January 2000

Acylation Stimulating Protein: A Potential Regulator of Fat Synthesis

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Summary and Implications

The long term goal of this project is to understand the molecular mechanisms controlling fat synthesis. These experiments indicate that acylation stimulating protein (ASP) can stimulate the incorporation of fatty acids into lipid in cultured adipose tissue. This finding justifies a future effort to determine if manipulation of ASP can modify fat deposition.

Introduction

Several hormones are known to influence fat accretion by stimulating the mobilization of fat stores. Growth hormone (PST), beta adrenergic agonists, and certain steroids have this effect. Application of this knowledge may someday allow swine producers to reduce backfat in these pigs. However, in certain situations it may be advantageous to enhance fat accretion. For example, intramuscular fat contributes to meat juiciness and flavor, and perhaps to tenderness. If a hormone which stimulates fat accretion could be identified, pork quality may be improved by: 1) enhancing intramuscular fat content; or 2) reducing deposition of fat in undesirable depots.

Acylation stimulating protein (ASP) was identified by Canadian researchers who were studying the development of fat cells in obese people (Cianflone et al., 1989). They found that ASP can stimulate fat cells to synthesize and store fat. Their reports then prompted our interest in whether ASP regulates fat synthesis in the pig. We initially determined that pigs do express a gene which codes for ASP. The objective of the current research was to determine if ASP purified from human blood (hASP) can stimulate fat synthesis in porcine adipose tissue.

Materials and Methods

Experiment 1

The objective of the first experiment was to determine if hASP could enhance fat synthesis in cultured porcine adipose tissue. Eight barrows ranging in weight from 210 to 270 lb (four Whiteline and four Genepool) were transported from the UNL swine facility at Mead to Lincoln and housed in individual pens. Pigs had ad libitum access to a corn-soybean meal diet containing 14% crude protein except as indicated in Experiment 2. A sample of subcutaneous adipose tissue was surgically obtained from each pig during anesthesia. The inner layer of each sample was cut into 15-mg sections and incubated in multi-well plates in buffered nutrient media containing radioactive oleate at 39° C for 2 hr. During this incubation, tissue sections from each pig were exposed to 0, .1, 1, or 10 micromolar doses of hASP. Following the incubation, fat synthesis was determined by assaying the incorporation of radioactive oleate into extractable lipid.

Experiment 2

The objective of this experiment was to determine whether the sensitivity of porcine adipose tissue to hASP is influenced by energy status of the pig. The eight barrows described above were allocated into two groups; each group was composed of two Whiteline and two Genepool pigs. One group had ad libitum access to feed and the other group was restricted to 1.2 lb/day (~50% of maintenance energy requirement). After 3 wk, adipose tissue samples were obtained and cultured as described for Experiment 1. During the following 3 wk, the feeding regimen was reversed and adipose tissue samples were again obtained and cultured.

Results and Discussion

The results of Experiment 1 are presented in Figure 1. Fat synthesis in adipose tissue was enhanced by hASP ($P < .10$). Incorporation of oleate was 20% greater in tissue exposed to the high dose of hASP than in the control. We interpret this result to mean that ASP can promote fat synthesis. The response of 20% which we observed, however, is less than the response observed by others in human fat cells. Perhaps ASP derived from pigs would have been more effective than human ASP. Thus far we do not have purified porcine ASP.

In Experiment 2 we hypothesized that fat cells that are actively synthesizing lipid may differ in sensitivity to hASP compared to fat cells derived from energy-restricted pigs. In this experiment, the pigs gained 48.5 lb during the 3-wk-period of ad libitum

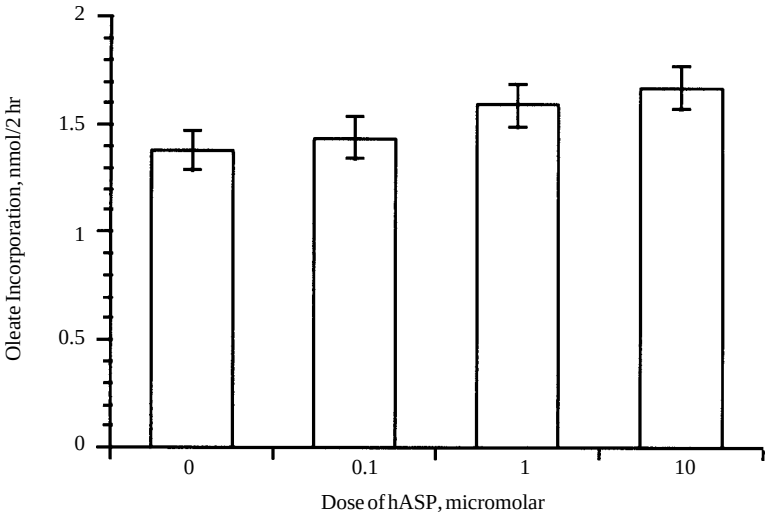

Figure 1. Oleate incorporation into total extractable lipid of adipose tissue cultured in presence of four concentrations of hASP (Experiment 1). Error bars represent SEM. Main effect of ASP (P < .10).

