



INVESTIGATION ON THE SPOILING OF MEAT USING PTR-MS

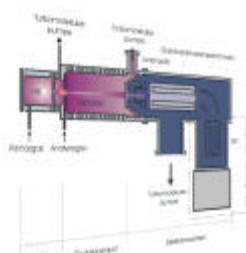
D. MAYR^a, R. MARGESIN^b, F. SCHINNER^b, T.D. MÄRK^a

^aInstitut für Ionophysik, Universität Innsbruck, Technikerstr. 25, A-6020 Innsbruck, Austria
^bInstitut für Mikrobiologie, Universität Innsbruck, Technikerstr. 25, A-6020 Innsbruck, Austria

Introduction

The method currently used for determining the status of meat, with respect to spoilage, is analysis of the counts of total bacteria and/or specific spoilage bacteria. An obvious drawback with a bacteriological method is the incubation period of 1-2 days that is required for colony formation. For enrichment cultures several days are needed. In the present work we have measured the concentrations of several "spoiling compounds" in the headspace air of different kinds of meat that was stored at 4 °C. We compared beef and pork as well as the effect of different kinds of packaging (normal air versus vacuum). The goal of these investigations is to replace the time-consuming bacteriological method by fast headspace air measurements to facilitate the investigation of a huge number of meat samples in very short time and to determine the remaining shelf-life of meat during storage from the emissions.

Schematic representation of the PTR-MS



Experimental

The measurements were performed using a Proton-Transfer-Reaction-Mass-Spectrometer (PTR-MS) system that allows for on-line monitoring of the concentrations of volatile organic compounds (VOCs). The system and measuring procedure has been described in detail in Refs. (1) and (2). The meat samples (about 15 g) were placed in a glass flask (300 ml) that was incubated at 25 °C. The headspace air was drawn at 114 ml/min by a vacuum pump, 14 ml/min of which was led through a heated teflon transfer line into the PTR-MS system for on-line analysis. The mass spectrometric data were collected for $m = 20-260$ amu. The meat samples were all cut from the same piece of meat, and each of them was separately packed and stored at 4 °C in a refrigerator. The emissions of 22 pork samples packed in normal air were measured one by one in the course of 13 days. Seventeen beef samples packed in normal air and 16 beef samples packed in vacuum were investigated in the same way for 10 days. An additional experiment was to measure the VOCs of vacuum-packed beef that was exposed to air after unpacking and incubated for 2 days at 25 °C after a storage time of 6.4 days at 4 °C.

Results

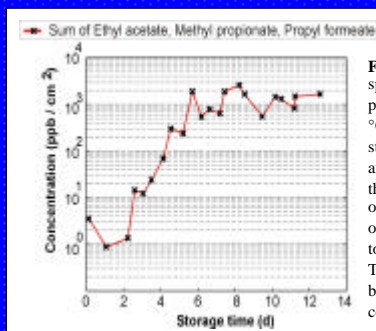


Fig. 1: Concentration of typical spoiling compounds emitted by pork pieces that were stored at 4 °C for 13 days. The concentrations started to exponentially increase after 3.5 days. After about 6 days the concentrations remained more or less unchanged. This behavior of the emitted VOCs corresponds to a typical bacterial growth curve. Therefore, we conclude that bacteria produce these components.

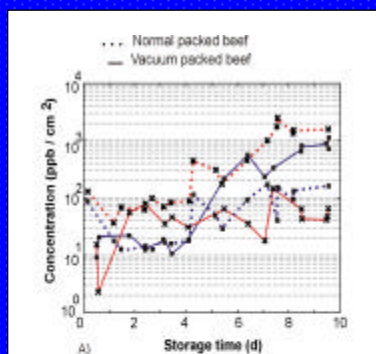
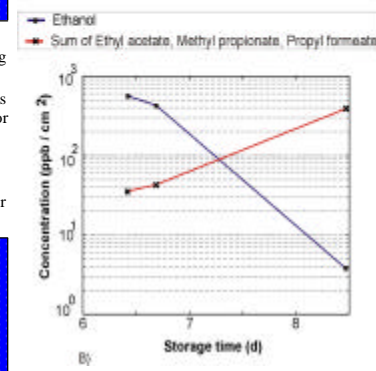


Fig. 2: A) Comparison of the emissions of normal air-packed and vacuum-packed beef in the course of time: The C3-esters (ethylacetate, methylpropionate, propylformate) are typical spoiling compounds emitted under aerobic conditions (normal air packed beef), and ethanol is typically emitted under anaerobic conditions (vacuum-packed beef). B) A vacuum-packed beef sample was stored after a first measurement (storage time = 6.4 d at 4°C) unwrapped in an open glass flask for 2 days at 25 °C, and emissions were measured 6.5 and 49.25 h after the first measurement. Ethanol, the typical spoiling compound emitted by vacuum-packed meat, strongly decreased and the C3-esters increased. Lactic bacteria producing ethanol under anaerobic conditions can also grow under aerobic conditions but stop ethanol production. So either lactic bacteria switched over their metabolism or aerobic bacteria (producing C3-esters) replaced the lactic bacteria with time.



Conclusion

In the present work we have found that the time dependence of some VOCs emitted by spoiling meat seems to be comparable to a bacterial growth curve. We have shown big differences in the emissions of normal air- and vacuum-packed meat, which result from different bacteria living under aerobic and anaerobic conditions. Encouraged by these results we will repeat the measurements and additionally we will carry out a bacteriological examination at the same time.

References

- (1) W. Lindinger, A. Hansel, A. Jordan, *Int. J. Mass Spectrom. Ion Processes* **173** (1998) 191-241.
- (2) A. Hansel, A. Jordan, R. Holzinger, P. Prazeller, W. Vogel, W. Lindinger, *Int. J. Mass Spectrom. Ion Processes* **149/150** (1995) 609-619.

Acknowledgement

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