Fat, kg	12.5	12,5
Black pepper, kg	0.2	0,2
Salt mixture (0.5% nitrite), kg	2	-
Salt mixture (0.25% nitrite), kg	-	2
Polyphosphate, kg	0.2	0,2
Cold water, kg	25	23
Lactic acid, kg	-	0,125
Isolated soy protein, kg	-	2

As raw material it was used pork shoulder with pH 5.8. It was intended to lower meat pH value between 5.50 and 5.65 and the value obtained after addition of lactic acid and cold storage for 4 hours was 5.57.

Experimental simulations were evaluated during 42 days. Evaluation intervals were: day 10, day 20, day 30, day 37 and day 42. Sensory evaluation of colour was performed by a trained panel using a hedonic preference scale from 1 to 9. (1 = dislike extremely and 9 = like extremely). Each time was made also determination of total number of germs (Compact Dry TC method) and colour measurements (CIE L*a*b* method). After 1, 6, 10, 15 and 42 days from manufacturing was determined the residual nitrite content (Hungarian Standard MSZ 6905-81) (1981). Test 2 was evaluated at 49 days and 56 days and on day 44 for test 1, respectively on day 58 for test 2 was determined the number of coliforms (Compact Dry CF method).

As shown in figure 56, the sensory characteristics of the two experimental simulations have depreciated along the interval. At the beginning, they were quite close but at the end of the range test 2 remained much higher. At the end of 42 days for test 1 was most impaired the taste, followed closely by the smell. The colour was fairly constant in the first 30 days but then according to panelists declined sharply. The texture was fairly constant throughout the interval. Test 2 was assessed up to 56 days because after 42 days its sensory characteristics were still appreciated by the consumers. The nine panelists felt that at te end of evaluation period, the colour of test 2 was the one who depreciated the most.

In figures 55 and 57 it can be seen the stability in time of sensory characteristics of the two experimental simulations. Colour measurement showed an increase of brightness of the two experimental simulations over the interval. Test 1 had higher values compared with Test 2 (Figure 58). Colour component a* decreased over the interval but the difference was small between the first and last day (figure 59). Test 1 was slightly higher than test 2. In case of colour component b* has not been significant changes. Its average value decreased by the end of the range but the difference was small (figure 60).

Residual nitrite content of the two samples are found in table 39.

Table 39. Residual nitrite content of samples 1 and 2 in different intervals of the manufacturing

Test	1 day	5 days	10 days	15 days	42 days
Test 1	76 mg/1000g	73 mg/1000g	72 mg/1000g	69 mg/1000g	52 mg/1000g
Test 2	19 mg/1000g	17 mg/1000g	16 mg/1000g	14 mg/1000g	11 mg/100g

Total number of germ evolution for the two experimental simulations are found in figures 62 and 63. After 42 days for test 1 and 56 days for test 2, the value of this microbiological parameter was higher than 10^5 cfu/g. According to this, the shelflife was considered to be 40 days for test 1 and 54 days for test 2. After 44 days for test 1 and 58 days for test 2 it was determined the number of coliform bacteria but they were absent in both cases.

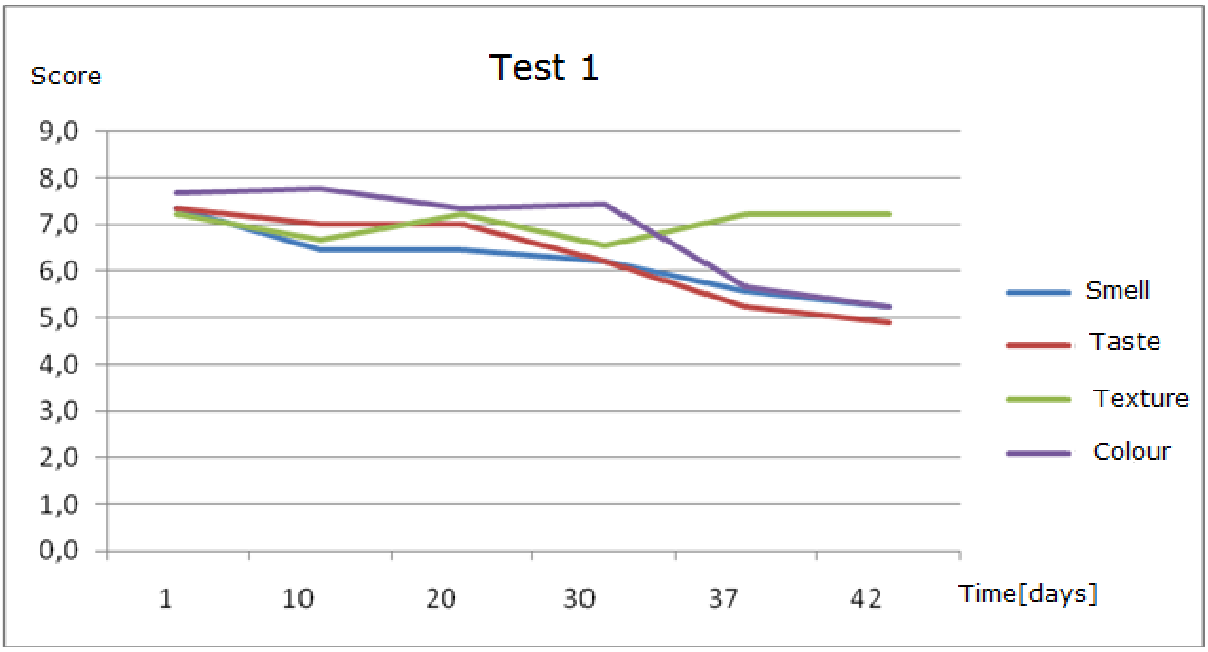

Figure 55. Stability in time of sensory characteristics of sample 1 (reference)

