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Marbling Texture Does Not Affect Muscle Fiber Type of Beef Strip Loin Steaks

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Introduction

Marbling texture is not included in the U.S. Department of Agriculture beef quality grading standards (USDA, 1997). However, beef carcasses with coarse marbling in the ribeye are routinely not included in branded beef programs. Currently, 75% of the branded beef programs monitored by the USDA Agricultural Marketing Service require medium to fine marbling in the ribeye (USDA, 2017). In a study by Moody et al. (1970), the impact of marbling texture on tenderness and palatability was evaluated. Data from this study showed fine marbled steaks were more tender as they had lower Warner-Bratzler shear force values than coarse marbled steaks (Moody et al., 1970). However, no additional research has been conducted to determine why fine marbled steaks displayed lower Warner-Bratzler shear force values. Increased muscle fiber cross-sectional area has been linked to decreased tenderness (Seideman et al., 1987; Crouse et al., 1991; Ebarb et al., 2016). To our knowledge, no research has been conducted to determine the effects of marbling texture on muscle fiber type and size. Therefore, the purpose of this study was to determine the impact of marbling texture on muscle fiber characteristics.

Experimental Procedure

Top Choice (Modest^{00} – Moderate^{100}), Low Choice (Small marbling), and Select (Slight marbling) beef strip loins (Institutional Meat Purchase Specifications #180; n = 117; 39/quality grade) of three marbling texture treatments (fine, medium, and coarse) were selected through visual appraisal using the USDA-AMS-LS-SB-02 marbling texture reference card. To qualify for each texture treatment group, 75% of the marbling in the ribeye had to meet the USDA standard for each texture classification. Following selection, strip loins were fabricated into 1-in steaks and frozen prior to analysis. During fabrication, the face steak was removed, and the second steak was used for histology analysis. From each steak, four marbling flecks and surrounding muscle tissue were removed for muscle fiber analyses.

The marbling flecks and surrounding tissue were embedded in tissue-freezing medium (Tissue Tek OCT; VWR; Radnor, PA) and stored at -112°F. Cryosection collection and immunohistochemical analysis were performed using the methods of Phelps et al. (2014). A cryosection was taken from each marbling fleck, incubated in a series of

antibody solutions, and coverslipped for imaging. Cryosections were imaged close to the marbling fleck at 100-fold magnification using a Nikon TI-U inverted microscope (Nikon; Lewisville, TX) equipped with an X-Cite 120XL epifluorescence illumination system (EXFO; Mississagua, Ontario, Canada) and a DS-QiMC digital camera. Photomicrographs were analyzed using NIS-Elements Imaging Software (Basic Research 3.3; Nikon Instruments, Inc., Melville, NY) and muscle fibers were analyzed for muscle fiber cross-sectional area and myosin heavy chain type distribution. A minimum of 3 photomicrographs were taken and a minimum of 300 fibers were analyzed per section.

Results and Discussion

Marbling texture did not impact ($P>0.05$) fiber cross-sectional area for any of the three myosin heavy chain (Type I, Type IIA, and Type IIX) isoforms (Figure 1). Moreover, marbling texture did affect ($P<0.05$) the distribution of the myosin heavy chain isoforms (Figure 1). Steaks with medium marbling texture displayed a greater ($P<0.05$) amount of Type IIA fibers than the fine and coarse marbled steaks. Fine and coarse marbled steaks showed similar ($P>0.05$) percentages of Type IIA fibers. In contrast, fine and coarse marbled steaks displayed a greater ($P<0.05$) percentage of myosin heavy chain type IIX fibers compared to medium marbled steaks. Fine and coarse marbled steaks were similar ($P<0.05$) for the percentage of myosin heavy chain type IIX fiber type. Quality grade (Top Choice, Low Choice, and Select) and marbling texture (fine, medium, and coarse) did not impact ($P>0.05$) fiber cross-sectional area (Figure 2). Additionally, quality grade had no impact ($P>0.05$) on myosin heavy chain fiber type among Type IA, Type IIA, or Type IIX fiber distribution (Figure 2).

Implications

These results indicate that marbling texture does not impact muscle fiber cross-sectional area. Any potential difference in tenderness with varying marbling texture is not due to muscle fiber cross-sectional area or fiber type.

