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Influence on Body Fat of Linoleic Acid Isomers

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A conjugated isomer of linoleic acid, C18:2 Δ10,12, caused body fat depletion when fed to mice. The effect was greater in mice fed essential fatty acid (linoleic/linolenic) deficient diets.

Summary

In two studies mice were fed diets containing either a mixture of, or individual conjugated linoleic acid (CLA) isomers in the presence or absence of essential fatty acids. Mice fed the C18:2 Δ10,12 CLA isomer lost as much body fat as those fed a mixture of isomers. This effect was not caused by the C18:2 Δ9,11 isomer (predominant in beef) or by restricted feed intake. The loss was much greater in mice consuming an essential fatty acid deficient diet versus a control diet. This supports our hypothesis that for CLA to deplete body fat, it must first be metabolized in a manner similar to linoleic acid. Furthermore, we suggest that the loss of body fat may be mediated by metabolism of CLA to an isomer of arachidonic acid.

Introduction

Conjugated linoleic acid (CLA) is a group of isomers of linoleic acid (C18:2 Δ9,12), some of which are produced naturally and deposited in the fat of ruminant animals. CLA consumption has health benefits regarding cancer, cardiovascular disease and body composition. The predominant naturally occurring isomer is C18:2 Δ9,11 (CLA 9/11), while commercially synthesized CLA products usually contain relatively equal amounts of C18:2 Δ10,12 (CLA 10/12) and CLA 9/11 as well as smaller quantities of other isomers. The diverse benefits of CLA may depend on different isomers. Therefore our first objective was to determine which isomer(s) are responsible for the loss of body fat in mice.

Arachidonic acid (C20:4Δ5,8,11,14) is synthesized in animals from dietary linoleic acid. Similarly, CLA 10/12 can be metabolized to C20:4 Δ5,8,12,14. This product of CLA metabolism could antagonize the normal production of prostaglandins from arachidonic acid and therefore, mice fed a diet deficient in linoleic acid, and thus arachidonic acid, may be especially sensitive to the antiobesity effect of dietary CLA. Our second objective was to compare the effect of CLA in dietary essential fatty acid-adequate and -deficient diets.

Procedure

Experiment 1

Seventy-two mixed sex mice were allotted to one of five rations (each 7% fat) for five days:

Control	purified diet with 7% soy oil
Pair-Fed	control diet at intake of CLA Mix
CLA Mix	2% CLA Mix and 5% soy oil
CLA 9/11	0.82% CLA 9/11 isomer and 6.18% soy oil
CLA 10/12	0.88% CLA 10/12 isomer and 6.12% soy oil

Feed intake and body weight were measured daily. After five days the mice were killed and retroperitoneal (RP) fat pads were removed and weighed. Body fat was determined on carcasses by ether extraction.

Experiment 2

Eighty newly weaned male mice were fed either a control diet (7% soy oil) or an essential fatty acid deficient (EFAD) diet (7% coconut oil) for 6 weeks. Henceforth, half of each group of mice was supplemented with 0.5% CLA, replacing either soy or coconut oil, for two weeks. Then the mice were killed. RP fat pads, epidymal fat pads, and livers were removed and weighed. Carcass fat was determined by ether extraction.

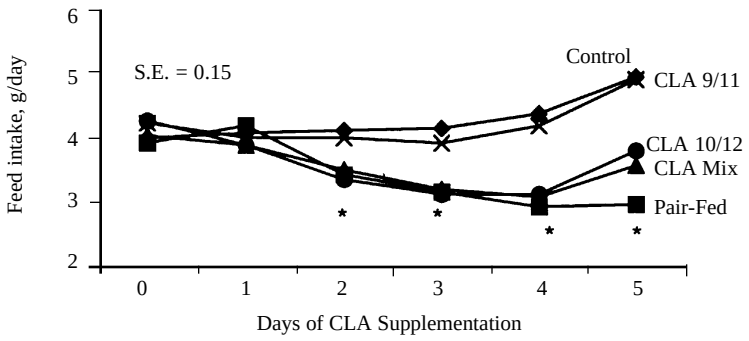

Figure 1. Effect of CLA Mix or individual isomers on feed intake (Experiment 1). *CLA 10/12, CLA Mix, and Pair-Fed differ from Control ($P < 0.001$).