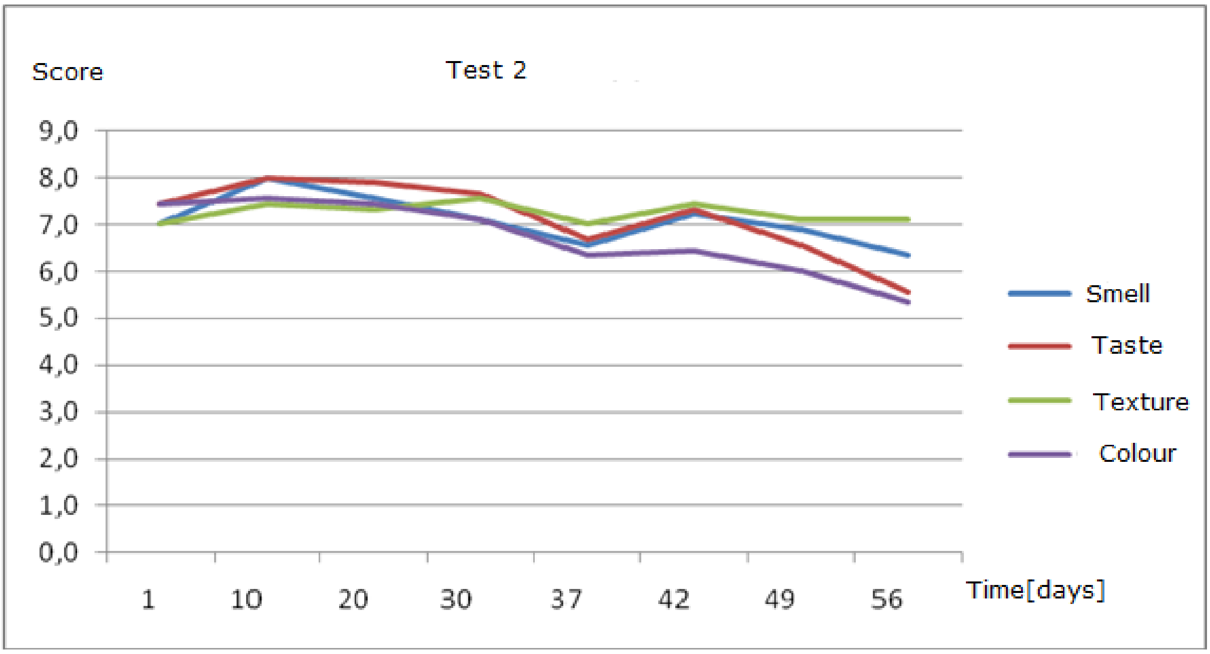

Figure 57. Stability in time of sensory characteristics of sample 2 (sample with hurdle factors)

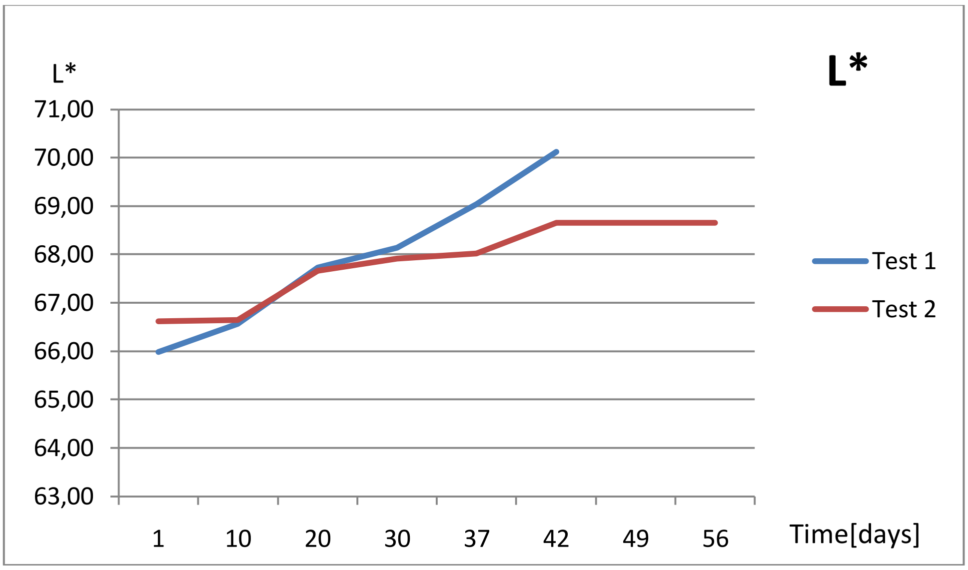

Figure 58. Change of the brightness of test 1 (reference) and test 2 (test with hurdle factors) during the evaluation interval

