

Project Summary

The Role of Fatty Acids at Enhancing Marbling Development through Bovine G-coupled Protein Receptors (GPR)

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Background

The goal of this research project was to utilize both a cell culture and adipose tissue model to investigate the effect of specific fatty acids on differentiation of muscle-derived and intramuscular and subcutaneous preadipocytes. Furthermore, researchers hypothesized from prior research that an important membrane bound receptor, GPR43, may be critical in regulating marbling development in beef cattle.

Methodology

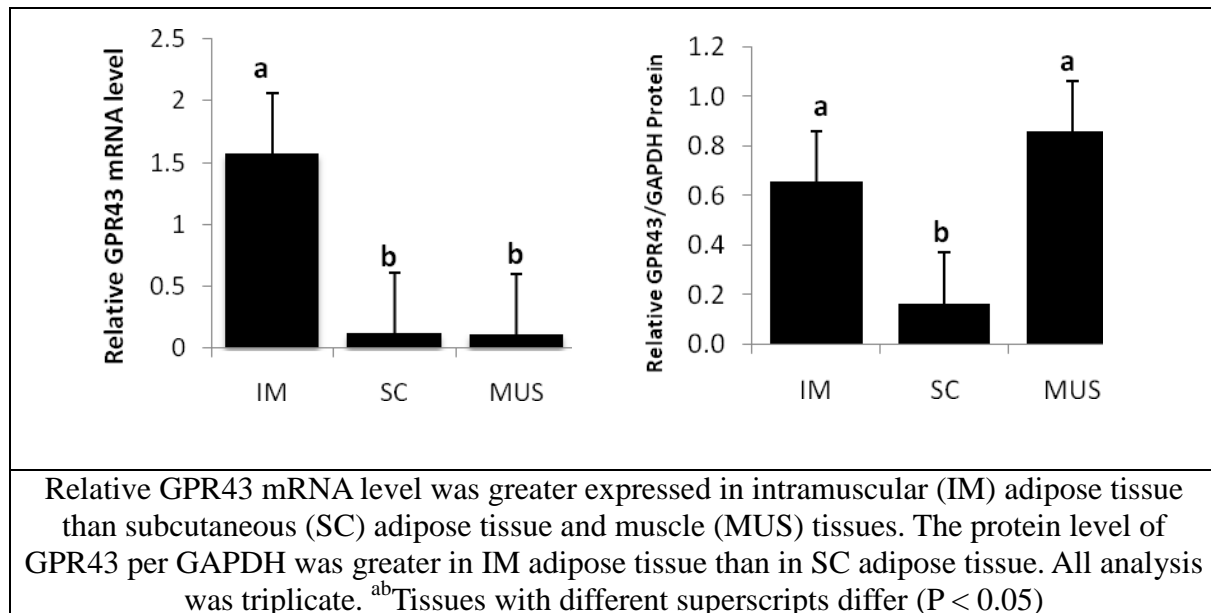
Eight Wagyu crossbred steers were adapted to a corn-based finishing diet, slaughtered at 16 months of age, and intramuscular (i.m.) adipose tissue was removed immediately for explant culture *in vitro*. Adipose tissue explants were cultured for 72 hours in the absence of 50 μ M oleic acid, 50 μ M alpha-linolenic acid, or 25 μ M oleic acid plus 25 μ M alpha-linolenic acid. Additionally, an i.m. preadipocyte cell line was grown to confluence and treated with the same concentrations of oleic acid and alpha-linolenic acid. Adipose tissue explants were rinsed exhaustively and fatty acid concentrations were measured. Neither oleic acid nor alpha-linolenic acid affected tissue fatty acid concentrations, although alpha-linolenic acid tended ($P = 0.08$) to increase i.m. alpha-linolenic acid concentrations. Adipose tissue explants were incubated in the presence of 1 μ Ci each of [14 C] acetate and [5,6- 3 H] glucose to quantify lipid synthesis from acetate and glucose. Oleic acid in combination with alpha-linolenic acid tended ($P = 0.07$) to increase acetate but not glucose incorporation into total lipids. However, mRNA levels for AMPK α , GPR43, C/EBP β , GLUT4, PPAR gamma, and SCD were unaffected by media fatty acids in adipose tissue explants. In contrast, mRNA levels for AMPK α , GPR43, C/EBP β , GLUT4, and SCD were depressed by alpha-linolenic acid in bovine i.m. adipose tissue preadipocytes.

