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RESEARCH & TECHNOLOGY DEVELOPMENT FOR THE CANADIAN BEEF INDUSTRY
Beef Science Cluster

# Molecular factors influencing maintenance energy requirements in mature beef cows

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## Project Title:

The Impact of Nutrition and Residual Feed Intake on Tissue and Molecular Characterization, Manipulation of Maintenance Energy Costs, and Fetal Growth and Programming in Wintering Pregnant Beef Cows

## Researchers:

**Kendall Swanson, Ph.D.** kendall.swanson@ndsu.edu
Kendall Swanson, Ph.D.(North Dakota State University), Katie Wood and Brian McBride, Ph.D. (University of Guelph), and Carolyn Fitzsimmons, Ph.D. (Agriculture and Agri-Food Canada)

## *Background*

Feed costs represent a significant input cost in the cow-calf sector. The majority of the feed energy needed by the cow is used to meet the animal's "maintenance requirements". These include cellular processes such as ion transport, protein turnover, cell proliferation, gluconeogenesis, and energy signalling to maintain muscles, bones, lungs, heart, brain, digestive organs and hormonal systems. Improving the efficiency of these maintenance functions should reduce maintenance energy requirements and reduce feed requirements.

Cows may be able to reprioritize their energy use during pregnancy. This allows the cow to use less energy to maintain herself, and divert more towards the growing calf. Understanding how this repartitioning works may help identify ways to improve the efficiency of cow-calf production.

A better understanding of organ metabolism is the first step. Internal organs represent a small proportion of the body but represent a large proportion of total energy requirements. Animals with smaller visceral organs are likely to be more metabolically efficient. Previous research has investigated visceral organ mass in growing animals, but limited information is available on the effects of nutrition and pregnancy on visceral organ mass in cows.

Better understanding maintenance requirements and energy metabolism in the mature cow may lead to the development of management and nutritional approaches that improve feed efficiency of cows.

## *Objectives*

To determine:

1. How nutrient restriction of pregnant beef cows during mid-to late gestation impacts performance, visceral organ mass, liver metabolic rate, enzymes and proteins involved in energy metabolism, and
2. The influence of pregnancy in mature beef cows on performance, internal organ size, liver metabolic rate, and proteins involved in energy metabolism.

## *What they did*

Two experiments were conducted. In the first experiment, mature pregnant beef cows were fed at a high level of intake (approximately 140% of NE requirements) and at a restricted level of intake (approximately 85% of NE requirements) to induce differing metabolic states. Cows were slaughtered, tissue samples taken and visceral organs were weighed. Samples were analyzed for selected proteins relating to energy metabolism. Liver metabolic rate and circulating metabolites were also measured.

In the second study, pregnant and open cows were fed a free choice haylage and straw ration before slaughter. Tissue samples were collected at slaughter and organ weights were recorded. Similarly to the first experiment, tissues were analyzed for proteins relating to energy metabolism.

## *What they learned*

In the first study, the metabolic rate of the liver was reduced in the restricted fed cows, indicating that the liver responds to changes in energy status. Cows fed the restricted diet had increased ubiquitin abundance in muscle. Ubiquitin is an indicator of protein breakdown. This indicates that rates of protein synthesis and degradation may play important roles in energy metabolism and maintenance requirements in mature cows. Another protein involved in energy regulation (peroxisome proliferator-activated receptor gamma coactivator 1-alpha or PGC1-) was lower in the liver of restricted fed cows than in those fed at a high level of intake. This may be related to the lower levels of thyroid hormone triiodothyronine ($T_3$) concentrations observed in restricted cows. $T_3$ is a known stimulator of PGC1-. These proteins may be specific targets for future studies aimed at improving feed efficiency in cows through nutrition, management, or genetic improvement programs.

The second study found that pregnant cows had smaller livers and smaller rumens. Late in pregnancy, the expanding uterus reduces the amount of space available for the rumen. This reduction in rumen size limits how much pregnant cows can eat in late gestation. This may result in cows not consuming enough to meet their energy requirements. The blood analysis results supported this idea. Increased levels of circulating fatty acids, beta-hydroxybutyrate and urea indicate that the pregnant cows were metabolizing their energy stores. Phosphorylated 5'adenosine monophosphate-activated protein kinase, was also higher in the rumen papillae tissue in pregnant cows. This enzyme is important for energy sensing in the cell, and may be a signal to pregnant cows to increase energy intake. In the liver, Na+/K+ ATPase, a cellular ion pumping protein, was also increased in pregnant cows. This may be a result of decreased liver size, increased demand on the liver to help support pregnancy, and hormonal interactions. Although more research is needed to better understand these observed differences, these results do indicate that pregnant cows repartition energy to support fetal growth and that specific cellular proteins are likely involved in regulating the use of energy by different tissues.

## *What it means*

These studies have identified proteins that respond to restricted feeding and pregnancy in mature beef cows. These proteins may be important in energy signalling and maintenance requirements for beef cows. Although more research is needed to determine how these proteins are regulated, they do identify possible key targets for possible genetic selection, identification of novel SNPs or through control through dietary, management or pharmacological manipulation.

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**For More Information Contact:**
Beef Cattle Research Council
#180, 6815 - 8th St. NE
Calgary, AB T2E 7H7
Tel: (403) 275-8558 Fax: (403) 274-5686
info@beefresearch.ca

**For More Information Visit:**
www.beefresearch.ca

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