Lactation

PICTURE the world without the production of milk. What would it look like? What products would cease to exist? Obvious answers, such as chocolate milk, cheese, ice cream, and sour cream emerge, but are there others? Milk production composes a large part of the agriculture industry from the milk produced in America's dairies to the growth and development of a variety of agricultural animals. In this unit, discover the process of lactation and how it affects the milk production industry. In addition, this unit discusses the effect various hormones, genetics, environmental factors, proper diet, and overall health play on milk production.

Objective:

Explain lactation and the components involved in milk production.

Key Terms:

alveoli
bovine somatotropin
colostrum
ketosis
lactation
lumen
mammary system
mastitis
milk fever
oxytocin
prolactin
sphincter muscle
teats
tertiary ducts

Lactation and Its Components

The process of **lactation** (the ability of the mammary system to produce milk) occurs due to the need for a mother mammal to supply nutrition to her offspring. All female animals with the ability to reproduce possess several interior and exterior components that intertwine to produce milk.

THE PROCESS OF MILK PRODUCTION

The **mammary system** plays a large role in milk production. Milk is released when offspring stimulate the mammary system, which allows the infants to consume the product. Milk production in the mammary system begins with blood flowing through specific parts of the system and charging the glands with nutrients and water that are processed and converted into milk. The process is divided into four main steps.

In the first step, blood is directed toward the mammary system and flows through a cluster of grape-like structures called **alveoli**, which extract raw materials from the blood stream and transfer the materials into milk. With this milk production, solids (e.g., proteins, carbohydrates, vitamins, and minerals) blend with water in the alveoli. Then the milk secreted in the alveoli begins to flow into a hollow cavity known as the **lumen**.

The linking of the lumen and the cluster of alveoli triggers the second step of the process and establishes the creation of the lobule, which creates a pathway for the milk to be released from the female body and to flow to the next mammary system component.

The third step of this process starts as milk exits the lumen through a specialized structure called the **tertiary ducts**, which provide the pathway from the lumen to the storage compartment of the mammary system. The milk remains in the gland cistern until it is released from the body. The size and shape of the gland cistern varies by animal, but it typically contains an upper area and a lower area where the milk is eventually released. To keep the milk in the storage compartment, a specialized muscle called the **sphincter muscle** contracts until milk letdown occurs.

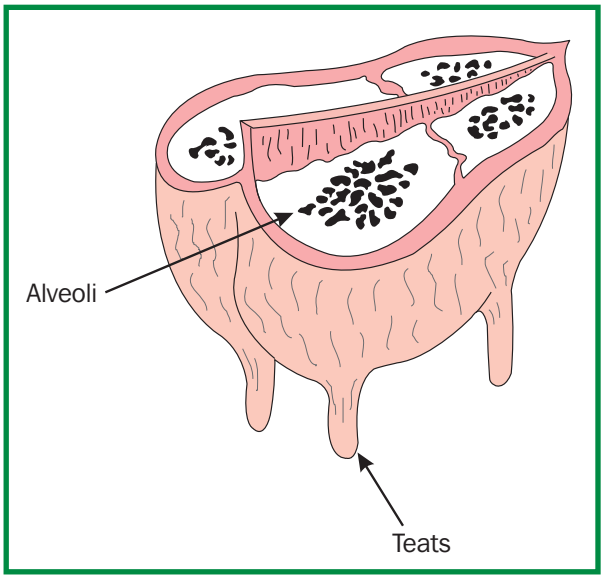

FIGURE 1. Structure of a cow's udder.

At this point, the final step begins. Milk letdown is stimulated and flows down the alveoli. This process utilizes gravity and pressure (from additional milk being produced) to exit the body through teats. These **teats** are elongated exterior structures that contain a small canal at the tips that open to release milk when suckled or stimulated.

THE COMPONENTS OF MILK AND COLOSTRUM

The proper production of milk is primarily due to the consumption of nutrients from feedstuffs and water by the female that are quickly converted within the body and released through the mammary system. Once the nutrition-rich blood reaches the mammary system, specific nutrients are extracted from the blood and converted into milk. These nutrients produce a

highly nutritious milk product known as **colostrum**. This milk, often called the "first milk," supports young animals until other feedstuffs (e.g., grass and grain) can be consumed.

Colostrum contains special antibodies that protect infant animals. These antibodies develop in the animal's immune system and work to ward off disease or sickness. Without these antibodies that originate from the immune system of the animal's mother, a young animal would likely perish within the first few days after birth. These antibodies are included in the first milk produced and remain in production until the antibodies are all used and colostrum is no longer produced.

The exact composition of milk varies by animal, but generally it is composed of 87 percent water and 13 percent solids. The water within milk serves as the carrying agent for the solids and aids in hydrating animals after consumption. Early in life, infants cannot consume water. As a result, these infants could die from dehydration without consuming the "first milk."