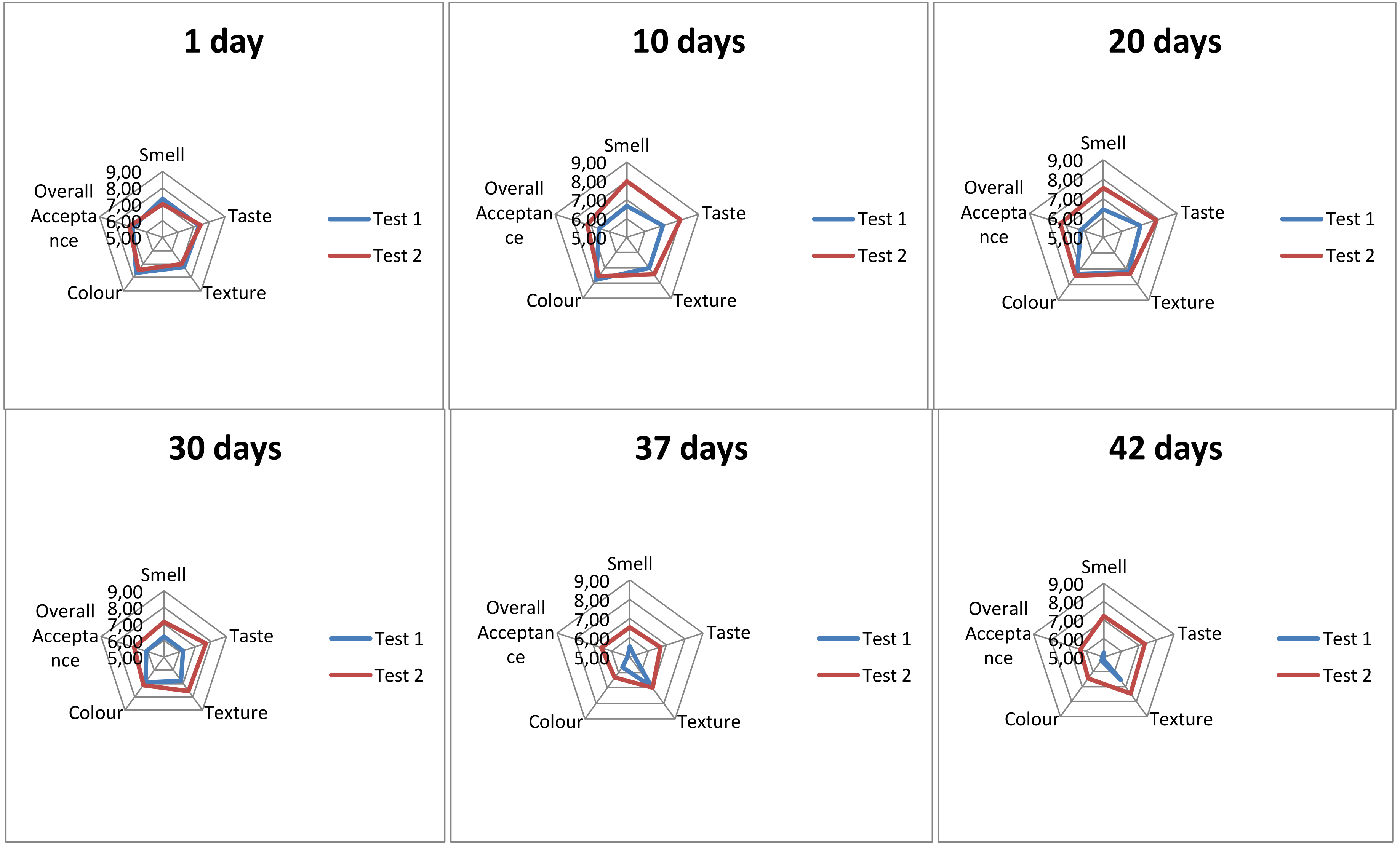

Figure 56. Comparative analysis of sensory attributes for test 1 and test 2 during the evaluation

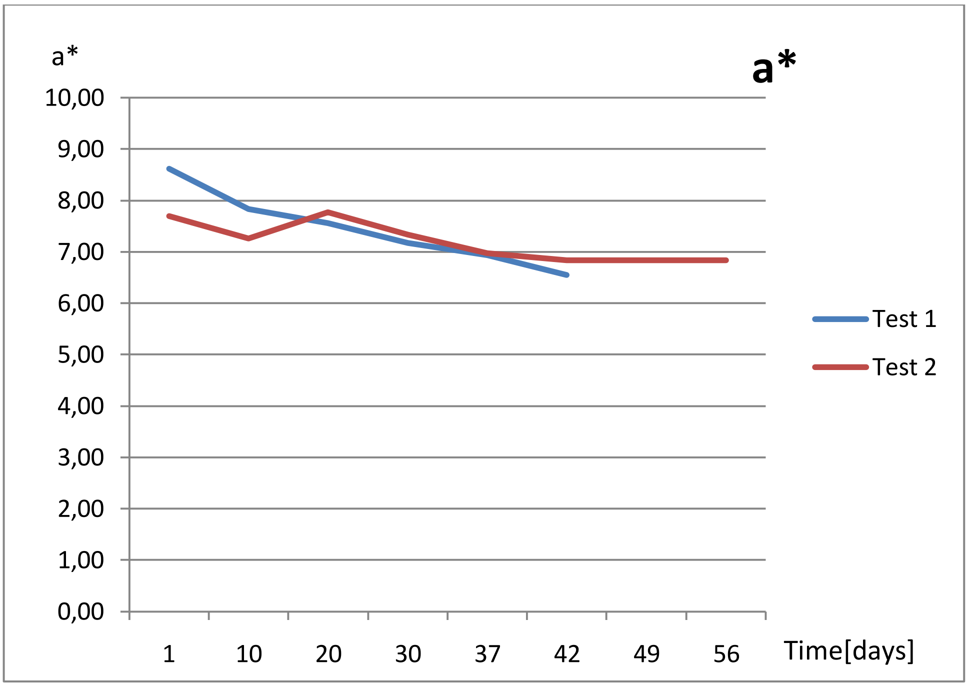

Figure 59. Change of the colour component a*of test 1 (reference) and test 2 (test with hurdle factors) during the evaluation interval

