Technical Note: Comparison of myofibril fragmentation index from fresh and frozen pork and lamb longissimus[1,2]

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ABSTRACT: The myofibril fragmentation index (MFI) is strongly associated with indices of meat tenderness, such as Warner-Bratzler shear force and sensory tenderness. The MFI is normally determined on fresh muscle. It is not known whether this index can be determined on frozen muscle. The objective of this experiment was, therefore, to determine whether there is a difference between MFI values of fresh and frozen lamb and pork longissimus. To compare the effect of freezing on MFI, longissimus samples were obtained from eight lamb carcasses at 1, 3, and 15 d postmortem and longissimus samples were obtained from 12 pork carcasses at 3 d postmortem. For each sample, MFI was conducted on both fresh muscle and snap-frozen muscle (frozen in liquid nitrogen and stored 23 to 26 d at –70°C). The R^2 between MFI of fresh and frozen muscle was 0.94 and 0.92 for lamb and pork longissimus, respectively. The differences between fresh and frozen MFI were not significant for either species ($P > 0.05$). These results indicate that it is not necessary to determine MFI on fresh muscle.

Key Words: Fragmentation, Lambs, Meat, Myofibrils, Pork

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Introduction

Myofibrillar fragmentation (the extent of fragmentation of myofibrils caused by homogenization) has been shown to be highly correlated with indices (shear force and sensory panel tenderness) of meat tenderness (Moller et al., 1973; Olson et al., 1976). Takahashi et al. (1967) demonstrated that the degree of myofibril fragmentation increased with postmortem storage in chicken pectoral muscle. Davey and Dickson (1969) demonstrated that turbidity (index of myofibril fragmentation) of myofibril suspension prepared by controlled homogenization (speed and time) increases with postmortem storage. Olson et al. (1976) used the protocol of Davey and Dickson (1969) but multiplied the turbidity values by a constant number and named it the myofibril fragmentation index (**MFI**). This index is a very useful indicator of meat tenderness, particularly for muscles that are not big enough to determine shear force or sensory tenderness. Although Culler et al. (1978) used frozen beef steaks to examine the relationship between MFI and indices of meat tenderness, we have always determined MFI on fresh muscle (e.g., Koohmaraie et al., 1987; Crouse and Koohmaraie, 1990; Koohmaraie, 1990). To our knowledge, other investigators, with the exception of Culler et al. (1978), also have used fresh muscle to study myofibril fragmentation during postmortem storage or its relationship to indices of meat tenderness. For time and other constraints, it would be far easier if MFI could be determined on frozen muscle. Furthermore, measures of tenderness are frequently obtained on frozen and thawed samples. The objective of this study was to compare and correlate MFI values obtained using fresh and frozen muscle.

Materials and Methods

Animals

The Roman L. Hruska U.S. Meat Animal Research Center (**MARC**) Animal Care and Use Committee approved the use of animals in this study.

Lambs. Eight crossbred lambs (Dorset × Romanov) were slaughtered and a portion of the longissimus was removed at 1, 3, and 15 d postmortem. The longissimus portions were trimmed of visible fat and connective tissue, cut into small pieces, and sampled for MFI deter-

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mination. For MFI determination on frozen muscle, a portion of cut longissimus was snap-frozen in liquid nitrogen and stored at –70°C for 23 to 26 d.

Pork. Twelve F_2 Duroc × Landrace pigs were slaughtered at a commercial pork processing facility. Loins were transported to MARC and sampled for MFI measurement at d 3 postmortem. Samples for MFI determination on frozen muscle and fresh muscle were prepared as described above.

Myofibril Fragmentation Index (MFI)

The MFI of fresh and frozen samples (after 15 min of thawing in 10 volumes of extraction buffer) was determined following the procedure of Olson et al. (1976) as modified by Culler et al. (1978).

Statistical Analysis

Data from both experiments (lamb and pork) were analyzed by one-way ANOVA (SAS Inst. Inc., Cary, NC) for a completely randomized design. The main effect was freezing treatment (frozen and fresh). In the lamb experiment, different postmortem storage times were used to increase the variation in MFI in the experimental samples. The effect of length of postmortem storage was of no interest; thus, postmortem times were pooled within freezing treatment.

