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CORRELATION ANALYSIS OF INTRAMUSCULAR FAT DEPOSITION WITH GROWTH, MEAT QUALITY, LIPID METABOLIC ENZYMES IN YAKS AT DIFFERENT AGES

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I. INTRODUCTION

As the primary domestic livestock on the Qinghai-Tibetan Plateau, yak (*Bos grunniens*) is the main source of animal-derived food for local inhabitants, providing meat and milk, as well as significant contribution to China's beef market. However, compared to other beef cattle breeds, yaks had lower deposition efficiency of intramuscular fat (IMF), which plays a crucial role in meat quality influencing juiciness, tenderness and palatability. The IMF results from dynamic change of lipogenesis and lipolysis processes within intramuscular adipocytes. The characteristic of IMF deposition in yak may be attributed to the differences of intramuscular lipid metabolism and its regulation mechanism during the growth process. Therefore, the aim of this study was to investigate the correlative relationships of IMF deposition with growth, meat quality, hormones and lipid metabolic enzymes among yaks at different age stages.

II. MATERIALS AND METHODS

The Institutional Animal Care and Use Committee of the Sichuan Academy of Grassland Sciences approved all procedures in this study. A total of 30 healthy male yaks with different ages (0.5, 1.5, 2.5, 3.5, and 4.5 years old, 6 yaks per age group) were selected from the herd grazing on the same natural pasture. Body weight and size were measured and blood samples were harvested before morning grazing. Serum biochemistry and metabolic regulatory hormones including Insulin (INS), Glucagon (GLN), Leptin (LEP), Adiponectin (APN), Insulin-like growth factor-1 (IGF-1) and Resistin (RETN) were detected using an automatic biochemical analyzer and commercial ELISA kits. Subsequently, all thirty yaks were slaughtered following standard procedure. Samples of *Longissimus dorsi* were collected for the analysis of meat quality (shear force, cooked meat percentage, pH and meat colour), nutrients composition (moisture, protein, IMF contents and fatty acids composition) and activity and concentrations of key enzymes related to lipid metabolism including Acetyl-coA carboxylase (ACC), Fatty acid synthase (FAS), Diacylglycerol acyltransferase 1 (DGAT1), Lipoprotein lipase(LPL), Stearoyl-CoA desaturase (SCD), Hormone sensitive lipase (HSL), Acyl-CoA oxidase (ACOX) and Carnitine palmitoyltransferase 1 (CPT-1). Data analysis was conducted using the Pearson Correlation Analysis procedure of the SAS.

III. RESULTS AND DISCUSSION

Growth performance

The IMF content of *Longissimus dorsi* demonstrated significant positive correlations with age (r=0.90, P<0.01), body weight (r=0.91, P<0.01), height (r=0.90, P<0.01), length (r=0.85, P<0.01) and circumference of chest (r=0.85, P<0.01) and cannon bone (r=0.77, P<0.01) of yaks. We also observed significant positive correlations of age with body weight (r=0.97, P<0.01) and body size traits (P<0.01) .

Serum metabolites

The serum urea level positively associated with IMF content (r=0.42, P=0.03) and age (r=0.52, P<0.01). Additionally, significantly positive correlations were observed between glucose and urea level (r=0.47, P=0.02), and between total protein and globulin (r=0.87, P<0.01). The results revealed that serum cholesterol concentration was positively correlated with IMF level (r=0.46, P=0.02) and age of yaks (r=0.51, P<0.01). A significantly positive correlation between the non-esterified fatty acid and β-hydroxybutyric acid was found as well (r=0.47, P=0.03).

Serum metabolic regulatory hormones

The IMF deposition in *Longissimus dorsi* positively correlated with LEP secretion (r=0.55, P<0.01). McFadin *et al.* (2003) also reported a postive correlation between serum leptin and marbling score in steers [1]. The IMF negatively correlated with serum GLN (r=-0.45, P=0.02), IGF-1 (r=-0.70, P<0.01) and RETN (r=-0.38, P=0.04). There were significantly positive relationships of age with INS (r=0.54, P<0.01) and LEP (r=0.64, P<0.01), and negative ones with GLN (r=-0.49, P=0.01), IGF-1 (r=-0.72, P<0.01) and RETN (r=-0.42, P=0.02).