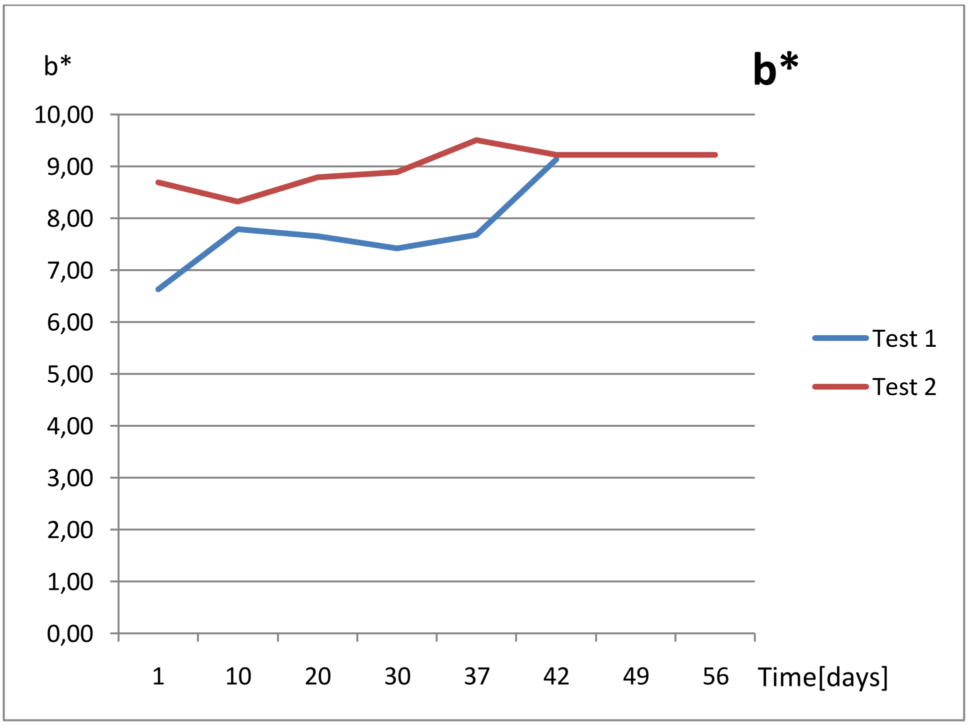

Figure 60. Change of the colour component b*of test 1 (reference) and test 2 (test with hurdle factors) during the evaluation interval

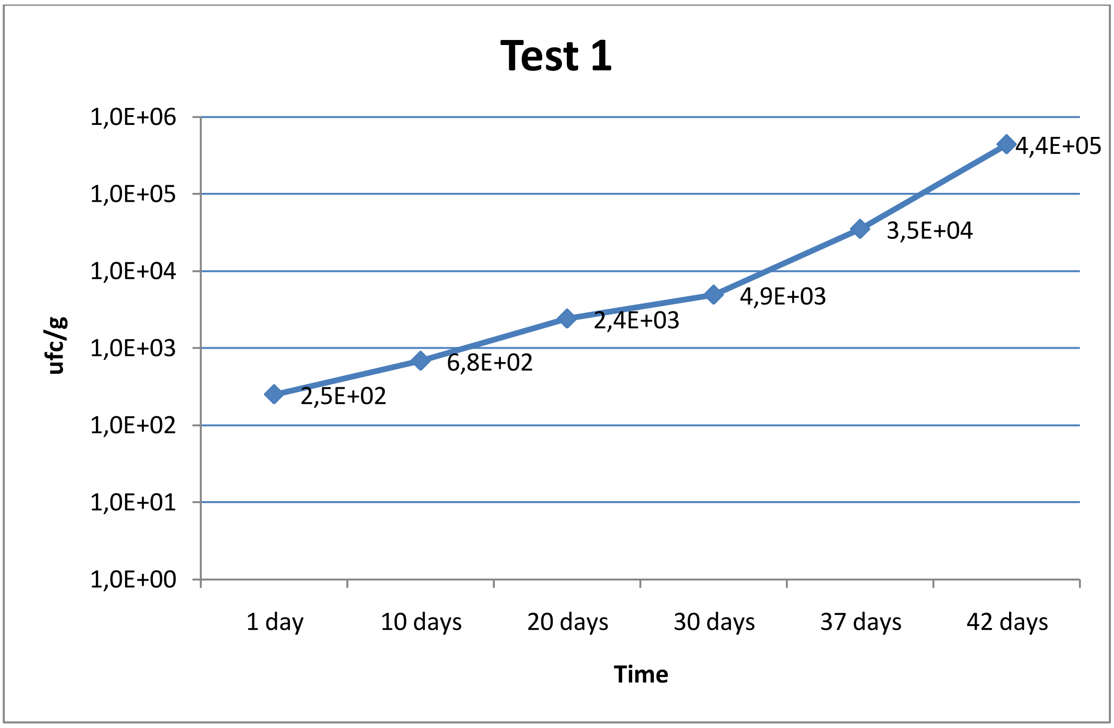

Figure 62. Evolution of the total number of germs in test 1 (reference) during the evaluation interval

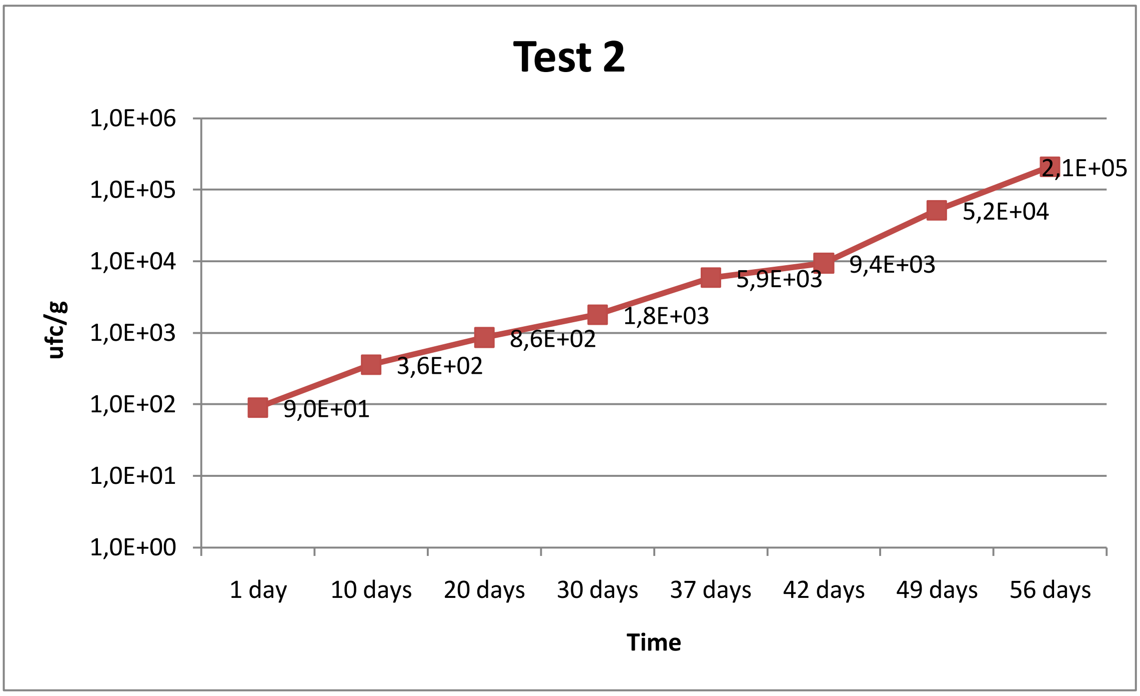

Figure 63. Evolution of the total number of germs in test 2 (test with hurdle factors) during the evaluation interval

