FATTY ACID COMPOSITION OF PLASMA AND SUBCUTANEOUS ADIPOSE TISSUE OF ANGUS AND WAGYU STEERS FED TO JAPANESE AND U.S. CARCASS ENDPOINTS

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Summary

We predicted that the lipid composition of subcutaneous adipose from Angus and Japanese Wagyu steers would not differ unless the steers were fed to a Japanese live weight. Eight steers of each breed type were assigned to a high-energy, corn-based diet. Another 8 steers of each breed type were a hay-based diet. Targeted final body weights were 1,200 lb (U.S. endpoint) and 1,400 lb (Japanese endpoint). Omega-6 and omega-3 fatty acids were higher in plasma of hay-fed steers than in corn-fed steers. Oleic acid was greater in fat from Wagyu steers than in Angus steers. Oleic acid in fat was decreased, and omega-3 fatty acids were increased slightly, by the hay diet. Melting points of lipids from the ribeye decreased with time, and were least in corn-fed steers (P = 0.05). Ribeye cholesterol increased with time. In conclusion, composition of carcass fat is profoundly influenced by diet and slaughter endpoint.

Introduction

Fatty acids in meat, especially monounsaturated fatty acids (MUFA), have been shown to influence beef palatability (Dryden and Marchello, 1970; Westerling and Hedrick, 1979) and fat softness (Perry et al., 1998). Fatty acid composition of subcutaneous fat is affected by breed, sex, age, and nutrition (Clemens et al., 1973; Yoshimura and Namikawa, 1983; Eichhorn et al., 1986; Huerta-Leidenz et al., 1993; Zembayashi, 1993; Mandell et al., 1998). Japanese Black (Wagyu) steers have been known to produce carcasses that have adipose tissues with higher percentages of MUFA than Holstein, Japanese Brown, Charolais, or Angus steers (Sturdivant et al., 1992; May et al., 1993; Zembayashi et al. 1995; Oka et al., 2002). The longer finishing period of Wagyu cattle compared to other breed types (Lunt et al., 1993) may contribute to the higher concentration of adipose tissue MUFA. Therefore, this study was designed to document the interaction between diet and slaughter endpoint on composition of fat from Angus and cross bred Wagyu steers.

Experimental Procedures

Animals and Diets

Sixteen Wagyu crossbred (7/8 Wagyu or higher) and 16 Angus steers were purchased as calves at weaning (approximately 8 months of age). Coastal bermuda grass hay containing 9.5% crude protein was fed free choice for 8 d after the steers were transported to the Texas A&M University Research Center, McGregor. Eight steers of each breed type were assigned to a high-energy, corn-based diet containing 48% ground corn, 20% ground milo, 15% cottonseed hulls, 7.5% molasses, 0.96% limestone, 0.56% trace mineral salt, and 0.08% vitamin premix (Table 1). The diet was designed to achieve an average gain of 3 lb per day, and was fed free choice for 8 or 16 months after weaning (n = 4 per breed and time on feed). The remaining 8 steers of each breed type were offered coastal bermuda grass hay free choice, supplemented with non-protein nitrogen in a cooked molasses carrier, and fed daily an amount of the corn-based diet estimated to achieve a targeted rate of gain of 2 lb per day. The hay-fed steers were fed for 12 or 20 months after weaning (n = 4 per breed and time on feed). The average initial weights for Wagyu and Angus steers were 382 lb and 462 lb, respectively. Targeted final body weights were 1,200 lb for steers fed for either 8 months on corn or 12 months on the hay-based diet (U.S. endpoint), and were 1,400 lb for steers fed for either 16 months on corn or 20 months on the hay-based diet (Japanese endpoint). Diet and time-on-feed were totally confounded in the trial but diet effect was not of particular interest; rather, different diets were utilized to produce similar carcass weights within breed at different ages and days-on-feed. Moreover, the corn-based diet was formulated to be similar to diets typically fed to Angus steers in the U.S., whereas the hay-based diet was intended to be more like diets Wagyu cattle might be fed in Japan.

The steers in each diet/endpoint group were slaughtered on two consecutive days. One Angus

steer from the 8-month, corn-fed group escaped the holding pen before slaughter, and had to be removed from the investigation. Details about carcass traits of these cattle are presented by Lunt et al. (2005) in this issue.