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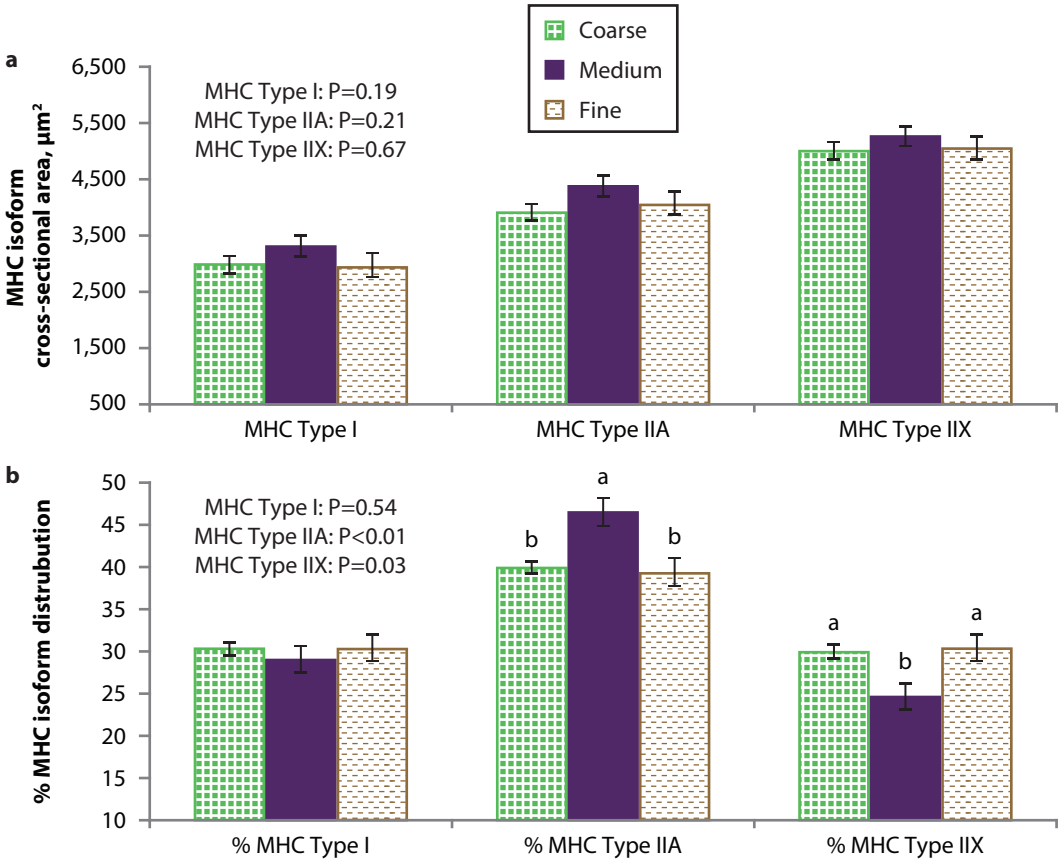

Figure 1. Least squares means of myosin heavy chain (MHC) (a) cross-sectional area and (b) fiber type distribution of beef strip loin steaks of varying marbling texture treatments.
[ab]means within a panel and same myosin heavy chain isoform without a common superscript differ (P<0.05).

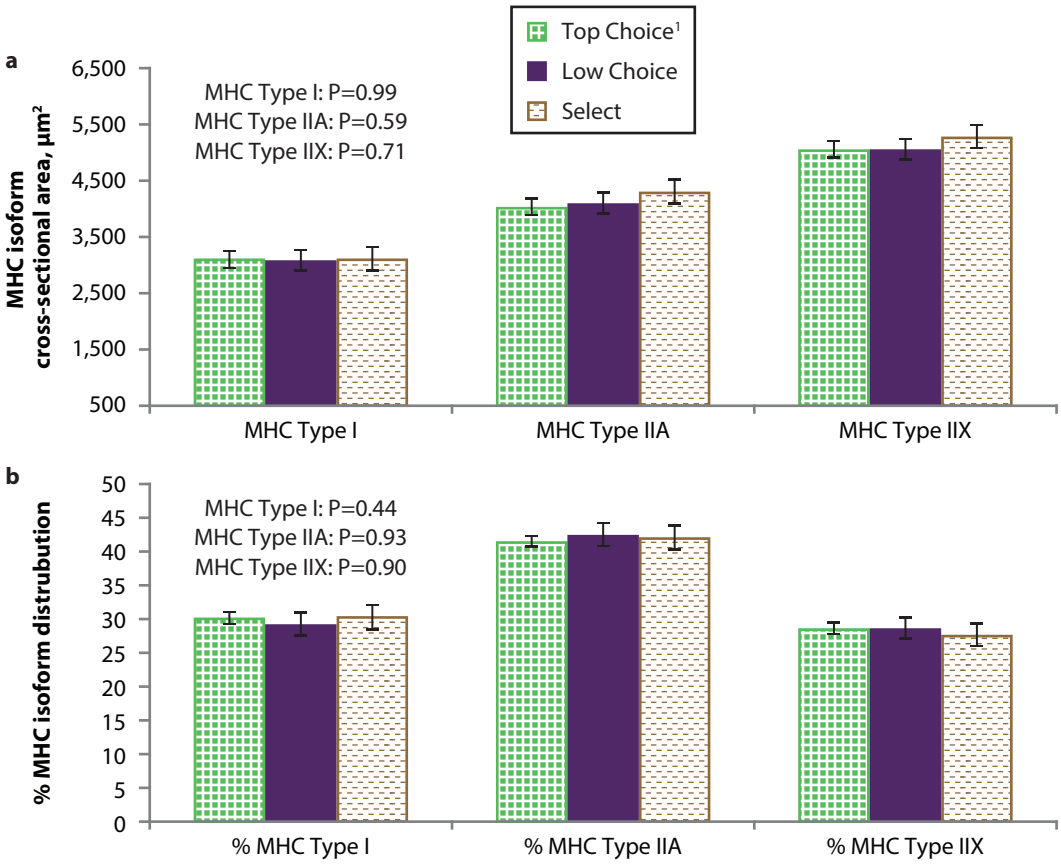

Figure 2. Least squares means of myosin heavy chain (MHC) a) cross-sectional area and b) fiber type distribution of beef strip loin steaks of varying quality grade treatments.
[1]Top Choice = marbling score of Modest[00] to Moderate[100].