Chapter 9. Research on the replacement of chemical nitrite

To replace chemical nitrite was used a functional mix based on celery that has ingredients like celery powder, sea salt, yeast extract, maltodextrin, vegetable fat and raw cane sugar. This mix contains nitrite obtained by enzymatic reduction of nitrate form celery. The nitrite content is 0.88%.

The experimental simulation made (test 3) has almost the same formula like test 1 the difference being that test 3 contains 1,98% iodized salt instead of 2% mixture salt and 0,3% functional mix. The heat treatment applied was the normal pasteurization. This test was analyzed in comparison with test 1 during 42 days, at the same intervals specified in chapter 8 and the analysis were similar to those described in chapter 8. (Figures 62, 63, 64, and 66).

Throughout the interval, test 3 was considered superior to test 1, in sensory terms. At the beginning of the evaluation interval the results were close but the last two evaluations showed that test 1 was more degraded than test 3. Taste and colour were the first two characteristics which reduced their acceptability. The texture was considered to be almost constant and the smell was degraded by the end of the period but was rated better than the taste and colour (Figure 64).

The measurements made by CIE L*a*b* method showed that test 3 was brighter than test 1 and in both cases the final value was higher than the initial one (Figure 66). Colour components a* and b* had almost equals values for the two simulations (Figures 67 and 68). At the end of the evaluation period both samples obtained lower values for the colour component a*. Chromatic component b* was higher for test 3 and the differences between the first day and the last day were very low.

Figure 64. Evolution of sensory characteristics of test 3 (simulation with functional mix) by the point of view of the panelists

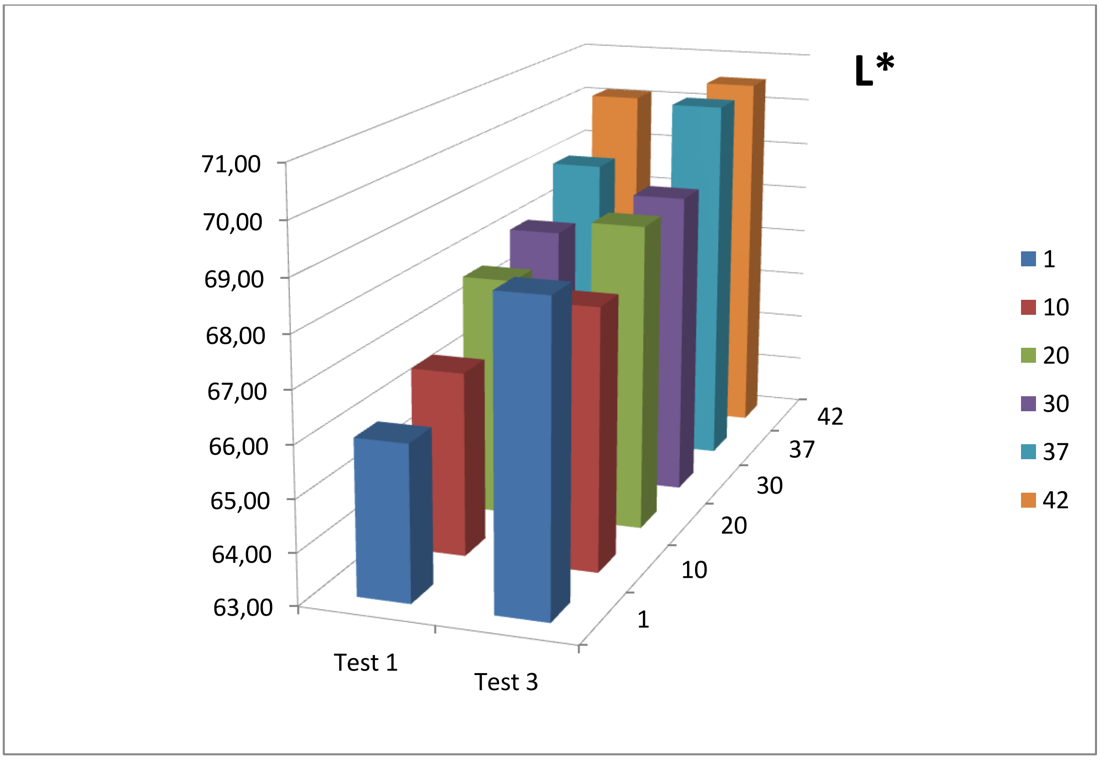

Figure 66. Comparing the brightness of test 1 (reference) and test 3 (simulation with functional mix

