Changes in the microbiological quality and content of biogenic amines in chicken fillets packed using various techniques and stored under different conditions

Marta Chmiel[1], Olga Świder[2], Elżbieta Hać-Szymańczuk[3], Aneta Cegiełka[1], Lech Adamczak[1], Tomasz Florowski[1], Dorota Pietrzak[1], Marcin Bryła[2], Marek Roszko[2]

[1] Division of Meat Technology, Department of Food Technology and Food Evaluation, Warsaw University of Life Sciences - SGGW, 166 Nowoursynowska Street, 02-787 Warsaw, Poland
[2] Department of Food Safety and Chemical Analysis, Institute of Agricultural and Food Biotechnology, 36 Rakowiecka Street, 02-532 Warsaw, Poland
[3] Department of Food Biotechnology and Food Microbiology, Warsaw University of Life Sciences - SGGW, 166 Nowoursynowska Street, 02-787 Warsaw, Poland

Introduction: As an indicator for food safety and quality biogenic amines (BAs) are recently proposed, as an increase in the BAs content of a food product during the storage can be used to assess food spoilage process (Ruiz-Capillas, & Herrero, 2019). The aim of this study was to determine the BAs formed in chicken breast meat packaged using different techniques during the storage under different conditions, to correlate the microbiological quality of chicken meat with BAs formation and to assess the suitability of selected BAs as indicators of chicken meat spoilage.

Material and methods: The study material was skinless, boneless chicken fillets (m. pectoralis major) obtained and then packed in industrial conditions in three experimental series. Meat packaged in either air packaging (AP), high-oxygen modified atmosphere Hi-O2-MAP (75% O2 and 25% CO2), or vacuum (VP) was stored in a cold room (2.2 °C±0.3 °C) or exposed in a display case (average temperature 3.5 °C) for 9 days. From each of the packaging techniques 24 packages were prepared, which amounted to 72 packages in total. The quality of the meat was determined on day 1, 3, 6, 7, 8 and 9 of the storage or exposure time. The microbiological analyses included the determination of the total plate count (TPC) of aerobic mesophilic microorganisms (PCS, 2013), lactic acid bacteria – LAB (PCS, 2002), count of Pseudomonas spp. (PCS, 2010) and count of Enterobacteriaceae (PCS, 2005). The method used for determination of biogenic amines was based on our previous reports (Świder, Roszko, Wójcicki, & Szymczyk, 2020). Biogenic amine index (BAI) was calculated by summing putrescine, cadaverine, histamine and tyramine levels according to Triki et al. (2018). The One-Way ANOVA analysis of variance was used to determine the influence of time or conditions of storage or packaging technique on the meat quality. The detailed testing was conducted using Tukey's HSD test (significance level $\alpha = 0.05$). Pearson's correlation coefficients were used to determine the relationship between BAs and bacterial counts.

Results: The initial TPC of chicken fillets was 2.57-3.04 log cfu/g. Over time, regardless of the packaging technique and storage conditions, a systematic, significant ($p \leq 0.05$) increase in TPC was observed to >7.5 log cfu/g (AP and VP; display case) determined on day 9th. In case of LAB, the maximum level of 7 log cfu/g was exceeded on day 9th for AP meat stored in the cold room and on day 9th for AP and VP meat from the display case. Cadaverine and tyramine dominated in quantitative terms in chicken fillets, regardless of packaging technique and storage conditions (166.00 mg/kg in AP meat in cold room on day 9th and 175.03 mg/kg on day 9th in MAP meat in display case, respectively). With the storage time, the content of putrescine, and to a lesser extent histamine (up to 5.98 mg/kg on day 8th in VP meat in display case), also increased. On the basis of the values of correlation coefficients between the bacterial groups and the concentration of particular BAs, it was found that the most useful for the evaluation of chicken meat freshness would be the determination of cadaverine, putrescine contents or BAI. Taking into account the BAI, chicken fillets packed in Hi-O2-MAP, stored both in the cold room and exposed in the display case were characterized by the highest quality. The BAI value for Hi-O2-MAP chicken meat exceeded 50 mg/g on the 7th day of storage, both in the cold room and in the display case.

Conclusions: The results of this study indicate that there is a potential to gain understanding of spoilage of packed chicken meat through the analysis of biogenic amines content in association with microbiological analysis.

Literature:

1. Ruiz-Capillas, C., & Herrero, A. M. (2019). Impact of biogenic amines on food quality and safety. Foods, 8, 62.
2. PCS. (2002). Polish Standard PN-ISO 15214:2002. Microbiology of Food and Animal Feeding Stuffs: Horizontal Method for the Enumeration of Mesophilic Lactic Acid Bacteria. Plate method at 30 °C. Polish Committee for Standardization, Warsaw.
3. PCS. (2005). Polish Standard PN-ISO 21528-2:2005. Microbiology of Food and Animal Feeding Stuffs. Horizontal Methods for the Detection and Enumeration of Enterobacteriaceae. Part 2: Colony-count method. Polish Committee for Standardization, Warsaw.
4. PCS. (2010). Polish Standard PN-EN ISO 13720:2010. Meat and Meat Products - Enumeration of Presumptive Pseudomonas spp. Polish Committee for Standardization, Warsaw.
5. PCS. (2013). Polish Standard PN-EN ISO 4833-2:2013-12. Microbiology of the Food Chain. Horizontal Method for the Enumeration of Microorganisms. Part 2. Colony Count at 30 Degrees C by the Surface Plating Technique. Polish Committee for Standardization, Warsaw.
6. Świder, O., Roszko, M. Ł., Wójcicki, M., & Szymczyk, K. (2020). Biogenic amines and free amino acids in traditional fermented vegetables-dietary risk evaluation. Journal of Agricultural and Food Chemistry, 68, 856-868.
7. Triki, M., Herrero, A. M., Jiménez-Colmenero, F., & Ruiz-Capillas, C. (2018). Quality assessment of fresh meat from several species based on free amino acid and biogenic amine contents during chilled storage. Foods, 7, 132.