A COMPARISON OF MEAT PROPERTIES OF YOUNG CATTLE WITH LOW OR ADEQUATE LIVER COPPER CONCENTRATIONS

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SUMMARY

The mechanical properties of cooked samples of *M. pectoralis profundus* from young cattle (carcass weight 184 kg, age 297 days) with low (LCu), 8 mg/kg of dry matter, or adequate (ACu) 132 mg/kg, liver copper concentrations were measured. There were no significant differences in Warner-Bratzler peak force, initial yield force, or peak force minus initial yield force values due to liver copper status. Liver copper status did not affect the values of parameters from tensile (adhesion) force-deformation measurements, considered to reflect intramuscular connective tissue strength. There were no differential changes in values of parameters from Warner-Bratzler and adhesion measurements with increased cooking (60°C for 1 hr, 80°C for 1 hr, 80°C for 5 hr) between samples from the LCu and ACu groups.

It was concluded that low copper status, of the order of that of the LCu animals, had no effect on the contribution of intramuscular connective tissue to meat toughness.

INTRODUCTION

Copper deficiency can produce defects in the connective tissue of animals. Clinically, the deficiency retards skeletal growth and bone development and weakens vascular connective tissue. Carnes (1968) considered that the weakness of vascular connective tissue was the result of defects in elastin and, possibly, the molecular structure of collagen. Chou, Savage and O'Dell (1969) showed that in the collagen of tendons of copper deficient chicks the ratio of to chains was increased three-fold.

The common effect of copper deficiency on cross-linking in collagen and elastin results from a reduced activity of tissue monoamine oxidase (Carnes 1968; Chou, Savage and O'Dell 1969; Dutson 1976). Reduced cross-linking in collagen and elastin, weakens connective tissue, and increases collagen solubility.

No one appears to have tested the effects of copper deficiency on the mechanical properties of cooked beef. In the experiment described below the mechanical properties of cooked samples of muscle, with a relatively high collagen content, from young cattle with either a low, c. 8 mg of copper per kg of liver dry matter, or an adequate, c. 132 mg of copper per kg of liver dry matter, are compared.

MATERIALS AND METHODS

Animals

The 24 animals, steers and heifers, were born, and raised together, on a farm which had a history of copper deficiency. Two groups, LCu and ACu, each of twelve animals, were compared. The animals in the LCu group received a single subcutaneous injection of 400 mg of copper glycinate containing 120 mg of elemental copper (Glaxo Australia Ltd.) at birth. Animals in the ACu group received a total of 10 such injections at intervals of 4-6 weeks.

The animals were slaughtered at a commercial meatworks. The caudate lobe of the liver was removed

TABLE 1

MEAN (±S.E.) WARNER BRATZLER INITIAL YIELD (IY), PEAK FORCE (PF), AND PEAK FORCE MINUS INITIAL YIELD (PF-IY) VALUES (KG) OF SAMPLES OF M.PECTORALIS PROFUNDUS, FROM YOUNG CATTLE WITH LOW (LCu) OR ADEQUATE (ACu) LIVER COPPER CONCENTRATIONS

Group			Low Copper	Adequate Copper
Cooking Conditions Temp(°C)	Time(hr)	Parameter		
60	1	PF	4.24±0.24	4.27±0.22
60	1	IY	1.91±0.10	1.87±0.09
60	1	PF-IY	2.33±0.25	2.40±0.20
80	1	PF	4.47±0.19	4.62±0.14
80	1	IY	3.17±0.14	3.47±0.13
80	1	PF-IY	1.30±0.18	1.15±0.13
80	5	PF	2.87±0.14	2.86±0.12
80	5	IY	2.63±0.57	2.65±0.12
80	5	PF-IY	0.24±0.04	0.21±0.01

TABLE 2

MEAN (±S.E.) ADHESION MEASUREMENTS OF SAMPLES OF THE M.PECTORALIS PROFUNDUS OF YOUNG CATTLE WITH LOW (LCu) OR ADEQUATE (ACu) LIVER COPPER CONCENTRATIONS