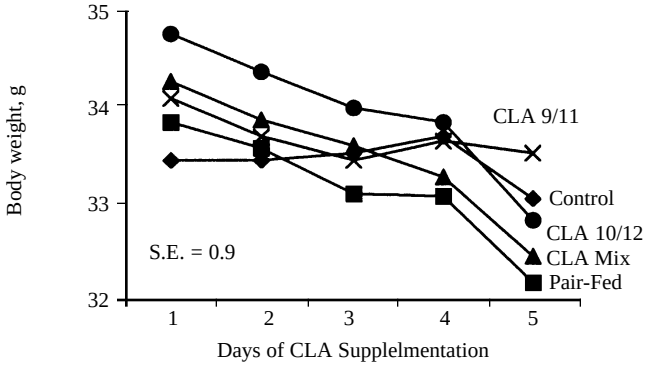

Figure 2. Effect of CLA Mix or individual isomers on BW (Experiment 1). No effect on BW was detected.

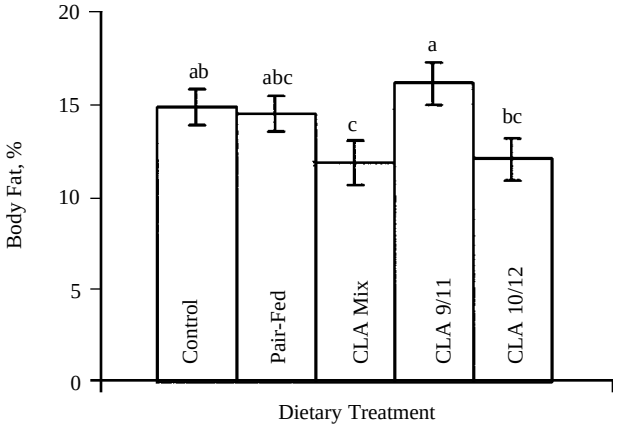

Figure 3. Effect of CLA Mix or individual isomers on body fat (Experiment 1). [abc]Means with different superscripts differ ($P < 0.05$).

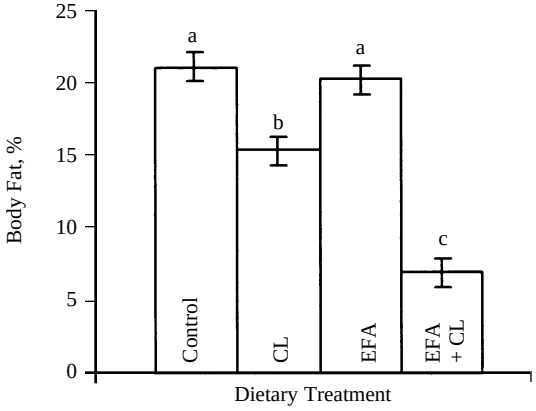

Figure 4. Effect of essential fatty acid deficiency (EFAD) and CLA supplementation on body fat (Experiment 2). [abc]Means with different superscripts differ ($P < 0.0001$).

Results

Experiment 1

Feed intake was reduced ($P < 0.001$) in mice fed CLA Mix and CLA 10/12 as well as the Pair-Fed mice, starting on day 2 (Figure 1). However body weight was not affected by diet in this short period (Figure 2). After 5 days of CLA supplementation there was a 20% loss ($P < 0.05$) of body fat in mice fed the CLA Mix and CLA 10/12 isomer compared to Control mice (Figure 3).

Experiment 2

Supplementation of CLA reduced ($P < 0.05$) both feed intake and body weight in the final two weeks of the study. CLA reduced ($P < 0.001$) RP (49%) and epidymal (19%) fat pad weights when added to the control diet. Furthermore, CLA reduced total body fat by 27% (Figure 4). The EFAD diet alone had no effect on feed intake, body weight, or body fat. However, when CLA was fed to mice deficient in essential fatty acids, its effects were greatly amplified ($P < 0.0001$); a 73% reduction in RP, 57% in epidymal, and 66% in total body fat (Figure 4).

In conclusion, CLA 10/12 is responsible for the loss of body fat observed when mice are fed a mixture of CLA isomers. This loss of body fat may be mediated through metabolism of CLA to an isomer of arachidonic acid. Arachidonic acid is a precursor to the series 2 prostaglandins, which have a multitude of actions in the body. Therefore, inhibition of the conversion of arachidonic acid to prostaglandin, or the production of prostaglandin-like molecules from CLA could explain the varied benefits of CLA. Essential fatty acids (linoleic and linolenic) partially protect against the full effect of CLA, possibly via competition for a common metabolic path.

Although ruminant-derived food products contain mainly the CLA 9/11 isomer, which does not appear to have any antiobesity effect, it is known that the CLA in beef and milk provides other health benefits such as mitigation of several cancers. CLA 9/11 can be metabolized similarly to CLA 10/12, forming a C20:4 Δ5,8,11,13 isomer of arachidonic acid. Therefore the health benefits of CLA, other than loss of body fat, may also be acting through this pathway.

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