NRI research highlights

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Controlling Growth Hormone Aids Calf Growth and Milk Production

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Growth hormone is a primary regulator of body growth in calves and of milk secretion in mature cattle. Although injecting growth hormone (also called bovine somatotropin or bST) increases milk yield by as much as 17%, lactating dairy cows often temporarily lose weight because they do not initially eat enough to meet the increased metabolic demands for producing more milk.

Researchers at Michigan State University are exploring new ways to simultaneously increase both milk production and feed intake in lactating dairy cows. This approach requires a better understanding of the physiological signals that control secretion of growth hormone and appetite in cattle.

Bruce Fox, Michigan State University

Identifying Signals in the Brain

Initially the researchers began studies – funded by USDA's National Research Initiative (NRI) Competitive Grants Program – to identify the signals in the brain, specifically in the hypothalamus, that control secretion of growth hormone and, ultimately, body growth and milk production.

Previous research showed that two proteins located in the nerve cells of the hypothalamus regulate secretion of growth hormone. These proteins are growth hormone-releasing hormone, which stimulates release of growth hormone, and somatostatin, which inhibits release of growth hormone.

In partnership with private industry, the researchers have shown that administering growth hormone-releasing hormone to dairy cows increases secretion of growth hormone and boosts milk production by up to 30%, compared to an increase of 17% from administration of growth hormone. Thus, a better understanding of how growth hormone secretion is regulated might lead to new methods of improving the efficiency of growth and milk production.

Allen Tucker's research at Michigan State University on chemicals in the brain may lead to increased efficiency of growth of calves and of milk production in cows.

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The researchers needed to know how growth hormone-releasing hormone and somatostatin normally interact in the body. They already knew that concentrations of growth hormone in blood decrease after feeding. Therefore, activity of growth hormone-releasing hormone and somatostatin nerves could be related to changes in concentrations of growth hormone before, during, and after feeding.

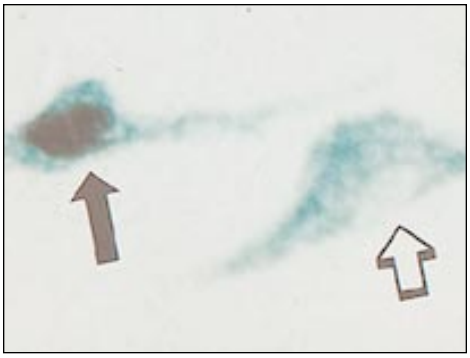
Factors Controlling Nerve Activity

The researchers determined that feeding suppressed activity of growth hormone-releasing hormone nerves. This may account at least partially for the decrease in secretion of growth hormone after feeding. Growth hormone-secreting cells are unresponsive to growth hormone-releasing hormone for several hours after feeding.

With respect to somatostatin, decreased secretion of growth hormone would be expected to be associated with increased activity of somatostatin nerves (see photo below). However, when secretion of growth hormone declined after feeding, activity of somatostatin nerve cells unexpectedly decreased. This suggested that additional substances produced in the brain might control secretion of growth hormone around the time of feeding.

Considering this, the scientists turned their attention to another brain chemical, neuropeptide Y, which had been shown to simultaneously stimulate secretion of growth hormone and appetite in sheep.

The researchers have now determined that neuropeptide Y increases secretion of growth hormone-releasing hormone without affecting release of somatostatin. Thus, it may be possible to stimulate secretion of growth hormone and concurrently increase appetite, which could lead to an increase in body growth in calves and milk production in cows greater than that observed with growth hormone alone.



A somatostatin neuron in the bovine brain (hypothalamus) that is inactive (open arrow) and another that has been activated by brain chemicals (solid arrow).

Christopher McMahon

Impact

There are many signals in the brain that control appetite, body growth, and lactation in cattle. One of these signals, growth hormone-releasing hormone, has already been shown to increase lactation by as much as 30%. As additional signals are identified and their functions understood, it will be possible to further enhance efficiency of growth and lactation in cattle.

The research reported in this factsheet came out of the Animal Growth, Development, 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@reeusda.gov). The factsheet also is accessible via the NRI section of the Cooperative State Research, Education, and Extension Service website (http://www.reeusda.gov/nri).