Results and Discussion

Investigations of the effects of carcass maturity, marbling level, and other muscle traits on MFI have been carried out on frozen and thawed longissimus (Culler et al., 1978; Parrish et al., 1979). All other studies seem to have been conducted using fresh muscle. The relationship of MFI to measures of tenderness seems to have been unaffected by the freezing status of the experimental muscle. While this manuscript was being reviewed for publication in the *Journal of Animal Science*, Hopkins et al. (2000) published their work on the effect of freezing on MFI of d-1 and d-3 lamb. Although the data provided by Hopkins et al. (2000) clearly established that MFI can be determined on frozen muscle, there are significant differences between the present study and that of Hopkins et al. (2000) that are worth noting. Hopkins et al. (2000) used only one lamb and two postmortem times (d 1 and 3), whereas we used eight lambs and three postmortem times (d 1, 3, and 15) as well as 12 pork longissimus samples at d 3 postmortem. The range of observed MFI values cannot be discerned from Hopkins et al. (2000), but the present study had MFI values ranging from less than 30 to greater than 90. This study was undertaken to determine whether MFI can be determined on frozen muscle. The relationship between MFI of fresh and frozen samples was strong for lamb ($R^2 = 0.94$) and pork ($R^2 = 0.92$) longissimus (Figures 1 and 2, respectively). Moreover, the mean MFI value was similar for fresh and frozen samples within each species ($P > 0.05$). Whereas there was no effect of freezing on MFI values in the present study, Hopkins et al. (2000) reported that MFI values were lower for frozen samples than for fresh samples at homogenization speeds of 5,000 and 10,000 rpm. However, they found that MFI values were similar for fresh and frozen samples at a homogenization speed of 15,000 rpm. We used a different type of homogenizer than Hopkins et al. (2000), and our homogenizer operated at a higher rate of speed (20,000 rpm). Moreover, we homogenized our sample for one 30s burst, and Hopkins et al. (2000) homogenized their samples twice for 30 s. Therefore, we do not know how the level of homogenization that we obtained compared to that in the study of Hopkins et al. (2000). Although it may be tempting to compare the MFI values we obtained to those of

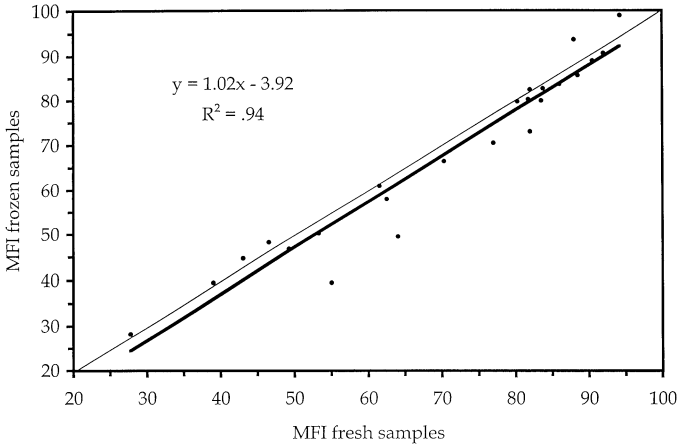

Figure 1. The relationship between myofibril fragmentation index of fresh and frozen lamb longissimus. A thin line is drawn along the points where the frozen values are equal to the fresh values.

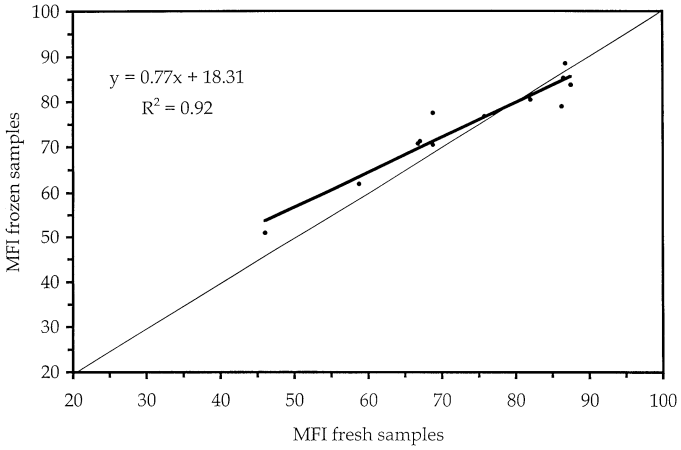

Figure 2. The relationship between myofibril fragmentation index of fresh and frozen pork longissimus. A thin line is drawn along the points where the frozen values are equal to the fresh values.

Hopkins et al. (2000), that is likely pointless because the data of Hopkins et al. (2000) are limited to one lamb. The results of the present experiment indicate that MFI can be determined on either fresh or frozen and thawed muscle.

Implications

The myofibrillar fragmentation index is normally measured on fresh muscle. This study was conducted to determine whether the myofibrillar fragmentation index can be measured on muscle that has been frozen. The difference between the myofibrillar fragmentation index determined on fresh and frozen muscle was not significant. Hence, with the protocol used in this study, the myofibrillar fragmentation index can be measured on muscle that has been frozen.

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