Group			Low Copper	Adequate Copper
Cooking Condition Temp(°C)	Time(hr)	Parameter		
60	1	A	0.55±0.06	0.57±0.06
80	1	IY force	0.60±0.02	0.53±0.04
80	5	(kg)	0.61±0.02	0.49±0.04
60	1	B	0.53±0.08	0.51±0.04
80	1	IY distance	0.45±0.04	0.38±0.04
80	5	(cm)	0.39±0.08	0.28±0.04
60	1	C	1.15±0.08	1.17±0.07
80	1	Peak force	1.62±0.10	1.75±0.08
80	5	(kg)	1.35±0.10	1.32±0.07
60	1	D	1.44±0.1	1.44±0.1
80	1	Final yield	2.24±0.2	2.28±0.1
80	5	distance(cm)	2.12±0.2	2.24±0.2
60	1	E	146±14	140±10
80	1	Work done	323±43	344±36
80	5	(arbitrary units)	362±83	355±57

for the determination of dry matter and liver copper concentration (Bingley and Anderson 1972). Carcasses were chilled for 18 hr before they were boned. The brisket (= *M. pectoralis superficialis* and *M. pectoralis profundus* PP) was removed at this time, frozen, transported, to the Meat Research Laboratory, and stored. When required, the briskets were thawed at 5°C overnight and the PP dissected from the thawed briskets.

Three samples (approximately 150 g each) were cut from each PP muscle. They were assigned in a randomised manner to one of three cooking treatments. Samples were cooked in polyethylene bags totally immersed in water in a water bath either at 60°C for 1 hr, or 80°C for 1 hr or 80°C for 5 hr. After cooking, samples were cooled, dried with paper towels and stored, overnight at 1°C, before mechanical evaluations were performed.

Sub-samples were cut from each cooked sample for Warner-Bratzler shear and adhesion measurements. Initial yield (IY) and peak shear force (PF) values were determined from Warner-Bratzler force-deformation curves (Bouton and Harris 1972a).

Adhesion measurements were carried out as previously described (Bouton and Harris 1972a). The following parameters were quantified from the adhesion force-deformation curves (Bouton, Harris and Shorthose 1975):-

(A) initial yield force (kg), taken at the first major inflexion of the curve; (B) initial yield distance(cm), the distance from the first registration of force to the critical yield; (C) peak force(kg), the maximum force registered; (D) final yield distance (cm), the distance from the first registration of force to the distance at which the sample broke; (E) work done, was the area under the force-deformation curve.

RESULTS

Mean liver copper concentrations (p.p.m. of dry matter) were 7.8 0.1 and 131.5 8.1 for the LCu and ACu groups. Neither mean age at slaughter (298 v 297 days) nor mean carcass weight (183.3 v 185.1 kg) differed between the LCu and ACu groups, respectively.

The means and standard errors of the parameters determined from the Warner-Bratzler shear force-deformation curves are given in Table 1. Means and standard errors of parameters determined from adhesion force-deformation curves are given in Table 2.

There were no significant differences in any of the parameters measured between the two groups of animals. There were significant differences between the three cooking regimes. Warner Bratzler IY and PF values were significantly affected by the cooking regime. PF-IY values decreased significantly with the increase in cooking intensity from 60C for 1 hr to 80C for 5 hr.

Similarly, the cooking regime used influenced the values of the parameters determined from the force-deformation curves of adhesion measurements. Final yield distance and the work done both increased as cooking temperature was increased from 60°C to 80°C. Peak force values (C) were least in samples cooked for 1 hr at 60°C and greatest for samples cooked for 1 hr at 80°C. Although increased cooking decreased Warner Bratzler PF-IY values there were no differential effects of copper status on these decreases.

DISCUSSION

The *M.pectoralis profundus* was used in this experiment as it has a relatively high connective tissue content (Ramsbottom and Stradine 1948), is restrained from shortening postmortem, and has a sarcomere length of about 2.8 m (Bouton, Harris and Shorthose 1975).

PF-IY values and initial yield force values (A) and peak force values (C), in the adhesion measurements, are all considered to be indices of connective tissue strength in cooked meats; values for this parameter increase with animal age, are not affected when meat is aged, and are reduced with increases in cooking intensity (Bouton, Harris and Shorthose 1975).

If the copper deficiency in LCu animals was sufficient to reduce connective tissue strength then PF-IY values from Warner-Bratzler shear force measurements and A & C values would have been expected to have decreased.

Also the weakening effect of increasingly extreme cooking conditions would have been expected to have been greater on the values of the above parameters for samples from LCu animals.

It could be concluded either that copper deficiency has no effect on the contribution of intramuscular connective tissue to meat toughness or that the deficiency in the LCu group was not sufficiently severe to affect collagen metabolism.

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