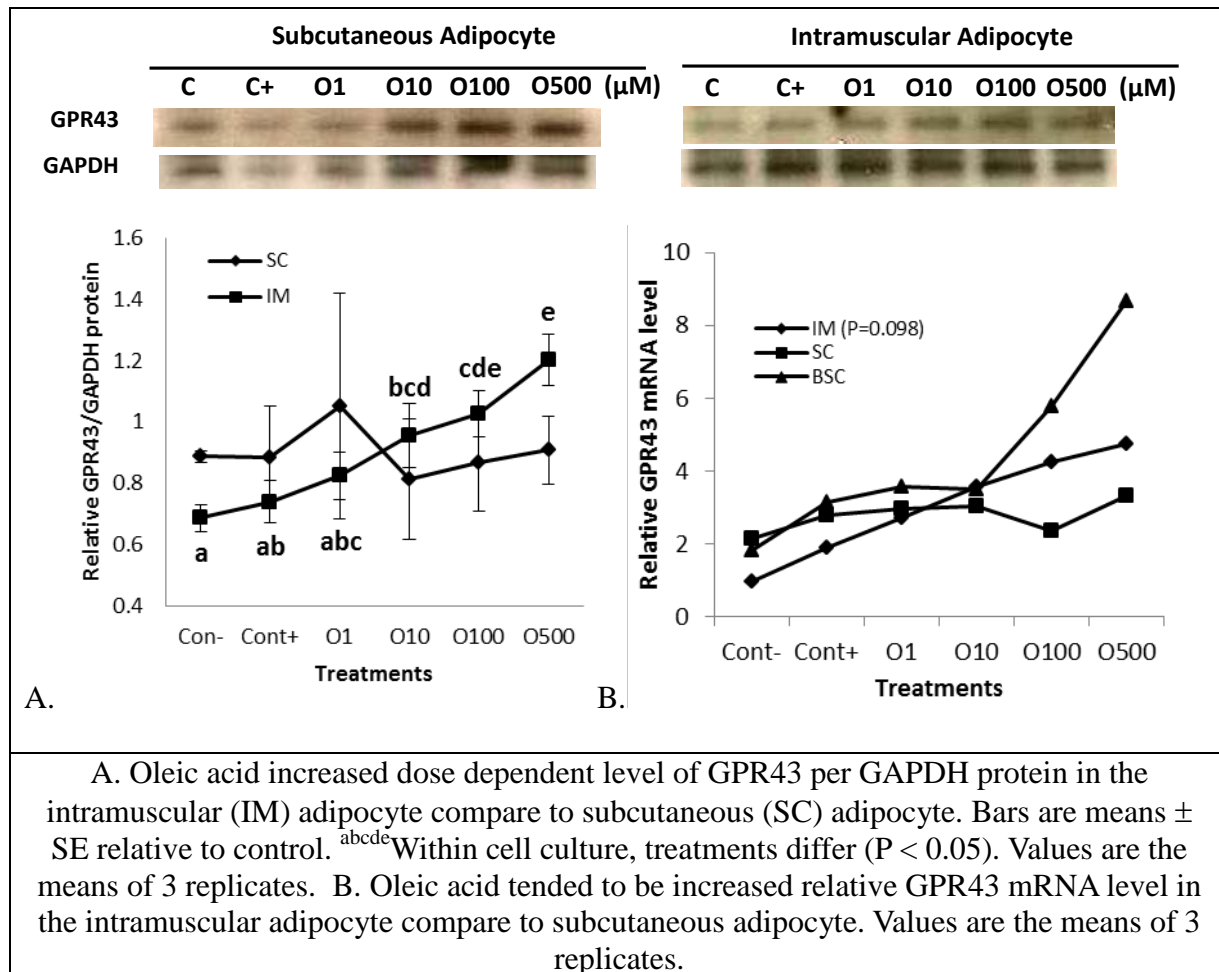
Findings

Intramuscular adipose tissue had greater levels of both GPR43 protein and mRNA as compared to subcutaneous adipose tissue. These data point to a potential difference between the two fat stores that could be exploited to enhance marbling without increasing carcass backfat in beef cattle. Additionally, GPR43 mRNA and protein levels in intramuscular (IM) preadipocytes were regulated in a dose-dependent fashion with oleic acid treatment while the subcutaneous (SC) preadipocytes were not. Data also indicated that three different bovine primary cell cultures (bovine muscle satellite cells, IM preadipocytes and SC preadipocytes) are differentially affected by the dose-dependent treatment with oleic acid. Western blot analysis illustrated that a greater ($P < 0.05$) amount of oleic acid enhanced the GPR43 to GAPDH protein ratio in IM adipocytes but did not affect ($P > 0.10$) SC adipocytes. The mRNA level of GPR43 tended to increase ($P = 0.098$) with dose titration of the IM adipocytes but did not affect ($P > 0.10$) SC adipocytes. This data demonstrated that oleic acid may have autocrine or paracrine effects in stimulating marbling development but SC adipose development may be differentially regulated. Interestingly, oleic acid increased ($P < 0.05$) GPR43 mRNA level in the BSC. This data indicated that dose dependent treatment of oleic acid enhanced IM adipocyte development and appeared to have similar effects on cultured muscle satellite cells. Therefore, researchers concluded oleic acid may be a critical factor to enhance GPR43 pathway in the bovine IM adipose tissues.

Implications

By increasing marbling, important palatability factors such as flavor and juiciness will be enhanced. These desirable changes in palatability traits will ultimately improve beef consumer. Increased consumer satisfaction will in turn improve overall beef demand. Currently, feedlots could overfeed pens of cattle to ensure adequate marbling. This practice results in poorer feed efficiencies and higher cost of gains. These findings begin to unravel the mystery behind key factors regulating marbling development in cattle. Researchers' long-term goal is to develop intervention strategies, like a specific pharmacological agent capable of binding to GPR43, that can be administered at the optimal time during the feeding period to “turn on” marbling adipocytes and have no effect on s.c. adipocytes. In theory, higher or as high marbling scores could be achieved earlier in the finishing period with lower overall cost of gains.





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