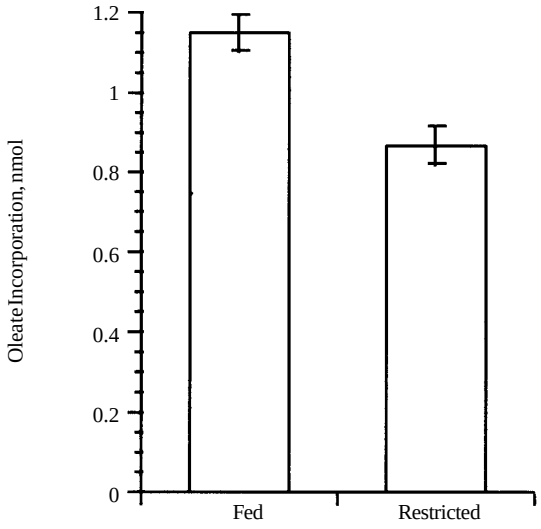

Figure 2. Oleate incorporation into total extractable lipid of adipose tissue derived from feed-restricted and ad libitum feeding pigs (Experiment 2). Main effect of diet (P < .01).

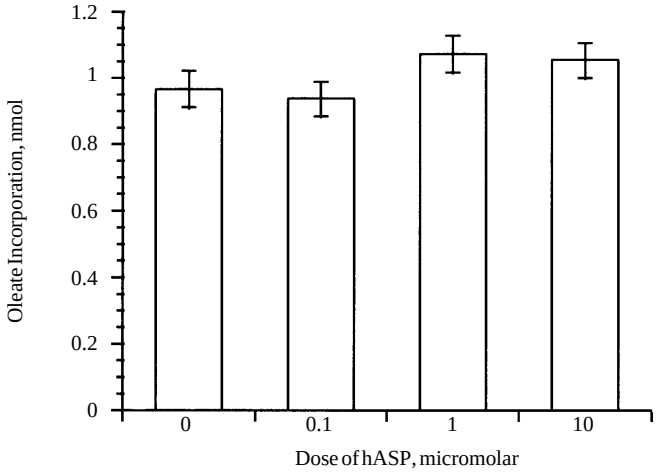

Figure 3. Oleate incorporation into total extractable lipid of adipose tissue cultured in presence of four concentrations of hASP (Experiment 2). Error bars represent SEM. Main effect of ASP (P < .01). ASP by Diet interaction (P > .50).

feeding, and lost 4.3 lb during the 3 wk that intake was restricted to 50% of predicted maintenance energy requirement. The rate of fat synthesis was reduced 24% in samples obtained from feed-restricted pigs as compared to pigs with unrestricted feed intake (P < .01; Figure 2). In contrast to our hypothesis, however, the effect of hASP was not influenced by feed intake (P > .5). Human ASP increased oleate incorporation by about 10% regardless of whether the tissue sample was derived from feed-restricted pigs or pigs that had ad libitum access to feed (P < .10; Figure 3).

The results of this research support the hypothesis that ASP is a hormonal regulator of fat synthesis in pigs. In two experiments, we observed a stimulation of oleate incorporation into lipid in cultured adipose tissue due to hASP exposure. The effect we observed was not as strong as that reported for human fat cells, and we have not demonstrated that pigs produce ASP protein. However, we have found that pigs produce mRNA from an ASP gene and we have used a clone of this mRNA to produce small amounts of porcine ASP protein. We are currently making an antibody to this protein and hope to purify ASP from porcine blood with this antibody.

Our ultimate goal is to find ways to improve pork production efficiency and(or) pork product quality. It may be possible to accomplish this by manipulating fat accretion by altering the effect of ASP in specific tissues. However, it is too early to determine if it will be practical to modify ASP or its effects. Regardless of whether ASP can be manipulated to improve pork production, learning about its mechanism adds to our overall understanding of pig biology which will ultimately lead to applications for pork producers.

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[1]Carin Ramsel was an undergraduate research assistant and is currently enrolled in Kansas State University Veterinary College. Sheila Jacobi was a graduate research assistant and is currently employed by Ohio State University. Jess Miner is an assistant professor in animal science. This project was funded by the National Pork Producers Council on behalf of the Nebraska Pork Producers Association.