

Meta-analysis of the relationship between collagen characteristics and beef tenderness

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Introduction: Connective tissue is believed to define the “background toughness” of meat (Sentandreu et al., 2002) and collagen content and solubility have been shown to affect meat tenderness. However, contradictory findings for the correlations between collagen characteristics and tenderness attributes have been reported. A meta-analysis of published data offers one approach to reveal the general relationship between collagen characteristics and sensory and shear force attributes of meat.

Methods: A literature search was conducted in Web of Science using the search terms collagen, tenderness and beef (n=615) or collagen, shear and beef (n=377), resulting in a combined total of 700 papers. From these papers were selected 19 peer-reviewed journal articles published in English that reported correlation coefficients (Pearson's r) between tenderness attributes (Warner Bratzler shear force (WBSF) and sensory tenderness score) and collagen characteristics (collagen content and solubility) of beef. A series of meta-analyses of correlation coefficients were conducted with a random-effects model in RStudio (Harrer et al., 2019). The overall effect (r), 95% confidence interval (CI), prediction interval and heterogeneity (I²) were visualized by forest plots. Subgroup analysis was carried out by categorizing data into two different muscle groups (loin and others). Meta-regression of correlation coefficients across age (months) were also conducted.

Results: Significant correlations and moderate to high heterogeneity were found between total collagen content and WBSF (r=0.27, CI=0.14 to 0.38, I²=91%, p<0.001) and sensory tenderness (r=-0.20, CI=-0.29 to -0.11, I²=49%, p<0.001). There was also a significant correlation with moderate heterogeneity between collagen solubility and WBSF (r=-0.17, CI=-0.28 to -0.05, I²=36%, p=0.004). However, there was no significant relationship between collagen solubility and sensory tenderness, possibly due to a small number of studies.

For the significant correlations, subgroup analysis results showed that the heterogeneity of loin muscle was higher than other muscles. Also, the estimated r of loin was significantly lower than other muscles for the correlation between collagen solubility and WBSF and between collagen content and sensory tenderness. For the meta-regression of correlation coefficients across age, no significant effects of age could be determined.

Conclusions: The correlations between tenderness attributes and collagen characteristics were significant but weak, except for the correlation between collagen solubility and sensory tenderness. Loin muscle showed greater variation and a lower estimated r compared to other muscles. Age did not affect the correlations, but limited studies were involved. More studies with various muscles and ages are required to develop an in-depth understanding of the relationship between collagen characteristics and meat tenderness.

Acknowledgements and Financial support statement: Nil

Literature:

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