EFFECT OF PORCINE REPRODUCTIVE AND RESPIRATORY SYNDROME INFECTION ON MUSCLE PROTEIN CHANGES IN RELATION TO PORK QUALITY TRAITS

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Background

Porcine reproductive respiratory syndrome (PRRS) is a highly contagious viral disease whose two major features are respiratory and reproductive failure. An influenza-like illness is often observed consisting of a transient loss of appetite, slight hyperthermia and respiratory distress. Pathogens such as PRRSV are common in a large percentage of swineherds in the Europe, often causing infection without obvious disease signs. Nevertheless, these sub clinical infections have been associated with productions losses through decreased weight gain and poor feed efficiency in nursery to finishing pigs. Antibodies against the virus evinced the existence of the disease in Lithuania in 1998 and PRRS is today detected in the majority of large Lithuanian pig breeding farms. It has been observed that 40% of pigs from these breeding facilities react to PRRS antibody. Several studies have evaluated the financial impact of acute disease out-breaks in swine operations however there is currently little information available on how PRRSV affects meat quality. Better control of meat quality is of major importance for pig producers and retailers in order to satisfy the consumer's requirement for a consistently satisfactory product. In order to produce 'healthier" meat products we need to fully understand the impact that sub clinical infection with various pathogens would have on the structural and meat quality traits.

Objectives

The objectives of the study reported here were to investigate the effect of PRRSV infection on muscle protein changes and to relate this to the meat quality traits in the porcine *M. Longissimus dorsi* (LD) muscle.

MethodsDetection of PRRSV positive and negative pigs was carried out using the Enzyme Linked Immuno-Sorbent Assay (ELISA) test. The animals were classified into three groups, non-infected (control), infected with only PRRSV (infected) and infected with PRRSV complicated with other bacterial species (co-infected). This classification was made on the ground of clinical signs of PRRS infection and elevations of body temperature (Testo 110 insertion thermo-element, Testo, Germany) at the time of slaughter.
Meat samples from *M.Longissimus dorsi* at the last vertebrae thoracic were taken and frozen in liquid nitrogen for histochemical properties. Twenty-four hours after slaughter additional samples were removed from the same muscles and part of the samples aged at 2^0C for an additional 2 and 5 days. pH_1, ultimate pH (pH-meter NWK Binar pH - K21 CE, Germany), drip loss, surface colour (Minolta Chroma Meter CR-300), sarcoplasmic, myofibrillar and total protein solubility (Warner et al., 1997) were determined for animals in each of the classification groups. For investigations of meat ultrastructure small muscle samples of 3 x 3 x 10 mm were removed from muscles and fixed in cold 2.5% glutaraldehyde in 0.1 M sodium cacodylate buffer. Samples were prepared for microscopy as described Taylor and Koohmaraie (1998). Thin sections were stained with uranyl acetate and lead citrate and examined by transmission electron microscopy. Semithin plastic sections were stained by method of Ridgway RL (1986).

Results and discussion

An increase in body temperature of up to 41^0C at slaughter and rapid pH decline during the first hour was observed for co-infected animals compared to those of infected and control animals. Mean pH_1 was significantly lower in muscle samples from co-infected animals (5.35 versus 6.0-6.2), and as a consequence, the drip loss values were higher ($P<0.01$). Ultimate pH and drip loss (24-48 h) for the samples from the uncomplicated PRRS virus infected animal group did not differ significantly from the control group (Fig. 1). Differences between the animals' groups in protein solubility are shown in Figure 2. Corresponding with faster pH decline, co-infected animal group samples exhibited lower ($P<0.05$) protein solubility for all three protein fractions (sarcoplasmic, myofibrillar and total protein fractions) compared with infected and control, although the relative differences were smaller among groups for sarcoplasmic protein solubility (SPS). Meat from PRRSV infected animals was shown to have comparable protein solubility values to that of controls. The results obtained for sarcoplasmic, myofibrillar and total protein solubility for co-infected animals group meat are similar to those obtained by Joo et al. (1999) for PSE pork.
Samples in each animal group differed significantly ($P<0.05$) in lightness. However there were no significant ($P>0.05$) differences in redness, yellowness, chroma and hue between groups. The lightness as an indicator of objective pork loin colour appeared to decrease with increasing sarcoplasmic protein solubility (Fig.3). This correlation indicates that the pale colour in co-infected animal meat is highly related to the soluble sarcoplasmic protein concentration. The relationship between myofibrillar solubility and colour measurements was weaker. The percentage drip loss decreased with increasing sarcoplasmic protein solubility. This relationship implies that sarcoplasmic protein denaturation may affect the WHC to the same degree (Fig.4). The results consist with Joo et al., (1999) findings. They reported that the WHC is affected to a larger extent by the denaturation of sarcoplasmic proteins than that of myofibrillar. The differences of sarcoplasmic protein solubility within co-infected, infected and control meat samples may be due to differences of pH_1 (Fig.5), as earlier reports have shown a relationship between protein denaturation and pH.
The difference in myofibrillar protein solubility can be explained on the base of Monin and Laborde (1985) and Joo et al. (1999) theories. They reported that the reason for protein solubility changes is the precipitation of sarcoplasmic proteins onto those of myofibrils. The low solubility of myofibrillar protein could also be due to structural changes induced by the rapid pH decline.
The colour of meat could be determined not only by the biochemical changes, but also by the scattering properties of the meat (Offer et al., 1989). They concluded that the light scattering sources would correspond to small regions where the gap between adjacent myofibrils was wider than elsewhere. It is also known, that denervation, deprivation of blood supply, metabolic insufficiency and many others diseases affect myofilaments in myofibres undergoing degeneration. Depending upon severity and stage reached by degenerative process, various morphological changes can be seen. More marked changes include the destruction and loss of myofibrils over one or more sarcomere lengths. As a consequence of such a loss of myofibrils, there is a relative abundance of intervening sarcoplasm.
In our study, when comparison was made among control, infected and co-infected muscles, alterations were found in the muscle ultra structure (Figure 6, A, B, C).

