

REDOX POTENTIAL OF MEAT AND MEAT PRODUCTS

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Background:

Well known is the significance of the redox potential for microorganisms and therefore for the durability of food. However in meat products, this important parameter is not often used for the prediction of stability. This may be because one can produce reliable and reproducible readings of the redox potential only under certain conditions and because of a lack of practical applications, as a result of partly inaccurate measuring methods. Until today, only few surveys on redox potentials in meat and meat products are available (Snyder, 1996; Tomas, 1978; Wieberg and Nielsson, 1980; Wirth, 1974; Wirth and Leistner, 1969; Wojciechowski et al., 1976).

Objectives:

The objectives of this study are to describe briefly how to measure redox potentials (E_h) of meat and meat products and to give a compilation of typical redox potential values (E_h) of the different meat products on the German market. The redox potentials of different groups of meat and meat products are listed.

Method and Material:

According to the method of Rödel & Scheuer (1998) a combined calomel redox electrode (SCHOTT Geräte GmbH, Germany) was used for measuring in meat and meat products. The E_h -values were calculated according to the formula [$E_h = E + E_{\text{reference}}$]. The redox potential of meat, raw fermented sausage, raw cured ham, cooked sausage, scalding sausage, cooked ham type products, poultry meat products and canned sausage were measured and discussed.

Results and Discussion:

The redox potentials of meat products show a dramatic change compared to their starting material raw meat (see Fig. 1). Whereas the E_h values of raw meat are roughly between -200 to -300 mV in a negative area, those of meat products are in the positive area, with few exceptions. Processing such as fermentation or heating (cooking, scalding) as well as ingredients and additives (i.e. sodium ascorbate and sodium nitrite) obviously lead to a completely changed redox system in the processed product. The processed meat products can be divided into two groups according to their redox potentials. The fermented raw meat products (raw fermented sausage and raw ham) with E_h values from 100 to 200 mV and the heated meat products (cooked and scalding sausage as well as canned sausage) with values from -25 to 100 mV (see Fig. 1).

Redox potential of fresh meat

The redox system "fresh meat" cannot be compared to the redox system in the processed end product. The measuring values of fresh meat are in a very negative range, the median for fresh pork being roughly -200 mV and thus a little higher than the median for fresh beef at -250 mV. The redox potential value of fresh meat is difficult to determine because it seems to be not "buffered" and therefore is sensitive even to slight disturbances. For this reason it is absolutely necessary to cool the meat during the measuring in order to prevent a drift of the value due to microbial/enzymatic processes. However, the redox potential of raw fresh meat is only of secondary importance for the judgement of the quality and stability of meat products.

Redox potential of fermented raw meat products

The E_h values of fermented meat products are roughly between 100 and 200 mV and thus show the highest redox potentials of all products tested. The median values of the different kinds of raw sausages lie closely together. On average the redox potential of raw ham is higher than that of fermented sausage.

Redox potential of cooked and scalding sausage

Altogether the redox potential values of cooked and scalding sausage show a distinctly higher variability than those of fermented sausage products. This may be caused by the variety of added ingredients and additives for the product groups of cooked and scalding sausages. The medians of the E_h -values of the different kinds of cooked sausage range between 0 and 60 mV, except for brawn with a median of about 155 mV. For the different kinds of scalding sausage, the medians of the redox values range between 20 and 120 mV. Within the group of scalding sausages, products without addition of nitrite (pale frankfurter style sausage without nitrite in yellow casing, small white beef and veal boiling sausage (Weißwurst), frying sausage) are outstanding because of their highest median at about 120 mV and the widest scatter.

Redox potential of cooked ham type products

The redox potential values of cooked ham type products vary in a small range and the medians fluctuate around a value of 30 mV, which indicates a higher uniformity of these products with regard to processing and added materials.

Redox potential of poultry meat products

Poultry meat products including the whole range of cooked meat pieces, scalding sausage, cooked sausage, and fermented sausage,

show essentially "normal" redox potentials similar to those of the corresponding products made of beef or pork. The medians of the different products range between 50 and 130 mV. This can be seen as a further indication of the minor influence that the origin of the starting material 'meat' has on the redox potential of the processed product. Probably, the major determinants are the methods of processing and added materials.