Sample Collection
Immediately following removal of the hide, a section of the ribeye and overlying fat was removed from the carcass. Samples of fat were snap-frozen in liquid nitrogen and stored at –94 °C. Blood samples were collected at slaughter, and plasma were prepared and stored at –20°C until analyzed for fatty acid composition.

Lipid Analyses
Total lipid was extracted by a modification of the method of Folch et al. (1957). Fatty acid methyl esters were prepared as described by Morrison and Smith (1964) and analyzed using a Varian gas chromatograph. Individual FAME was quantified as a percentage of total FAME analyzed. Cholesterol concentration of the ribeye was analyzed by published methods (Rule et al., 1997; Rule et al., 2002) using gas chromatography. Melting points of the subcutaneous fat lipids were measured as described previously (Smith et al., 1998).

Results and Discussion

Plasma Fatty Acid Composition
Wagyu steers had lower plasma concentrations of palmitic acid, a saturated fatty acid (SFA), than Angus steers, but higher concentrations of palmitoleic acid, a monounsaturated fatty acid (MUFA). There was diet x endpoint interaction for SFA and MUFA; steers fed the corn diet to the Japanese endpoint had higher plasma MUFA and lower plasma SFA, then steers fed hay to the Japanese endpoint. Omega-6, but not omega-3 fatty acids were elevated in the plasma of hay-fed steers.

Fatty Acid Composition of Subcutaneous Fat
Subcutaneous fat from hay-fed steers contained more omega-3 and omega-6 fatty acids that fat from corn-fed steers. However, the concentration of omega-3 fatty acids was extremely low even in fat from hay-fed steers. In contrast, the concentration of MUFA was markedly reduced in fat from hay-fed steers, such that it was not as healthful as that from corn-fed steers.

In general, fatty acid composition in beef cattle is mainly affected by age and time on feed (Waldman et al., 1968; Leat, 1975; Huerta et al., 1996; Rule et al., 1997). In fat from Angus steers fed extended periods, the percentage of oleic acid reaches 45% of total fatty acids (May et al., 1993). We have demonstrated that MUFA increase with age in feedlot cattle (Huerta-Leidenz et al., 1996), and it is likely that the lower MUFA in the U.S. endpoint steers in the current study was due to the more youthful maturity of these cattle. Additionally, these data indicate that the differences in MUFA between Wagyu and other breed types is not expressed until the cattle reach greater maturity. Tanaka (1985) reported a higher percentage of oleic acid fat from Japanese Black steers as compared to Japanese Shorthorn or Holstein steers. The higher MUFA:SFA ratios may be more genetically determined than environmentally influenced. Wagyu steers have higher percentages of MUFA in their fat depots than Holstein or Angus steers (Yoshimura and Namikawa, 1983; May et al., 1993; Zembayashi et al., 1995). Sturdivant et al. (1992) postulated that elevated stearoyl-CoA desaturase activity could be responsible for the elevated MUFA observed in Wagyu cattle adipose tissue.

Melting Points and Cholesterol Concentrations
Fat from steers raised to the Japanese endpoint was softer than that from U.S. endpoint steers (Table 3). The concentration of cholesterol in the total ribeye was higher in the older, Japanese endpoint steers.

Variation in fatty acid composition, affects firmness of fat, which in turn affects the economics of meat processing and consumer acceptance of meat (Perry et al., 1998). Melting point of subcutaneous fat is significantly affected by sire breed, environment, and age. Subcutaneous fat from Brahman-sired steers had a lower melting point than from the *Bos taurus* steers (Perry et al., 1998). Multivariate analysis that included melting point in the model instead of sire breed showed that fatty acid composition was related to melting point and environment. Cholesterol content of bovine muscle and adipose tissue has proven resistant to nutritional (Christie, 1981; Eichhorn et al., 1986) and breed effects (Eichhorn et al., 1986; Wheeler et al., 1987). However, it is not known whether sire breed, maturity, and nutritional background interact to affect cholesterol in beef.

Implications

Contrary to popular belief, fat from corn-fed steers actually contained a more healthful fatty acid composition than fat from hay-fed steers. Hay feeding caused incremental increases in omega-3 fatty acids that were not nutritionally significant. Although feeding cattle to the Japanese endpoint resulted in softer fat, it also increased the cholesterol content of the meat.

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