The solids in milk are usually composed of proteins, carbohydrates, water-soluble vitamins, and minerals. The amount of each component varies by animal due to the environment in which it lives and the diet consumed. For example, some animals produce milk with high levels of carbohydrates because the environment demands higher levels of energy. Other animals produce milk with higher levels of protein to support rapid growth and development of young animals. In addition, milk is commonly consumed by humans and comprises a large part of a daily diet. It provides needed calcium and vitamin D to support healthy living and a balanced diet.

FIGURE 2. Piglets nursing.

HORMONES USED IN MILK PRODUCTION

Naturally produced and synthetic hormones are utilized in milk production to enhance the well-being of the animal and to improve reproduction. Without hormone use, milk production would be well below current production levels. Naturally produced hormones may be limited due to prior health conditions, which lead dairy producers to supplement with synthetic hormones to meet milk production demands. However, before a synthetic hormone is applied to an animal, the hormone must be approved by the U.S. Food and Drug Administration.

Many hormones occur in an animal's body naturally to influence milk production. These hormones serve as catalysts to the milk production process by stimulating milk letdown and milk production. These hormones also restart the reproductive process. For example, the lactation process is triggered by the hormone **prolactin**, which is naturally produced and is

released to activate the mammary gland to start milk production. Prolactin is produced throughout the pregnancy process and peaks shortly before giving birth.

Another naturally produced hormone is released at the start of lactation: **oxytocin**. The release of this hormone begins the mammary system milk-releasing process. Oxyctin's release is stimulated by the suckling of infant animals or the cleaning of teats.

Researchers began trying to produce synthetic hormones in the 1920s to increase milk production. The goal was to develop a synthetic hormone for commercial use that would safely enhance animal milk production. In addition to naturally produced hormones, many synthetic hormones are not widely used in milk production without the prescription of a veterinarian. In some regions, however, the use of bovine somatotropin is highly utilized in dairy cows. **Bovine somatotropin** (bST) is a naturally released hormone that regulates milk production levels. When supplemented in a synthetic form, cows produce more milk for a longer period of time than untreated cows.

FACTORS AFFECTING MILK PRODUCTION

Milk production success can be limited by various factors, such as genetics, disease, diet, environmental concerns, and body condition. If any of these factors are not in balance, the expected milk production is likely to decrease. For example, the genetic makeup of an animal can influence the amount of milk produced.

Producers often look at a variety of genetic factors when selecting animals for breeding. The goal of the producers is to select genetic matches that result in an animal that is expected to produce milk at high levels if all other factors are at an acceptable level.

Another factor that affects animal milk production levels deals with diet and the environment. Animals that are not fed properly or those stressed by the environment will likely have a decrease in milk production.

Common Disorders Affecting Dairy Cows

Ketosis deals with cows that are struggling with health problems during lactation, which lowers a cow's blood sugar, resulting in poor appetite and dullness. Dairy cows suffering from ketosis should be treated with propylene glycol.

Another disorder leading to health problems is fat cow syndrome, which deals with cows that are overly fat. The metabolic disorder, **milk fever**, leads to low blood calcium and paralysis in dairy cows, which is caused by the excessive feeding of calcium during the later stages of lactation or the dry period. To avoid milk fever, a producer should feed rations with low calcium-to-phosphorus levels.

One of the most common problems for milk production relates to mastitis. Dairy cows often get mastitis due to unclean areas and equipment. **Mastitis** deals with the inflammation of the mammary gland and often is not visible to the human eye. The spread of mastitis can be controlled with sanitary milking practices. In addition, animals need to be in proper body condition and have good overall health to produce milk at proper levels.

Summary:

All female animals suitable for reproduction must possess the necessary components for lactation to occur. Due to these complex components, a clear understanding of lactation is important for dairy producers. In addition to understanding the mammary system of a dairy cow, it is also important to consider the steps needed to produce colostrum and the use of natural and synthetic hormones for milk production. Finally, the success of milk production can be limited by a variety of factors, such as genetics, disease, diet, environmental concerns, and body condition of the animal.

Checking Your Knowledge:

1. What is colostrum?
2. At what percentages is milk composed of solids and water?
3. What are the two categories of hormones used in milk production?

Expanding Your Knowledge:

Visit a local dairy or production farm and recognize how the structure of the mammary system is understood to improve milk production levels for profit. List and describe five ways the dairy producer monitors outside factors that can affect milk production. In addition to identifying these factors, compare and contrast how naturally produced and synthetic hormones are utilized on the dairy.

Web Links:

The Daily Life of a Dairy Farm Owner, Safety Standards, and the Use of Technology
http://dairyfarmingtoday.org/DairyFarmingToday/Home/

Educational Dairy Programs and Research
http://www.livestocktrail.uiuc.edu/dairynet/

History and Step-by-Step Explanation of How Bovine Somatotropin Works
http://www.extension.umn.edu/distribution/livestocksystems/DI6337.html