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Mechanism Revealed for Sustaining Milk Production in Dairy Cows

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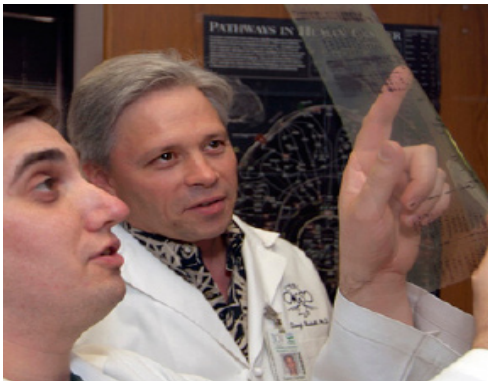
Research at Baylor College of Medicine has begun to identify mechanisms that control milk production in dairy cows.



Adam Gillum, USDA/ARS Children's Nutrition Research Center, Baylor College of Medicine

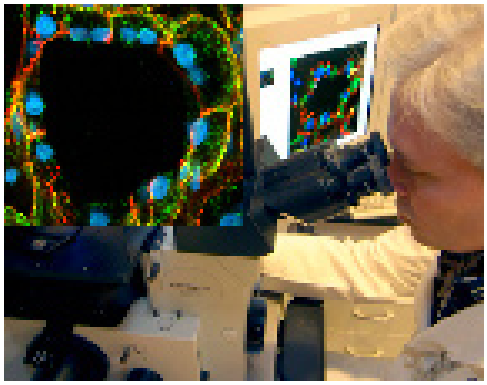
Researchers evaluate the phosphorylation of signaling proteins in mammary tissue samples

Milk production in dairy cattle peaks 6 to 8 weeks after calving and then declines throughout the remainder of the 10-month milking period. Lactation persistence, defined as the degree to which peak daily milk yield is maintained during lactation, is one of the most important determinants of profitability in a dairy herd. Improving persistence not only enhances profitability, but also can improve the sustainability of the dairy industry, enhance dairy cow welfare, and even reduce the potential environmental impact of dairy farming on our nation's ecosystems. The improvements in sustainability and animal welfare come from the fact that improved persistence will produce healthier cows that live longer. The main reason for the improvement is a potential to dramatically increase calving interval.

The greatest incidence of health problems in dairy cows around calving and just after calving. Therefore, developing novel strategies to enhance persistence and allow for an increased calving interval will ultimately reduce stress and enhance longevity of cows. This enhanced longevity is expected to translate into a reduced need for replacement animals. As a result, smaller herds could potentially produce the same amount of milk.

Among the most noteworthy of recent technological developments in the dairy industry is the commercial application of recombinant bovine somatotropin to enhance milk production. Injection of this hormone into dairy cows stimulates them to produce 10 to 20 percent more milk per day. In addition, the hormone has the ability to enhance lactation persistence under some circumstances. For several years this hormone has been thought to act through a growth factor called insulin-like growth factor I. The actual mechanisms through which these two proteins act on the lactating mammary gland are,

Phosphorylation (green) of signaling proteins in mammary cells can be detected and measured using a microscope



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however, poorly understood. In addition, current understanding of the processes that cause the loss of milk production in late lactation in dairy cows is only rudimentary.

Researchers at Baylor College of Medicine, funded by the National Research Initiative, are uncovering clues as to how somatotropin and insulin-like growth factor I regulate milk production. This research team has discovered that insulin-like growth factor I directly controls maintenance of milk production. By using transgenic technology, these researchers produced an animal model in which the growth factor was over expressed in the lactating mammary gland. With this model they found that the growth factor helps to extend the duration of peak milk production.

To understand how the growth factor improves milk production, the researchers used a test that measures the activity of 'signaling proteins' within the cells of the mammary gland. When these proteins are active in a cell, they form a network that tells the cell to make more milk. The test is based on the fact that these signaling proteins are activated when they become modified by a process known as 'phosphorylation'. This phosphorylation process results in the addition of phosphate to the signaling protein, which can be detected both in ground-up samples of mammary tissue and in mammary tissue sections that allow individual mammary cells to be directly observed with a microscope.

By using this test, these researchers found that the increased milk production in the transgenic model occurred through phosphorylation of a signaling protein that serves to bind the insulin-like growth factor I on the surface of mammary gland cells. Using this test to study other signaling proteins in mammary tissue from lactating animals, the researchers at Baylor have concluded that, in addition to signals that tell cells to make more milk, there are also signals that tell mammary cells to reduce milk production. Work is ongoing to compare the relative effects of these positive and negative signaling proteins in mammary tissue from both lactating dairy cows and other transgenic animal models of lactation. Soon, a greater understanding of positive and negative signaling networks in the lactating mammary gland should allow for advances in identifying novel approaches to enhancing lactation persistence.

Impact

Maintenance of peak milk production is critical to reducing escalating production costs in the dairy industry. This research has revealed a major mechanism controlling lactation and will lead to new management strategies for prolonging milk production at peak levels, thereby reducing production costs and improving profitability in the dairy industry.

The research reported in this fact sheet was sponsored by the Animal Growth and Nutrient Utilization Program of the National Research Initiative Competitive Grants Program. To be placed on the mailing list for this publication or to receive additional information, please contact the NRI (202-401-5022 or NRICGP@csrees.usda.gov). The fact sheet also is accessible via the NRI section of the Cooperative State Research, Education, and Extension Service Web site (http://www.csrees.usda.gov/nri).

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