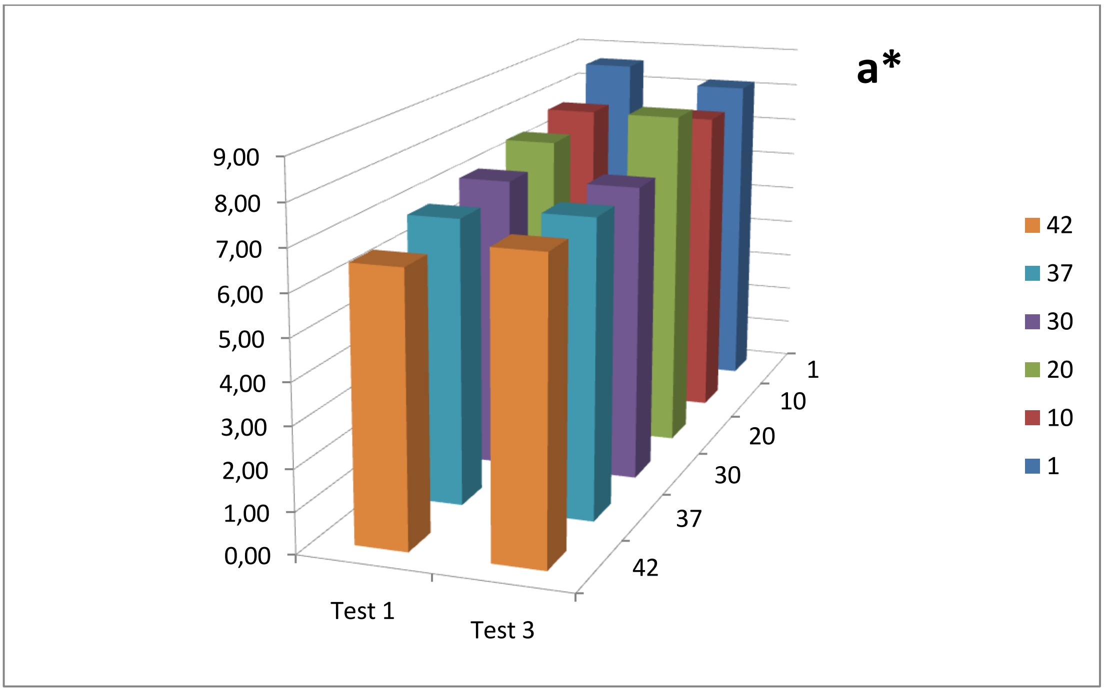

Figure 68. Comparison of chromatic component a* for test 1 (reference) and test 3 (simulation with functional mix)

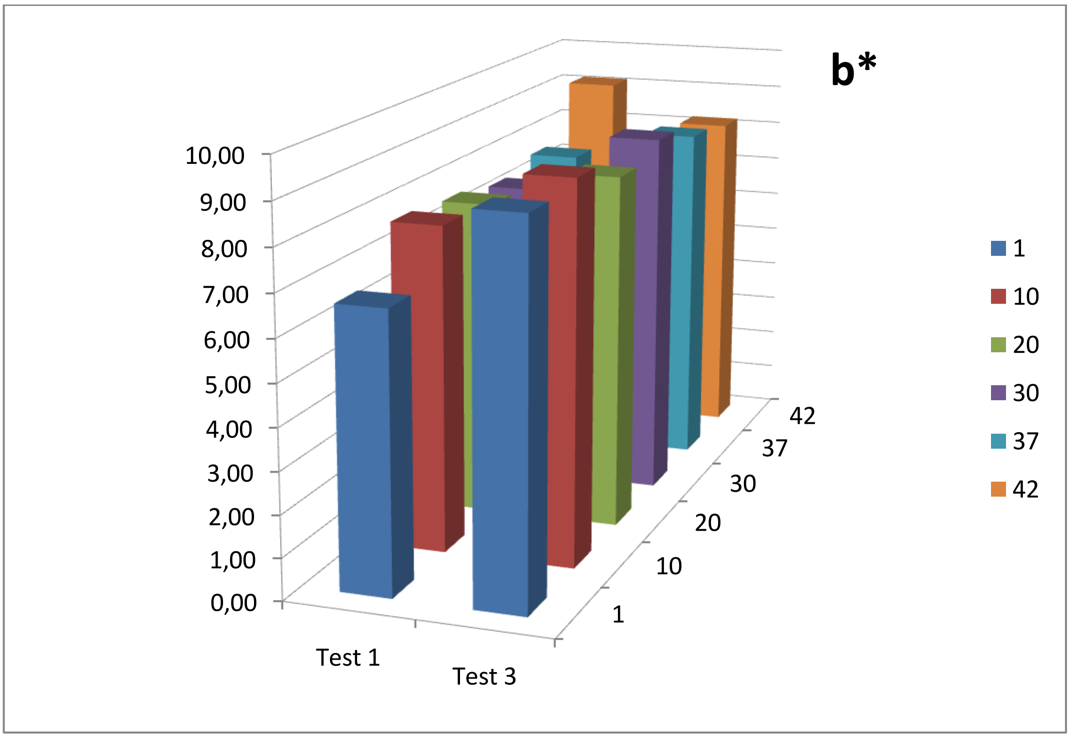

Figure 68. Comparison of chromatic component b* for test 1 (reference) and 3 (simulation with functional mix)

The results of measurements of residual nitrite of test 3, on days 1, 6, 10 and 15 after manufacturing were the same, namely, 5mg/1000g, and 4mg/1000g at the end of the evaluation interval. Percentage of residual nitrite in products with nitrite from natural sources is less than for products with chemical nitrite (MÂNDREAN and TIȚA, 2011a).

The total number has exceeded 10^5 ucf/g at day 42. On day 44 was determined the number of coliform bacteria in the product but they were absent. The product was considered to be safe for human consumption for 40 days from manufacturing.