Redox potential of canned sausages

Redox potential values of the category 'canned sausage' obviously occupy a special position among heated meat products because their medians lie at about 0 mV for canned scalding sausage and even below 0 mV for canned cooked sausage. The redox potential values of all other measured meat products generally are more positive. Since recipes for canned scalding or cooked sausage do not significantly differ from those for corresponding products in casings the low redox potential of the canned sausages can only be associated with the speciality of processing methods (high temperature, hermetic seal).

Conclusion:

The present report summarizes typical redox potential values of nearly 1000 individual samples of meat and meat products divided into 7 categories. It turns out that the low redox potential of meat increase distinctly after processing into meat products. Among these, fermented meat products, like fermented sausage and raw ham, show the highest (positive), canned sausage, in contrast, shows the lowest redox potential. This summary of redox potentials offers an enlarged basis regarding reflections on "predictive microbiology" for meat products. For the microbial stability of meat products the redox potential supports the 'hurdles' pH and a_w . This survey is also a guide to further studies on the improvement of quality in meat products. In this connection it is also interesting to search possibilities of influencing the redox potential by additives, pH or atmospheric oxygen (Rödel & Scheuer, 1999). One could also think about studies on possible connections between redox potential and taste of meat products.

Literature:

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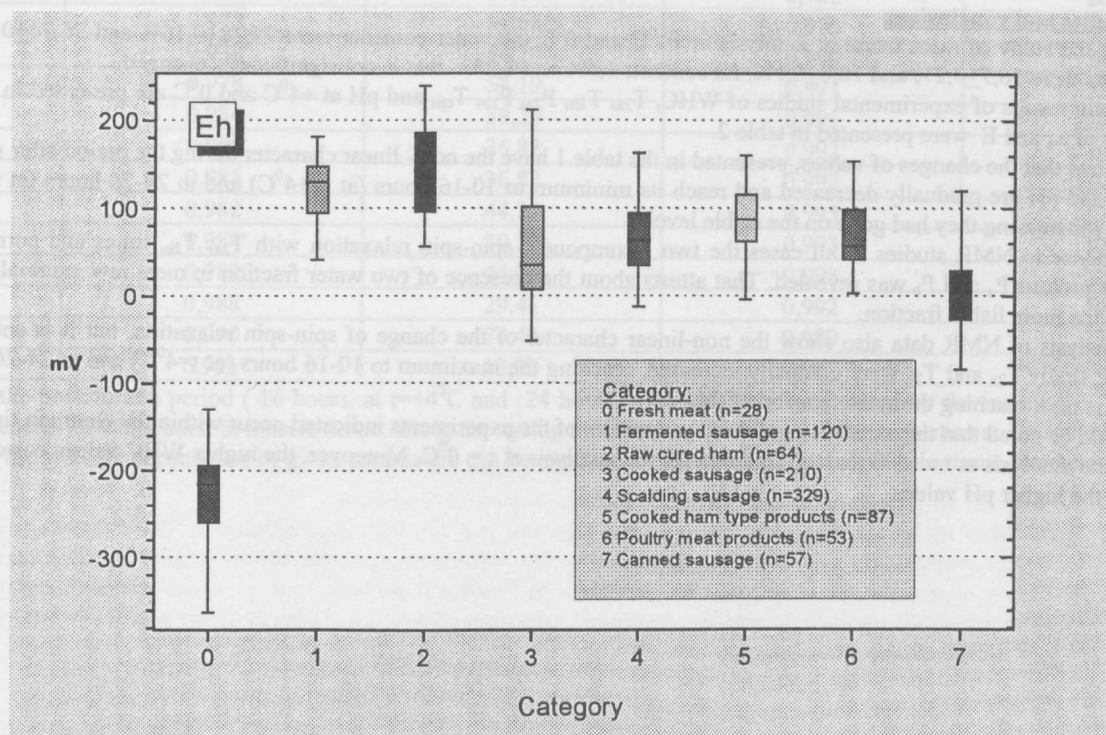


Fig. 1: Redox potential (E_h) of meat and meat products