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Changes in the Activity of Certain Muscle Glycolytic and Oxidative Enzymes During Feedlot Growth in Cattle

J. J. Guenther, J. R. Escoubas and K. K. Novotny

Story in Brief

Muscle tissue obtained from Hereford and Charolais crossbred steers slaughtered at 500, 700 and 900 lb was analyzed for anaerobic and aerobic enzyme activity. Lactate dehydrogenase and Glyceraldehyde phosphate dehydrogenase were chosen to represent enzymes of the anaerobic or glycolytic pathway; while Succinate dehydrogenase and Malate dehydrogenase were selected to represent enzymes of the oxidative pathway. Results indicated that glycolytic enzyme activity decreased during feedlot growth and oxidative enzyme activity increased, suggesting greater activity of the Type I muscle fibers than is commonly believed at this period of life in mammals.

Introduction

Beef muscle is made up of a mixture of Type I and Type II muscle fibers. These fibers greatly differ in their growth potential, growth impetus and metabolic characteristics. Type I fibers are slow contracting, exhibit mostly aerobic metabolism and are smaller than the Type II fibers, which are fast contracting and are primarily anaerobic in their metabolic capabilities. Work with various species of animals suggests that muscle metabolism adapts from a highly aerobic or oxidative state, in the newborn to a highly glycolytic or anaerobic state in the adult. Nevertheless, little quantitative data are available to indicate the changes occurring in specific glycolytic and oxidative muscle enzymes during feedlot growth and development of cattle. Thus the objective

of this study was to quantitate changes in the activity of certain "indicator" enzymes occurring in beef muscle during feedlot growth; for such subtle alterations at the ultrastructural level in muscle could influence or control the changes observed in the gross composition of cattle.

Materials and Methods

Muscle samples were obtained from fifteen Hereford and Charolais crossbred steer calves. Five of the steers were slaughtered at each of the following weight groups: 500 lb, 700 lb and 900 lb. Tissue was removed from the 12th-13th rib area of the right longissimus dorsi within 10 min post-mortem and immediately prepared for enzyme analysis. Twenty grams of minced muscle tissue were extracted in five volumes of ice cold, buffered sucrose solution containing 100mM EDTA, 42mM Tris-HCL, 8mM Tris-Base, 50 units/ml Heparin and 250mM Sucrose. Extraction pH was 7.4. The protein concentration of all extracts was determined by the method of Lowery, et al, 1951 (J.B.C., 193:265).

Lactate dehydrogenase and Glyceraldehyde phosphate dehydrogenase were chosen to represent the glycolytic enzymes and Succinate dehydrogenase and Malate dehydrogenase were selected to represent the oxidative enzymes. The activity of these enzymes was determined by procedures modified from those of Long, 1961 (Biochemists Handbook, D. VanNostrand Co.) and King, (J.B.C. 238:4032).

Results and Discussion

Anaerobic metabolism

As shown in Table 1 the activity of two key glycoltyic enzymes, Lactate dehydrogenase (LDH) and Glyceraldehyde phosphate dehydrogenase (GPD), decreased as feedlot weight increased. LDH activity dropped 130.8 international units (IU) between the 500 and 700 lb weight groups, then increased 52.4 IU between the 700 and 900 lb weight groups. Overall, there was a decrease of 78.4 IU or 18 percent in the activity of this enzyme during the feedlot period. The observed significance level of this change was 0.40, higher than that usually required to ascribe statistical significance.

GDP activity decreased 1.4 and 0.4 IU between the 500-700 and 700-900 lb weight groups, respectively. Percentage-wise, the overall drop in GPD activity was 85.7 percent. This was significant at the 0.06 level of probability.

Aerobic metabolism

Both Succinate dehydrogenase (SDH) and Malate dehydrogenase (MDH) displayed highly significant increases (O.S.L.=0.001 and 0.02, respectively) in activity during feedlot growth (Table 2). The overall change in

Table 1. Glycolytic enzyme activity in longissimus muscle of 500, 700 and 900 lb steers

Slaughter Weight Group (lb)	Lactate Dehydrogenase Activity (IU)	Glyceraldehyde Phosphate Dehydrogenase Activity (IU)
500	434.9	2.1
700	304.1	0.7
900	356.5	0.3

Table 2. Oxidative enzyme activity in longissimus muscle of 500, 700 and 900 lb steers

Slaughter Weight Group (lb)	Succinate Dehydrodenase Activity (IU)	Malate Dehydrogenase Activity (IU)
500	6.3	0.6
700	27.8	1.1
900	38.4	2.4

muscle SDH activity during feedlot growth was 32.1 IU, which was equivalent to an 83.6 percent increase. MDH activity increased 1.8 IU or 75 percent during this period.