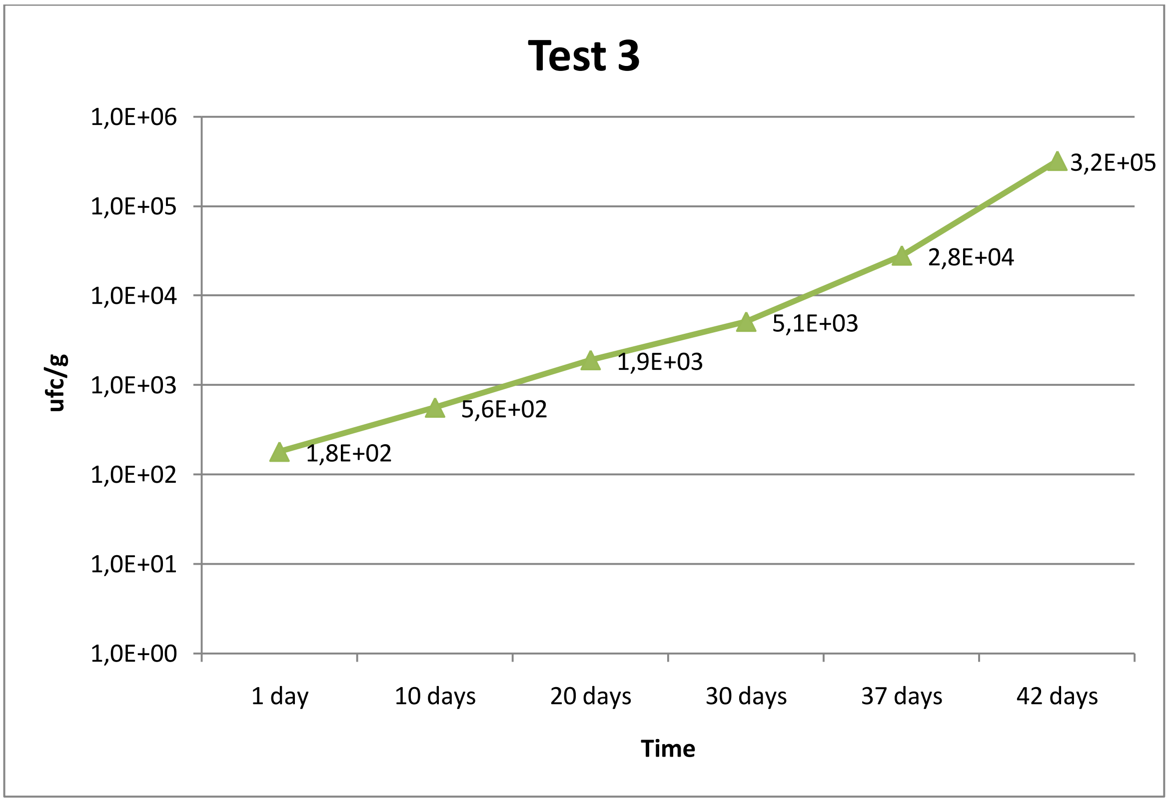

Figure 69. Evolution of the total number of germs in test 3 (simulation with functional mix)

Conclusions

Hurdle technology is an efficient method to ensure a safe product for consumption. Combination of Hurdle factors is not universal for all meat products. For each type of product are specific factors. Even it was investigated water activity it could not be used as a Hurdle for the bologna type sausage because it wasn't possible to be reduced to the needed level to inhibit harmful microorganism. For example for coliform bacteria this level is 0,95 but the sensory characteristics of the product do not allow to decrease it to this value.

Combining decreasing of pH with prolonged heat treatment yielded a product for that was possible to reduce half of the amount of nitrite, without affecting the sensory qualities. By applying this combination has been extended the shelflife of the product by 14 days. By determination of residual nitrite has been observed that its consuming rate is always above

30%. Not all nitrite is consumed during processing and by reducing the amount of nitrite added to the mixture of curing and the residual amount of nitrite is also reduced. The colour and flavor was almost the same in case of both tests. Prolonged heat treatment and pH decreasing resulted in providing to the product the conservation and antimicrobial action of nitrite and it's reducing with 50% is possible. Of course, for each product type, tests should be made because the minimum amount of nitrite necessary is different.

Substitution of chemical nitrite with a natural source proved to be a viable solution. Organoleptic characteristics were quite similar for the two samples. Even if the amount of nitrite comming from celery extract was lower than the chemical nitrite from the reference test, colour and flavor were not affected.

Determination of residual nitrite showed that nitrite from natural sources was almost completely consumed during processing which resulted in almost the same color as that of the reference test.

Personal contributions

Objectives of this doctoral thesis was made possible by a large accumulation of information from the literature but primarily through a large number of experimental determinations. In this sense we can define the following personal contributions which were reflected in releases that were made on various occasions (see list of published works):

- application of hurdle technology to a bologna type sausage

- use of high pasteurization as hurdle factor in order to reduce added nitrite to manufacture bologna type sausage<

- replacement of chemical nitrite used in the manufacture of a bologna type sausage *pork parizsi), with a natural source of nitrite

Future directions

Research started in this direction will be pursued by:

- application of hurdle technology at industrial level for cooked meat products, in the company Scandia Food;

- research on the effectiveness of nitrite in natural sources of bacteria Clostridium botulinum by studies undertaken with research centers in the country or abroad;

- possibilities for improving the manufacturing technology of cooked meat products.

Anexe 4. Scientif diseminations

List of published papers publicate

Papers in thesis area

1. **Mândrean Nicoleta, Tița Mihaela, Tița Ovidiu, Tița Cristina** (2009). The nitrite usage in meat industry in terms of food safety, In Proceedings of the 6th International conference Integrated systems for Agri-Food production, Nyiregyhaza, pag. 81 – 85, ISBN 978-963-9909-40-3 – **B+ (CNCSIS)**
2. **Mândrean Nicoleta, Oprean Letiția, Tița Ovidiu, Tița Mihaela** (2009). Implementation of HACCP system in the process of obtaining cooked salami. In Conference Proceedings volume II of Balkan region conference on engineering and business education & International conference on engineering and business education, Sibiu, pag. 399 – 402, ISSN 1843-6730 - **ISI Thomson Index**
3. **Mândrean Nicoleta**, **Tița Ovidiu** (2011). Celery, a natural alternative to chemical nitrite added to meat products. In Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj Napoca, Agriculture, volume 68(2), AcademicPres (EAP), Cluj Napoca, pag. 317-320, ISSN 1843-5246 **- ISI Thomson Index**
4. **Mândrean Nicoleta, Tița Ovidiu** (2011). The influence of the extent heat treatment and quantity of nitrite on colour of bologna type sausage (pork parizer). In Acta Alimentaria, Budapest, In press - **ISI Thomson Index**
5. **Mândrean Nicoleta, Tița Ovidiu** (2011). Assessment of hurdle technology application to meat products in order to reduce the amount of sodium nitrite used, In Proceedings of the 7th International Conference Integrated Systems for Agri-Food Production, Nyiregyhaza, pag.85-89 , ISBN 978-606-569-312-8, **B+ (CNCSIS)**
6. **Mândrean Nicoleta, Tița Ovidiu, Tița Mihaela** (2010). Pesticides in food. Solutions to avoid the contamination, In International Conference Agricultural and Food Sciences, Sibiu, ISBN 978-606-12-0068-9, pag. 29-34, **Conferință Internațională**

