Influence of air contact and pre-packaging treatment on the color stability of vacuum packaged beef

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I. INTRODUCTION

Today the most used aging method for meat is wet aging [1]. In this aging method, the meat is vacuum packaged and stored at low temperatures for a certain time [1]. Endogenous enzymes tenderize the meat, while spoilage, pathogen growth, and drying loss are minimized by the protective vacuum packaging [1]. As the color of meat is an important quality indicator for the customers, it is of highest importance, that the meat keeps its color during storage [2,3]. To test the influence of different (mis)treatments of the meat such as mechanical damage and extended storage at air before packaging, as well as different extents of vacuum, meat samples are packaged, and their spectral data is measured over the storage time. From the spectral data, the change of myoglobin redox forms is calculated to obtain information regarding discoloration processes. The experiment aims to determine the extent of the impact of the factors and whether production processes require optimization in certain areas.

II. MATERIALS AND METHODS

Vacuum packaged beef (from 3 young bulls) shoulder parts obtained frozen at -18 °C and thawed for 2 days at 2 °C. Then the packages are opened, and connective tissue and fat are manually removed using a knife. Afterwards, the samples are treated and packaged in polyamide/polyethylene foil as shown in Tab. 1. A slice of each animal underwent the different treatments to obtain biological replicates. The technical replicates were achieved by measuring each sample in triplicate.

Table 1 – Treatment methods and packaging atmospheres of the beef samples.

Atmosphere	Composition/Treatment
High Vacuum (HV)	15 mbar residue pressure
High Vacuum punctured (HV punctured)	15 mbar residue pressure, samples are punctured with a meat tenderizer before packaging
High Vacuum 2 hours of air contact (HV 2h Air)	15 mbar residue pressure, samples are in air contact for 2 hours before packaging
Low Vacuum (LV)	60 mbar residue pressure
Synthetic air (Air)	20 % oxygen, 80 % nitrogen

After packaging, the spectra of the samples were measured in the packaging over a time period of 14 days using a HunterLab UltraScan VIS 1091 Spectrophotometer. Between the measurements, the samples are stored dark at 2 °C. The sample packages and measurements both were performed in duplicate. The spectral data was used to calculate the myoglobin redox forms according to Li et al. [2]

III. RESULTS AND DISCUSSION

The calculated myoglobin redox forms can be seen in Fig. 1. The oxymyoglobin (OMb) levels show similar and constant values of all vacuum packaged samples between 0.3 and 0.4. An exception are the samples that were exposed to air before packaging and reached a value of 0.54, which is even higher than the value of the air-packed sample that was used as a reference (0.49). After one day of storage, the OMb levels of the HV 2h Air samples dropped to the level of the other vacuum packaged

samples, while the air packaged samples obtained their higher OMb level. This behavior can be explained by oxygen consumption due to mitochondrial respiration, leading to the deoxygenation of the oxymyoglobin [3]. The deoxymyoglobin (DMb) levels behave similar to all vacuum packaged samples except the HV 2h Air samples. They start at DMb levels around 0.75 increase slightly over the first day and then decline to final levels around 0.67. The HV 2h Air and Air samples start at lower DMb levels around 0.67 with the air sample constantly decreasing.

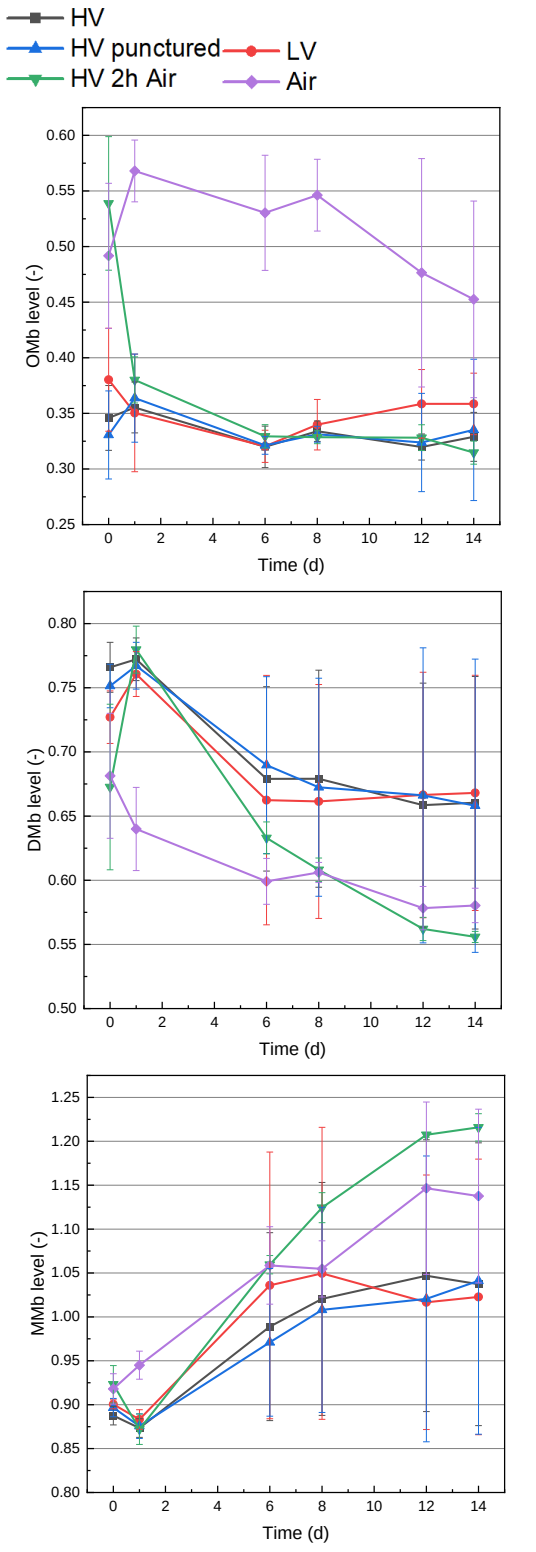

Figure 1. Oxy- (A), deoxy- (B), and metmyoglobin (C) levels of beef samples during storage.

The HV 2h Air samples show a strong increase in DMb levels over the first day in connection to the OMb decrease due to mitochondrial respiration [3]. Afterwards the DMb levels decrease strongly to slightly above 0.55 at day 14. This observation can be explained with the strong increase in metmyoglobin (MMb) levels of the samples. While all samples start at similar MMb levels around 0.9 the HV 2h Air samples show the highest final values of 1.22. The second highest MMb level is reached by the air packaged samples (1.12). The remaining vacuum packaged samples reach final values between 1.00 and 1.05. As the OMb level of these vacuum-packed samples is relatively stable, the decrease in DMb level and the corresponding increase in MMb level can be explained by MMb formation during storage, which leads to discoloration of the meat.

IV. CONCLUSION

The extent of vacuum applied in this experiment or mechanical damage did not influence the discoloration strongly. The prolonged air contact pre-packaging however, negatively influenced the meat color leading to higher MMb levels than simple air storage. These findings suggest that for optimal color stability, meat should be packaged as quickly as possible.

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REFERENCES

1. Terjung, N., Witte, F., & Heinz, V. (2021). The dry aged beef paradox: Why dry aging is sometimes not better than wet aging. Meat Science, 172, 108355.
2. Li, X., Lindahl, G., Zamaratskaia, G., Lundström, K. (2012). Influence of vacuum skin packaging on color stability of beef longissimus lumborum compared with vacuum and high-oxygen modified atmosphere packaging. Meat Science, 92(4), 604-609.
3. Mancini, R. (2013). Meat color. The science of meat quality, 177-198.