The Relationship between Serum Lipoprotein Levels and Marbling of Muscle Tissue in Beef Cattle
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ABSTRACT. The relationship between serum lipoprotein levels and the grades of marbling in muscle tissue was analyzed by gel filtration of lipoprotein fraction obtained from sera of 80 Japanese black beef cattle in the final stage of fattening. It was found that the increase in the Beef Marbling Standard number was positively correlated with the concentration of low-density lipoprotein cholesterol ($r=0.79$) and negatively with that of high-density lipoprotein cholesterol ($r=-0.47$). KEY WORDS: Japanese black beef cattle, marbling, serum lipoprotein.

Marbling of muscle tissue in beef cattle has been shown to be influenced by a variety of factors such as species, lineage and breeding environment [1, 3, 4, 8, 10], but much is still unknown about the mechanism of marble formation in muscle tissue. Because lipids are transported to muscle tissue by binding with lipoprotein, lipoprotein analysis is of primary importance in clarifying the mechanism of marbling formation. In the present study, serum lipoprotein analysis was carried out and the relation between lipid concentrations and marbling of muscle tissue was examined.

A total of 80 Japanese black cattle in the final stage of fattening were used in this study. Marbling of muscle tissue was assessed by the Beef Marbling Standard number (BMS No.) for 12 grades (Japan Meat Grading Association). Sera from these cattle were collected before shipment to the slaughter-house. Serum low-density lipoprotein (LDL) and high-density lipoprotein (HDL) were separated by gel filtration with Bio-gel A-5 m (200/400 mesh; Bio-Rad Laboratories, Richmond, CA, U.S.A.) [9]. Total cholesterol content in each fraction in the chromatography was determined with a kit (total cholesterol C test, Wako Pure Chemical Industries, Ltd., Osaka, Japan). Detection of apolipoprotein B-100 (apo B-100) in each fraction was carried out with a kit (Bovine apo B plate, Saikinkagaku Institute, Sendai, Japan). The LDL- and HDL-cholesterol levels were defined by integration with the cholesterol content in each fraction. Statistical analysis was performed by simple correlation analysis.

Figure 1 shows gel filtration chromatograms of the sera from two head of cattle. Apo B-100 (an apoprotein in LDL [5]) was detected in the LDL fraction, but not in the HDL fraction, suggesting that separation of both fractions was nearly complete. An increase in the LDL peak and a tendency to a decrease in the HDL peak were observed in BMS No. 12 of beef cattle (the highest degree of marbling in muscle tissue). Experiments were then performed to examine the relation between BMS No. and LDL-/HDL-cholesterol levels (Figs. 2 and 3). It was found that the

![Fig. 1. Elution profiles of beef serum from the Biogel A-5 m column. One ml of serum was applied to the column (10 × 90 mm) and eluted with 150 mM NaCl and 1 mM EDTA, pH 7.4, at a flow rate of 0.5 ml/min. The eluate was collected at 1.5 ml per tube. The chromatography was carried out at 4°C. LDL and HDL fractions are indicated by horizontal bars.](image1)

![Fig. 2. Correlations between the BMS No. of the beef muscle tissues and the concentration of LDL-cholesterol in the beef serum ($r=0.79$).](image2)

![Fig. 3. Correlations between the BMS No. of the beef muscle tissues and the concentration of HDL-cholesterol in the beef serum ($r=-0.47$).](image3)
increase in the BMS No. correlated positively with LDL-cholesterol \( r=0.79 \) and negatively with HDL-cholesterol \( r=-0.47 \). Serum very low-density lipoprotein (VLDL) is also assumed to be increased in BMS No. 12 of beef cattle, because LDL is derived from VLDL [2], but the peak corresponding to VLDL could not be clearly detected, presumably because of the limited sensitivity of the chromatography method.

The main role of LDL is to supply cholesterol to peripheral tissues [2]. Conversely, HDL plays a role in transporting back cholesterol from peripheral tissues to the liver [6]. It is known that cholesterol is closely related to the development of adipose tissue, and that the cholesterol content in adipose tissue is positively correlated to the volume of adipose tissue [7]. On examining the relation between the grades of marbling in muscle tissue and the lipoprotein content, the high marbling of muscle tissue in beef cattle was found to result in an increase in LDL-cholesterol and a decrease in HDL-cholesterol. These findings suggest that in beef cattle with high marbling of muscle tissue, the supply of cholesterol to peripheral tissues is accelerated and the reverse transportation of cholesterol from peripheral tissues is reduced.

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REFERENCES