Others published papers

7. **Tița Ovidiu, Mândrean Nicoleta, Tița Mihaela, Tița Cristina Maria** (2009). Role of insurance for occupational accidents and occupational diseases in food industry In Proceedings of The 4th International Conference on manufacturing science and education, Sibiu, pag 345-348, ISSN 1843-2522, **Conferință Internațională**
8. **Ketney Otto, Tița Mihaela, Tița Ovidiu, Mândrean Nicoleta** (2009). The analyze of dairy products by the quality point of view and the role of these teachers activities in training for future specialists in milk industry. In Proceedings of The 4th International Conference on manufacturing science and education, Sibiu, pag 231-234, ISSN 1843-2522 , **Conferință Internațională**
9. **Tița Mihaela, Oprean Letiția, Tița Ovidiu, Păcală Mariana, Goncea Monica, Mândrean Nicoleta, Noje Alexandra, Tița Cristina** (2009). Research on the traceability of milk products as raw material in obtaining gouda cheese. In Proceedings of the 2nd International Proficiency testing conference, Sibiu, pag 245-249, ISSN 2066– 737X, **Conferință Internațională**

10. **Tița Ovidiu, Oprean Letiția, Tița Mihaela, Gașpar Eniko, Mândrean Nicoleta, Păcală Mariana, Iancu Ramona, Lengyel Ecaterina** (2010). The influence of external factors on the alcoholic fermentation of wine yeasts. In Proceedings VIII International Terroir Congress, Volume I, Soave, pag 125-128, ISBN 978-88-97081-05-0, **Conferință Internațională**
11. **Tița Ovidiu, Oprean Letiția, Tița Mihaela Gașpar Eniko, Mândrean Nicoleta, Iancu Ramona, Lengyel Ecaterina** (2010). Capacite de fermentation des levures de vin par ajout de thiamine exogene. In Actes du Sixieme Colloque Franco-Roumain de Chimie Appliquee, COFrRoCA-2010, Orleans, pag. 175, ISSN 2068-6382, **Conferință Internațională**
12. **Tița Ovidiu, Oprean Letiția, Tița Mihaela, Gașpar Eniko, Mândrean Nicoleta, Lengyel Ecaterina, Tița Cristina** (2010). Recherches physico-chiques sur les qualites biotechnologiques des levures de vin. In Actes du Sixieme Colloque Franco-Roumain de Chimie Appliquee, COFrRoCA-2010, Orleans, pag. 176, ISSN 2068-6382, **Conferință Internațională**
13. **Ketney Otto, Tița Mihaela Adriana, Tița Ovidiu, Tița Cristina, Mândrean Nicoleta** (2009). Evaluation and monitoring milk - raw material quality in Maramures county in terms of content in aflatoxins. In Conference Proceedings volume II of Balkan region conference on engineering and business education & International conference on engineering and business education, Sibiu, pag. 407-410, ISSN 1843-6730 – **ISI Thomson Index**
14. **Ketney Otto, Tița Mihaela Adriana, Tița Ovidiu, Oprean Letiția, Mândrean Nicoleta** (2009). Elisa techniques to detect aflatoxins M1 in dairy products and the role of these activities in the training of the future specialists in expertise and quality control of milk and dairy products. In Conference Proceedings volume II of Balkan region conference on engineering and business education & International conference on engineering and business education, pag. 411-413, ISSN 1843-6730 - **ISI Thomson Index**

International seminar

An seminar with the subject “Role of nitrite an nitrate in meat products” sustaiend in Budapest as part of TECH.FOOD project (Nr. SEE/A/160/1.1/X), „Solutions and interventions for the technological transfer and the innovation of the agro-food sector in South East regions”

INVITATION

The TECH.FOOD project (Nr. SEE/A/160/1.1/X), „Solutions and interventions for the technological transfer and the innovation of the agro-food sector in South East regions" invites you to participate on the thematic course. **„Nitrites and nitrates in the meat industry"**

11. August 2011. 10,00 o'clock
Hungarian Meat Research Institute
1097 Budapest, Gubacsi út 6/b.

10,00 – 10,30
- **Introduction, presentation of the TECH.FOOD project**
  Kovács Ágnes, project manager, HMRI

10,30 – 11,30
- **Nitrite addition to meat products. Food safety and meat quality aspects**
- Dr. Zsarnóczay Gabriella, director, HMRI

11,30 – 12,00
- Coffee brake

12,00 – 13,30
- **Role of nitrite and nitrate in the meat products**
  Nicoleta Mandrean, PhD Student, Lucian Blaga University from Sibiu, Romania
- **13,30 – 14,00**
- **Questions and answers**

The project is financed by the EU SEE (South East Europe) Transnational Cooperation Programme and the Hungarian Government

Dr. Zsarnóczay Gabriella
director

Kovács Ágnes
project manager

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3. **Autar K., Egwu K. And Duc N.** (2008). Numerical methods with applications, Lulu.com, Raleigh
4. **Banu C.** (2007). Suveranitate, securitate şi siguranţă alimentară, Editura ASAB, Bucureşti
5. **Banu C.** (2009). Tratat de industrie alimentară. Tehnologii alimentare, Editura ASAB, București
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