Meat Quality

Among yaks at different ages, the IMF content had significantly positive correlations with shear force (r=0.69, P<0.01) and pH_{24h} (r=0.41, P=0.03), and negative correlation with meat colour a* (r=-0.45, P=0.01). Significantly positive

associations were identified between age and the following parameters: shear force (r=0.73, P<0.01) and pH_{24h} (r=0.51, P<0.01). Meanwhile, age negatively associated with meat colour a* (r=-0.40, P=0.03) and cooked meat percentage (r=-0.48, P<0.01).

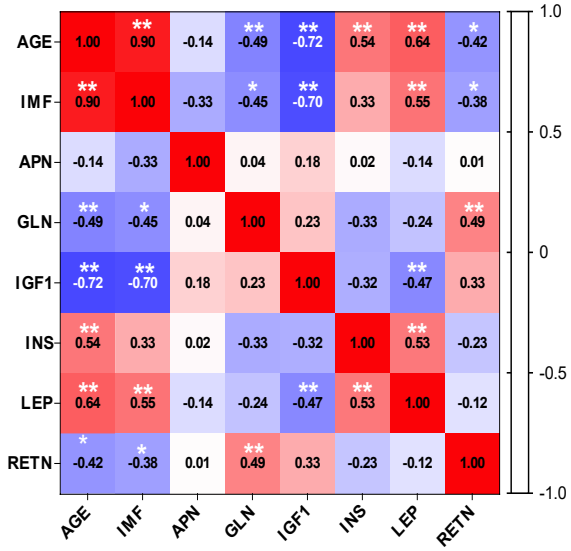


Figure 1. Correlation analysis of IMF with serum hormones in yaks at different ages

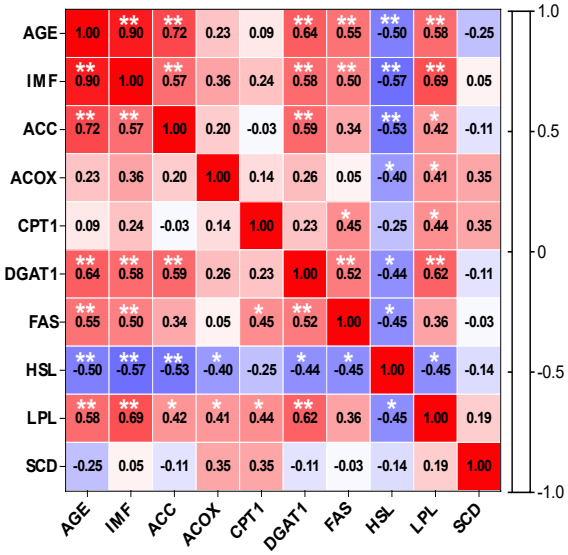


Figure 2. Correlation analysis of IMF with muscular lipogenesis and lipolysis enzymes in yaks at different ages

"*" indicates a significant correlation with P<0.05, and "**" indicates a extremely significant correlation with P<0.01.

Muscular nutrition components

Regarding to nutrition components, we found IMF had significantly negative correlations with protein (r=-0.45, P=0.01) and moisture contents (r=-0.47, P=0.01). The IMF was not significantly correlated with the proportions of saturated fatty acid, monounsaturated fatty acid and polyunsaturated fatty acids in the muscle of yaks at different ages (P>0.05). Furthermore, age had significantly negative correlations with muscular protein (r=-0.41, P=0.03) and moisture contents (r=-0.54, P<0.01).

Muscular lipogenesis and lipolysis enzymes

The IMF content of yaks at different ages significantly correlated with the activity and contents of lipogenesis enzymes ACC (r=0.57, P<0.01), DGAT1 (r=0.58, P<0.01), FAS (r=0.50, P=0.01) and LPL (r=0.69, P<0.01). Liu *et al.* (2018) found similar results that FAS gene expression was positively associated with IMF in pigs [2]. We also observed significantly negative correlation between IMF and HSL (r=-0.57, P<0.01). The results showed age had significantly positive correlational relationships with ACC (r=0.72, P<0.01), DGAT1 (r=0.64, P<0.01), FAS (r=0.55, P<0.01) and LPL (r=0.58, P<0.01), and a negative correlation with HSL (r=-0.50, P<0.01).

IV. CONCLUSION

In summary, age has significant correlations with growth, hormone secretion, meat quality and IMF content of yak. During the growth process, the Leptin and key enzymes in lipogenesis (ACC, FAS, DGAT1 and LPL) function as positively correlative factor, while the Glucagon, Insulin-like growth factor-1, Resistin and lipolysis enzyme HSL negatively associated with IMF content, indicating the metabolic and regulatory characteristic of IMF deposition in yak.

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