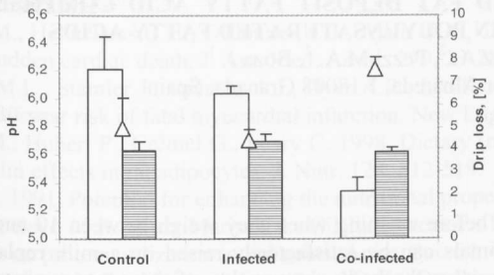


Figure 1. Changes in muscle drip loss and pH during time post-mortem (□-pH_1, ■-pH_{24}, Δ-drip loss).

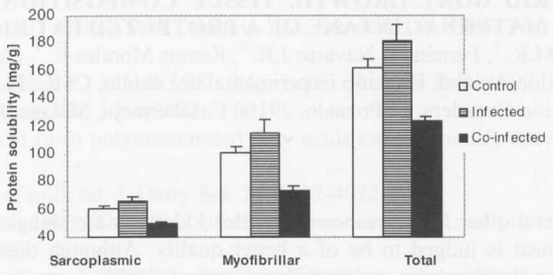


Figure 2. Comparison among the three animal groups in sarcoplasmic, myofibrillar and total protein solubility

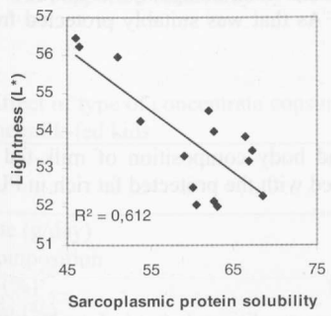


Figure 3. The relationship between SPS concentration and lightness

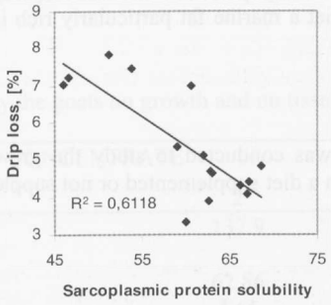


Figure 4. The relationship between SPS concentration and drip loss

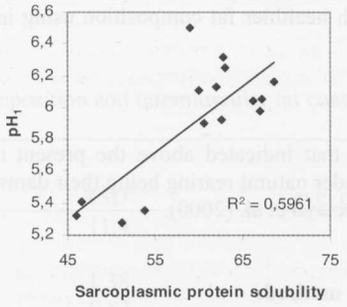
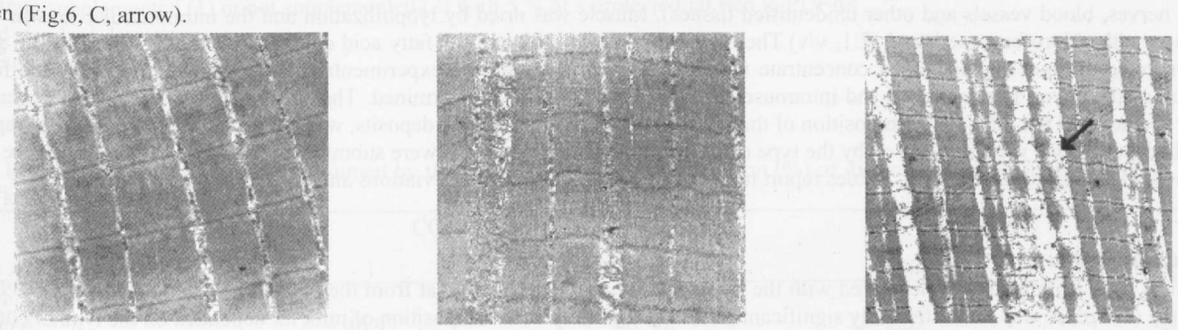


Figure 5 The relationship between SPS concentration and pH_1

A decrease in width of some myofibrils and the appearances of thin degraded sections within fibre bundles from co-infected animal group were seen (Fig.6, C, arrow).



A B C

Figure 6. Ultrastructure from control, infected and co-infected animal groups muscles: A - control (x 8200), B – infected (x 8200), C-co-infected (x 3900)

Conclusions

The results from the current study show that sarcoplasmic protein solubility was most closely correlated with L*, drip loss and pH_1 values. The effect of severe stage of illness on muscle lightness in co-infected animal group due to altered microstructure was found out.

In summary, meat from animals infected only with PRRSV was similar to that of controls with respect to pH, drip loss, protein solubility and histological properties. However meat from animals infected with PRRSV and having co-infections was PSE-like because of an observed rapid pH decrease, and increased drip loss, lighter surface, lower protein solubility and altered ultra structure.

Pertinent literature

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