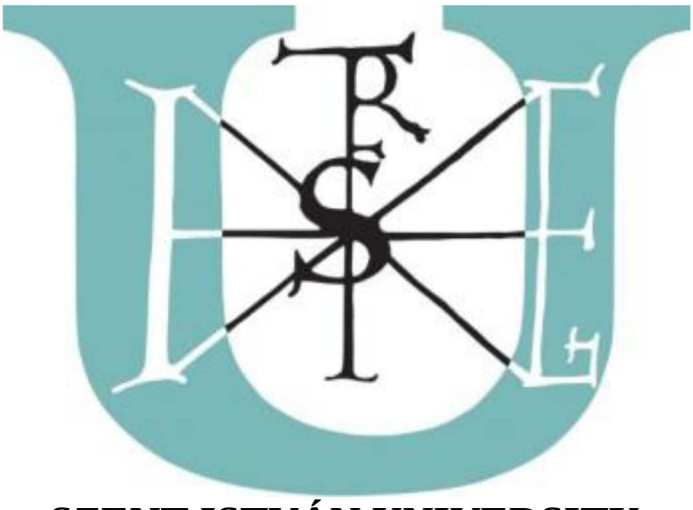

SZENT ISTVÁN UNIVERSITY
FACULTY OF FOOD SCIENCE

Theses of (Ph.D) dissertation

Effect of the combined minimal heat treatment and high hydrostatic pressure processing on the quality parameters of pork

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1. Inroduction and objectives

The sous-vide mild heat treatment is becoming more and more popular and it is already applied on a daily basis as a routine. The literature on this topic also states that there is a significant risk concerning food safety when producing and marketing mild heat treated products. As a novelty, sous-vide meat products appeared in retail, is therefore controversial. Sous-vide treatment applies a combination of three hurdles (vacuum packaging, heat treatment, refrigeration), a combination of preservation methods, which is a good example of using the Leistner hurdle theory. High hydrostatic pressure may be another barrier in this technology line so that these products of preferred sensory properties pose a lower risk.

During my doctoral research, these two minimal processig methods were in focus. The consecutive application of the sous-vide (anaerob LT-LT type heat treatment) and non-thermal HHP technology was investigated.

How does this two-step technology affect the properties of pork chops chosen as a raw material? Are there new effects compared to single treatments?

Beside the single heat treatment (60 ° C / 60 min) and single pressure treatment (300 and 600 MPa), I applied these treatments in combination in both treatment orders as well.

My research included the analysis of the microbiological parameters (aerobic, anaerobic and facultative anaerobic count, *L. monocytogenes* challenge test with an initial 5,3 logN/g) the changes in the structure of proteins (DSC, SDS-PAGE), pH, weight loss, dry matter%, color, texture, water holding capacity, TBA, fatty acid composition. The analysis of volatile components with electronic nose and analysis of NIR spectra allowed a complex comparison. During the 21-day storage experiment at 2 ° C and 8 ° C, the stability of the samples was investigated.

Based on my results, I can conclude that by combining the treatment methods, samples remained microbiologically adequate even during 21 days of storage at 8 ° C, even if the applied pressure treatment level was only 300 MPa. In contrast, the applied treatment levels (single heat treatment or pressure treatment) alone did not result in a microbiologically stable product during the 21 days storage at 8 ° C. At 300 MPa, the pressure-treated sample also exhibited the germ levels above the deterioration threshold even at the low (2 ° C) storage temperature for all three microbe groups.

The combined treatments where heat treatment followed the pressure treatment results in a safer and more stable product than in the case of using same treatments in reverse order. In this case, the *Listeria monocytogenes* remained below the detection level even at the higher storage temperature (21 days at 8 ° C), while the number of mesophilic aerobes, mesophilic anaerobic and facultative anaerobic microbes was significantly reduced by about two orders compared to the treatments in reverse order.

Pressure treatment with sous-vide heat treatment proved to be a more gentle technology than applying the same treatments in reverse order. The degree of denaturation of the proteins, the preservation of color and weight loss were less varied than in the reverse order treatments. Based on my experiments, I found a significant effect of the treatment sequence on these properties.

Electronic nose and near infrared spectroscopy (NIR) are suitable for distinguishing pork chops preserved by combined methods based on their complex signal response. The electronic nose was able to make difference between the pressure levels and the NIR technique showed greater differences in the order of treatment.

