BACTERIAL LIPOLYSIS BY *STAPHYLOCOCCUS XYLOSUS* COMPARED TO ENDOGENOUS LIPOLYSIS IN MEAT-FAT MIXTURES OF BEEF OR PORK

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BACKGROUND AND OBJECTIVES

Starter cultures of the family *Micrococcaceae* are generally believed to have lipolytic activity that may contribute to the aroma formation of fermented sausages (Geisen et al., 1992). However, lipolytic activity is also found in meat and fatty tissue and the contribution of meat and *Micrococci* enzymes, respectively, to lipolysis during the ripening of fermented sausage is unclear (Dainty and Blom, 1995). The aim of this study was to evaluate the relative contribution of endogenous and bacterial (*Staphylococcus xylosus*) lipolysis, respectively, using a sterile model system, and to study the differences between beef and pork in this system.

MATERIALS AND METHODS

Sterile meat-fat mixtures resembling the content of fermented sausage, containing pork and beef, respectively, were prepared according to Johansson and Borch (1993). One part of the mixtures was inoculated with a pure culture of *Staphylococcus xylosus* (strain M350, INRA, Theix, France) and the other was not inoculated. The mixtures were stored at 25°C for 12 days and analysed for bacterial growth and free fatty acids (FFA´s) (Johansson et al., 1994) before and after storage. The fat was extracted with chloroform:methanol:water (20:10:1) and the FFA´s were separated on an ion exchange resin (Gandemer, 1991). The fatty acid composition of the FFA´s was analysed using gas-liquid chromatography (Johansson et al., 1994) with an oven temperature of 100 to 220°C and a split injection of 1:3. The effect of the type of meat and inoculation with *S. xylosus* on the formation of FFA´s was evaluated by analysis of variance (SYSTAT for Windows: Statistics, Ver 5 Ed. Evanstone, IL, USA, SYSTAT Inc. 1992), and principal component analysis (PCA) (Unscrambler® Ver. 5.5, Camo A/S, Trondheim, Norway) was performed on the individual FFA´s.

RESULTS AND DISCUSSION

The uninoculated mixtures remained sterile during storage, while the bacterial counts either increased or decreased in the inoculated mixtures (Fig 1). Endogenous and bacterial formation of FFA´s was found in most of the mixtures (Fig.2) and there was a significant difference ($p < 0.01$) in endogenous lipolysis between beef and pork. There were also differences in endogenous lipolysis between the experiments, showing the variation between the different animals. On the other hand, the bacterial contribution of FFA´s was fairly constant, irrespective of endogenous lipolysis, type of meat or bacterial counts.

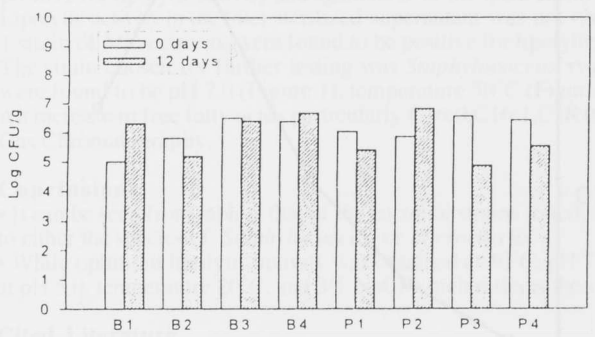

Figure 1. CFU before and after storage in meat-fat mixtures inoculated with *S. xylosus*

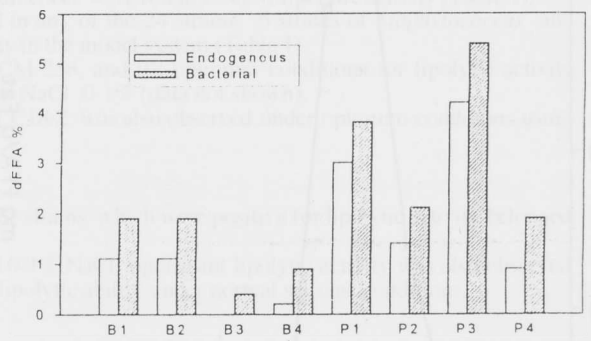

Figure 2. Endogenous and bacterial (*S. xylosus*) formation of FFA´s during 12 days´ storage of meat-fat mixtures of beef (B1-B4) and pork (P1-P4). dFFA = FFA´s after storage - FFA´s before storage

Palmitic acid (C16:0), stearic acid (C18:0), and oleic acid (C18:1) were hydrolysed from both beef and pork, while linoleic acid (C18:2) was mainly hydrolysed from pork. Also myristic acid (C14:0), palmitoleic acid (C16:1) and minor amounts of other fatty acids were found. C16:0, C18:0 and C18:1 are the main components of beef and pork fat and there is more C18:2 in pork than in beef fat. Consequently, the hydrolysed fatty acids reflected the fatty acid composition of the fats. PCA elucidated the changes in the individual FFA´s during storage. For pork, the pattern of lipolysis was much the same in all of the experiments, as PC1 explains most of the variation (Figs 3,4). The same fatty acids were hydrolysed by meat and bacterial enzymes. For beef, the pattern of lipolysis differed more between the experiments (Figs. 5,6). The pattern of bacterial lipolysis also differed. In one experiment (B1), the same fatty acids were hydrolysed by meat and bacterial enzymes, while in other experiments (B2 and B4) the endogenous and bacterial lipolysis gave different results, although the endogenous lipolysis was very low in experiment B4.

