

# FROM SHELLFISH TO UDDER HEALTH

Researchers develop product dairy farmers can use to improve cow health during dry-off while decreasing antibiotic use

**I**nnovative projects are needed to discover viable alternatives to antibiotic treatments currently used on farms. The project presented in this article is built from a surprising idea developed by seasoned researchers and a motivated student born on a dairy farm. This unique team has come together to generate a promising new product.

We know proper management of the transition period from lactation to dry-off is essential to maintain overall and, more specifically, dairy cow udder health. As a result, antibiotic treatments are often employed during this time to prevent mastitis from developing. Are there ways to reduce the risks of developing a mammary gland infection without using antibiotics? This question is pertinent to the Canadian dairy industry since there are debates about reducing antibiotic use as prophylactics and the potential for new legislation.

Research performed by Samuel Lanctôt, under the supervision of researchers Pierre Lacasse from Agriculture and Agri-Food Canada (AAFC) and Xin Zhao from McGill University, aims to tackle this question. As the son of a dairy farmer and student-researcher, Lanctôt bridges the divide from laboratory to farm as he searches for solutions to problems encountered by his fellow dairy farmers. He has developed an innovative treatment that can be used during the lactation to dry-off transition period

that may allow him to improve Canadian dairy cow health.

## THE DRY-OFF PERIOD IS FRAUGHT WITH RISK

A major problem encountered during dry-off is new mastitis development. This risk decreases once involution—when the udder shrinks to its original size prior to lactation—is complete. The process is the result of shrinking mammary tissue and cellular reorganization while the udder prepares itself for a dormant period. Immune cells accelerate this process by migrating into the udder where they facilitate digestion and mammary tissue reorganization.

Dairy cows, especially those with high milk production, are at increased risk of developing mastitis at the beginning of the dry-off period. Milk accumulation causes pressure to build in the udder and can cause leakage, force the teat open, or displace the waxy keratin plug formed in the teat. A displaced plug removes the first line of defence against infection since the plug forms a physical barrier that normally prevents micro-organisms from entering the teat. This is particularly dangerous because there are few immune cells to form the next line of defense, and those that are present are already busy with the involution process, which reduces their anti-infective ability.

Researchers can then hypothesize dry-off techniques that speed up involution and increase a cow's immune system, which will reduce the risk of developing mastitis or other infections during this period.

## A NATURAL PRODUCT FROM THE SEA

With this knowledge, the research group at AAFC's Sherbrooke Research and Development Centre sought to develop products that speed up involution and increase a cow's immune response. In collaboration with Dr. Patrick Fustier's group at Saint-Hyacinthe Research and Development Centre, researchers developed a hydrogel mainly composed of chitosan that can be inserted directly into the teat to recruit more immune cells to speed up involution. Chitosan is a polysaccharide derived from naturally-occurring chitin that forms part of the shell structure of crustaceans and shellfish, and which contains purported antifungal and antibacterial properties.

## WHAT IS A HYDROGEL?

Hydrogel is water-insoluble polymers that can form a gel with large absorptive ability. Their flexibility is comparable with that of living tissues, and because they are mostly made up of water, they are naturally compatible with these





tissues. Researchers are interested in hydrogels because they could potentially be used as long-term implants able to release therapeutic compounds over an extended period of time.

Researchers performed two experiments on seven and eight cows, respectively, from the Sherbrooke Centre herd to test the effect of a chitosan-based intramammary treatment on involution and immune function. They measured compound levels in milk and mammary secretions to monitor treatment outcome. The first study compared three formulations that differed in their viscosity and volume with a control treatment comprising just water. Incredibly, all three chitosan formulations significantly increased the number of immune cells in the udder and levels of compounds associated with involution, while stimulating local immune response.


Based on these promising results, researchers designed a second experiment to compare a pre-formulated chitosan-based treatment with three other treatments. The first treatment tried was a conventional teat sealant used alone, the second treatment was a conventional sealant combined with the pre-formulated chitosan treatment, and the third treatment was a control made up of water. This allowed researchers to clearly demonstrate the benefit of their chitosan treatment because only the cows treated with chitosan alone, or treated with chitosan in combination with teat sealant, had faster involution and increased immune cell recruitment to the mammary gland in the early stages of the dry-off period. This effect is not achieved when using conventional teat sealant alone and, remarkably, the hydrogel function is not affected by the teat sealant when used together.

## PREVENTION LEADS TO REDUCED ANTIBIOTIC USE

This study demonstrates a hydrogel made up of chitosan can be used in combination with existing mastitis-preventing tools during dry-off. In addition, the use of a chitosan-based hydrogel in combination with teat sealant may combine the benefits of stimulating the immune response while generating a physical barrier between the teat and outside environment. This method could potentially decrease prophylactic antibiotics while decreasing the risk of developing new mastitis infections during the dry-off period.

Researchers are in the process of patenting the use of a chitosan-based hydrogel, and future research projects will be performed in collaboration with partners in the industry. The objective of this project is to develop a safe

and effective product that can be used by dairy farmers to improve cow health during dry-off while simultaneously decreasing the need for prophylactic antibiotic treatment. This approach will serve the needs of the dairy industry while satisfying consumers concerned about antibiotic use on Canadian dairy farms.

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