In the combination of heat and pressure treatment, several measured properties showed no further degradation / change compared to the single treatments. Its

main significance is primarily related to the sous-vide heat treatment that creates the special organoleptic character. If important quality parameters do not change significantly due to HHP treatment in the technology row and food safety is not compromised, this combined dual treatment may be well-founded. At 300 MPa, the above values have been achieved. With a pressure treatment at 600 MPa in some cases causing further quality changes were observed in the samples (color, weight loss, TBA, texture). The treatment combination (HHP600 + SV), which resulted in the most stable microbiological condition during the 21-day storage period of 8 ° C, had the most powerful effect on other quality characteristics of the samples as well.

2. New scientific results (Thesis)

1. I proved that applying combined processsing methods (high pressure treatment: 300 or 600 MPa, 5 min., at ambient temperature;and low temperature heat treatment: 60 °C / 60 min.) pork chop (*musculus Longissimus thoracis et lumborum*) was microbiologically safe after a 21 day storage period at 8°C, even if the 300 MPa pressure level was applied. The processing methods applied as single treatments could not result in a safe product after the 21 days starage at 21 °C.

2. I found evidence that applying high pressure processing (300 or 600 MPa, 5 min., at ambient temperature) followed by the low temperature heat treatment (60 °C-os 60 perc) on pork chops (*musculus Longissimus thoracis et lumborum*) resulted in a safer product than in the case of applying the same two treatments in the reverse order, as the samples' microbial results were more stable even at the higher storage temperature (8 °C / 21 days). (*Listeria monocytogenes* CFU was below detection limit, while mezophil aerob, mezophil anaerob and fac. anaerob CFU was lower than in the samples where heat treatment was followed by the pressure treatment.

3. Proof was found that the pressure level has significant effect on weight loss, on redness (CIELab a*), on yellowness (CIELab b*) and on protein denaturation in the case of combined heat and pressure treated (heat treatment:60°C-os 60 min. pressure treatment: 300 or 600 MPa, 5 min., ambient temperature) pork chop samples (*musculus Longissimus thoracis et lumborum*).

4. I found proof through experience that the order of the treatment has significant effect on the weight loss, on redness (CIELab a*) and on the protein denaturation level of the combined heat (60 °C, 60 min.) and pressure (300 or 600 MPa, 5 min., ambient temperature) treated pork chop samples (*musculus Longissimus thoracis et lumborum*).

5. I proved that applying heat treatment (60 °C-os 60 perc) followed by the pressure treatment (300 or 600 MPa, 5 min., room temperature) on pork chop samples (*musculus Longissimus thoracis et lumborum*) is more gentle than the application of the same processing steps in the reverse order as some quality parameters were modified to a lesser extent (protein state, weight loss, color parameters).

6. I proved that complex data obtained from chemical sensors (Electronic nose) and near infrared spectroscopy (NIR) is suitable to distinguish pork chop samples (*musculus Longissimus thoracis et lumborum*) treated by combined processsing methods (high pressure treatment: 300 or 600 MPa, 5 min., at ambient temperature; and low temperature heat treatment: 60 °C / 60 min.).The electronic nose was able to separate samples by pressure level while the NIR method detected the treatment order.

3. Conclusions and recommendations

Based on the storage test carried out at two temperatures, it is possible to answer the question of how far the temperature exceeds the food safety risk and what other quality changes occur at handling and storing the sous-vide products. Combined heat and pressure treated samples that remained stable even at the elevated (8 ° C) temperatures demonstrate the effectiveness of the combination of the two minimal processing treatments applied in the study.

4. Related Publications

I. In IF-journals

Gy Kenesei, G Jónás, B Salamon, I Dalmadi

Thermograms of the combined High Hydrostatic Pressure and Sous-vide treated Longissimus dorsi of pork

JOURNAL OF PHYSICS-CONFERENCE SERIES 950: Paper 042007. 6 p. (2017) (IF: 0,45)

G Jonas, B Csehi, P Palotas, A Toth, **Gy Kenesei**, K Pasztor-Huszar, L Friedrich

Combined effects of high hydrostatic pressure and sodium nitrite on color, water holding capacity and texture of frankfurter

JOURNAL OF PHYSICS-CONFERENCE SERIES 950: Paper 042006. 6 p. (2017) (IF: 0,45)

Darnay Lívia, Dankovics Adrienn, Friedrich László, **Kenesei György**, Molnár Brigitta, Balla Csaba

Production of low-salt frankfurters with microbial transglutaminase

ACTA ALIMENTARIA HUNGARICA 43:(Suppl.) pp. 45-50. (2014) (IF: 0,456)

II. Conferences

Dalmadi I, Farkas V, **Kenesei Gy**

Effects of combinations of minimal processing techniques on the properties of seasoned pork meat determined by electronic nose