CONCLUSIONS

Endogenous lipolysis was found to contribute considerably to the total lipolysis in a fermented sausage model system. The endogenous lipolysis was more pronounced in pork than in beef. *Staphylococcus xylosus* showed lipolysis in model systems with beef as well as pork and the bacterial lipolysis was not influenced by the type of meat or by the level of endogenous lipolysis.

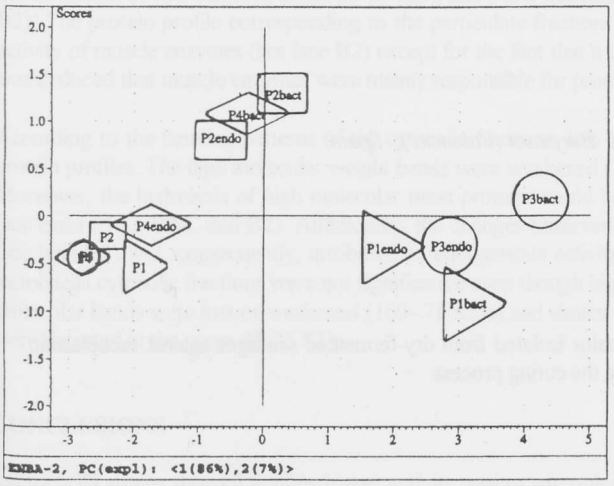

Figure 3. Score plot of meat-fat mixtures of pork before and after storage. P1-P4 = before storage; P1-P4endo = stored sterile mixtures; P1-P4bact = stored mixtures inoculated with *S. xylosus*. P1 ▷ P2 □ P3 ○ P4 ◇

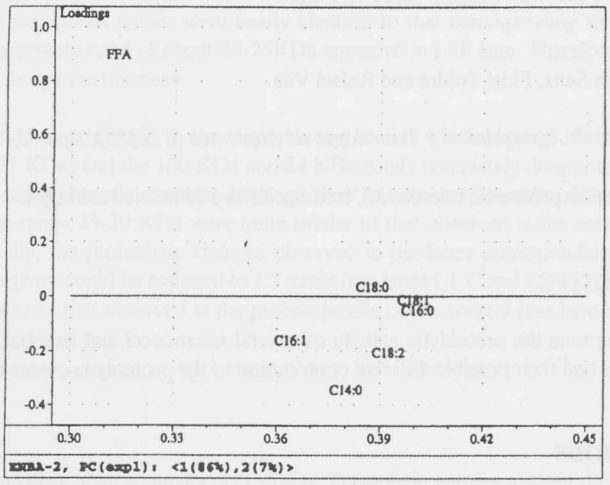

Figure 4. Loading plot of individual FFA´s. C14:0 = myristic acid, C16:0 = palmitic acid, C16:1 = palmitoleic acid, C18:0 = stearic acid, C18:1 = oleic acid, C18:2 = linoleic acid, FFA = sum of minor FFA´s.

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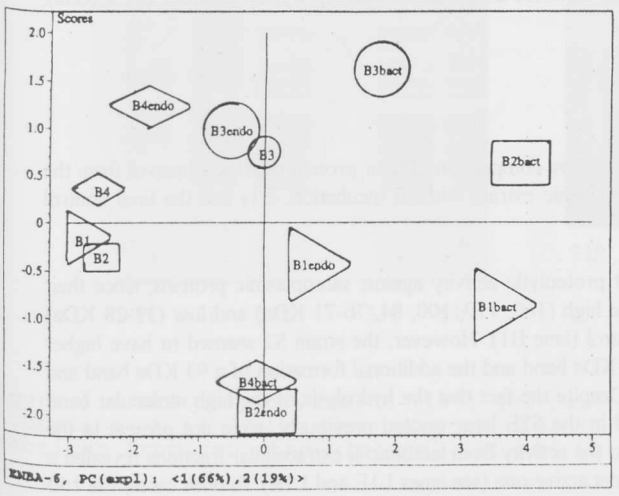

Figure 5. Score plot of meat-fat mixtures of beef before and after storage. B1-B4 = mixtures before storage; B1-B4endo = stored sterile mixtures; B1-B4bact = stored mixtures inoculated with *S. xylosus*. B1 ▷ B2 □ B3 ○ B4 ◇

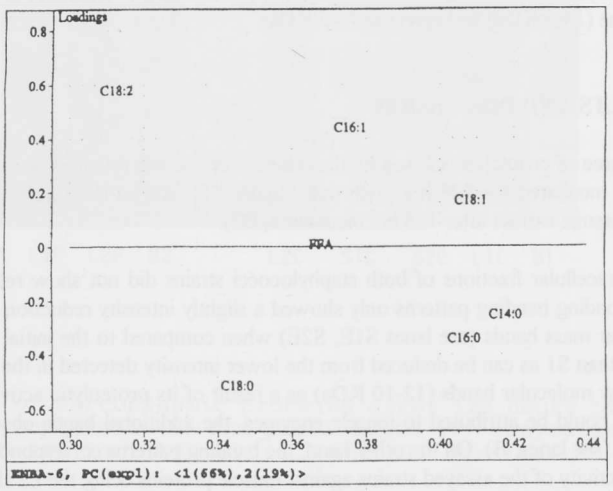

Figure 6. Loading plot of FFA´s. For explanations see Fig.4