In: Engelhardt Tekla, Dalmadi István, Baranyai László, Mohácsi-Farkas Csilla (szerk.)
Food Science Conference 2015 - Integration of science in food chain: Book of proceedings. Budapest, Magyarország, 2015.11.18-2015.11.19. Budapest: Corvinus University of Budapest, 2015. pp. 44-47. (ISBN:978-963-503-603-5)

Dalmadi I., Salamon B., **Kenesei Gy.**

Effect of combinations of minimal processing techniques on the properties of pork and beef meat determined by electronic nose

In: Engelhardt Tekla, Dalmadi István, Baranyai László, Mohácsi-Farkas Csilla (szerk.) Food Science Conference 2015 - Integration of science in food chain: Book of proceedings. Budapest, Magyarország, 2015.11.18-2015.11.19. Budapest: Corvinus University of Budapest, 2015. pp. 40-43. (ISBN:978-963-503-603-5)

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Nir spectrum of the combined ltlt and hhp treated longissimus dorsi of pork

In: Engelhardt Tekla, Dalmadi István, Baranyai László, Mohácsi-Farkas Csilla (szerk.) Food Science Conference 2015 - Integration of science in food chain: Book of proceedings. Budapest, Magyarország, 2015.11.18-2015.11.19. Budapest: Corvinus University of Budapest, 2015. pp. 121-124. (ISBN:978-963-503-603-5)

Kenesei Gy, Végh A, Salamon B, Dalmadi I

Sensory analysis and electronic nose of pork meat patties treated by heat and/or high hydrostatic pressure

In: Engelhardt Tekla, Dalmadi István, Baranyai László, Mohácsi-Farkas Csilla (szerk.) Food Science Conference 2015 - Integration of science in food chain: Book of proceedings. Budapest, Magyarország, 2015.11.18-2015.11.19. Budapest: Corvinus University of Budapest, 2015. pp. 125-128. (ISBN:978-963-503-603-5)

Őri-Korompa E, Simon-Sarkadi L, Mednyánszky Zs, Kiskó G, **Kenesei Gy**, Friedrich L

Changes in free amino acid and biogenic amine content od sous vide treated meat

In: Engelhardt Tekla, Dalmadi István, Baranyai László, Mohácsi-Farkas Csilla (szerk.) Food Science Conference 2015 - Integration of science in food chain: Book of proceedings.: Budapest, Magyarország, 2015.11.18-2015.11.19. Budapest: Corvinus University of Budapest, 2015. (ISBN:978-963-503-603-5)

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In: Dalmadi I, Engelhardt T, Bogó-Tóth Zs, Baranyai L, Bús-Pap J, Mohácsi-Farkas Cs (szerk.) Food Science Conference 2013 - With research for the success of Darányi Program: Book of proceedings. Budapest, Magyarország, 2013.11.07-2013.11.08. Budapest: Budapesti Corvinus Egyetem, Élelmiszertudományi Kar, 2013. pp. 291-294. (ISBN:978-963-503-550-2)

Kenesei Gy, Romvári R, Dalmadi I

Fatty acid composition of thermal / pressure processed pork chops

In: Livia Simon Sarkadi (szerk.) XIXth EuroFoodChem Conference. Budapest, Magyarország, 2017.10.04-2017.10.06. (Biochemical Section of the Hungarian Chemical Society) Budapest: Hungarian Chemical Society, 2017. p. 148.

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Effect of combined sous-vide and high hydrostatic pressure treatment on the quality and safety of pork chop

In: FoodMicro 2016 Abstract Book. 595 p. Dublin, Írország, 2016.07.19-2016.07.21. Dublin: p. 465.

Kenesei Gy, Jónás G, Salamon B, Dalmadi I

DSC curves of the HHP and LTLT treated Longissimus dorsi of pork

In: The Malta Consolider Group (szerk.) International Conference on High Pressure Science and Technology: Book of Abstracts. 573 p. Madrid, Spanyolország, 2015.08.30-2015.09.04. Madrid: p. 286.

Őri-Korompai E, Simon-Sarkadi L, Mednyánszky Zs, Kiskó G, **Kenesei Gy**, Friedrich L

Effect of sous vide treatment on free amino acid and biogenic amine content of different meat types during storage

In: EuroFoodChem XVIII.. Madrid, Spanyolország, 2015.10.13-2015.10.16. Paper CHC-P-182.

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Textural changes of the LTLT and HHP treated Longissimus dorsi of pork

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E Őri-Korompai, L Simon-Sarkadi, Zs Mednyánszky, G Kiskó, **Gy Kenesei**, L Friedrich

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Istanbul:2014. (European Chemistry Congress - 5th EuCheMS Book of Abstracts) Book of Abstracts vol 3. p.650.