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Mother's Milk: Understanding Mare Lactation

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Many think that lactation in the mare is not that important, especially compared to the dairy cow, from which milk is taken directly for human consumption. However, the importance of lactation in the mare must not be underestimated. Indeed, some cultures do collect milk from mares for human consumption, but normally mare milk production is only indirectly evident in the growth and development of her foal. As such, it warrants consideration in some detail. An understanding of lactation is important to provide the best start in life for the foal.

Anatomy of the Mammary Gland

Milk is produced in the udder or mammary gland of all mammals (hence the term mammal). Different mammals have a differing number of mammary glands situated in pairs along the abdomen on either side of the midline. Some mammals, such as pigs, have up to 20 (10 pairs), whereas primates have only two. The mare has four mammary glands (two pairs) situated between the hind legs; they are protected by a layer of skin and hair that covers the whole surface of the glands. In the area of the teats, the skin is hairless and particularly sensitive in order to react to the foal's suckling.

The mammary gland as a whole is supported by, and attached to, the body of the mare by sheets of ligaments (Figure 1). In most mammals, each gland has its own teat, so in the mare you would expect there to be four (like a cow). However, the mare is relatively unique in that each pair of glands on either side of the midline joins together and exits via a single teat, so the mare has only two teats (Figure 2).

The milk-producing tissue within the mammary glands is made up of millions of alveoli and interconnecting ducts. The alveoli are grouped together and are connected via a network of ducts, which eventually join together and empty into the gland cistern, the milk storage area above each teat. This arrangement can be compared with a bunch of grapes, with the grapes being the alveoli and the stalks the interconnecting ducts (Figure 3, page 54). At the end of each teat is a tight sphincter or muscle, which can withstand considerable pressure and thus prevent leakage of milk from the udder between sucklings. However, in some mares, the muscle is weak or the mammary gland is so full of milk (often near to parturition or foaling) that the sphincter cannot prevent leakage. If leakage does occur just prior to parturition, the colostrum (first milk) should be collected and frozen to give to the foal as soon as it is born.

The milk-secreting alveoli are lined with lactating cells surrounding a central cavity or lumen (Figure 4, page 54). This lumen is continuous with the interconnecting duct system within the gland. Milk is secreted by the lactating cells into the lumen and hence on to the teats for storage and easy access for the foal at suckling.

Each alveolus is surrounded by muscle cells, which contract at suckling to force milk out and into the duct system and thus increase the amount available to the foal. Each alveolus also has blood capillaries, which supply the alveoli with nutrients and milk components or building blocks.

Mammary Gland Growth and Development

Mammary gland development is first evident in the filly embryo. Cells between the hind limbs on either side of the midline multiply and develop to form mammary buds. At birth, very small glands and teats can be seen in filly foals, and develop as the body grows. Puberty marks the start of sexual activity, which in the mare consists of 21-day estrous cycles with associated hormone changes. The hormones that drive the estrous cycle increase mammary gland growth. During pregnancy, this growth is driven even more, largely due to the hormone progesterone (which dominates the mare's system throughout pregnancy).

At the foal's birth, the mammary gland is very well developed and is full of colostrum ready for the foal to suckle. However, mammary gland growth continues into lactation, with the glands increasing in size and milk production until about four to eight weeks after birth, when maximum milk yield is produced. From that time onward, the mammary glands decrease slowly in size as milk production declines, eventually returning to their normal non-pregnant size.

Milk Formation and Secretion

Milk is synthesized, or made, in the lactation cells lining the alveoli. The "building blocks" for each component of milk are obtained from small molecules in the blood supplying the mammary gland. The components pass from the blood supplying each alveolus across the cell membrane and into the lactating cell. The components are then built up within the cell and passed complete as lactose, lipids, and proteins across the opposite cell membrane (along with water) into the lumen of the alveoli. As the volume of milk builds up within the alveoli, the pressure drives milk along the interconnecting ducts to the teats in readiness for the foal.

The rate of milk secretion is controlled by hormones, which in turn are affected by the amount of milk the foal suckles. As the foal starts to eat forage or creep feed, he suckles less milk. In response to less suckling, hormones determine that fewer milk components pass into the lactating cells and less milk is secreted.

This direct effect of rate of suckling on milk production has implications on how we manage mares and their foals. If a foal is ill and does not suckle for 24 hours or so, the mammary gland will start to shut down. If left too long, it will not resume its previous level of production even if the foal recovers and returns to suckle the mare. Such foals need to be watched in case there is not enough milk available for them. This shutting down of milk production can be avoided by continuing to milk the mare by hand while the foal is away.

Similarly, if a foal is weaned off the mare and returned to her, he will not be able to suckle milk, as the mammary gland will have already shut down its milk production.

Milk Yield (The Lactation Curve)

"Milk Production Over Time" on page 55 illustrates the amount of milk that an average mare produces at different times after the birth of her foal. The shape of the graph is termed the lactation curve. This lactation curve can be changed quite significantly by the way we manage the mare and her foal in early life.

Under natural conditions, such as in feral mares, milk production increases over the first four to eight weeks of lactation until a peak is reached of 2.1-3.1 gallons (8-12 liters) per day. In Thoroughbreds and larger breeds, maximum milk production is 2.6-4.7 gallons (10-18 liters) per day. This compares to up to 13 gallons (50 liters) per day produced by a good dairy cow.

After eight weeks or so, the foal normally has begun to obtain some food or nutrients from sources other than its dam, such as pasture. As the foal gradually obtains more food elsewhere, he demands less milk from his dam. Therefore, the mammary glands' production decreases.

In managed mares and foals, man manipulates the shape of the lactation curve by providing the foal with supplementary food in the form of creep feed. This foal food is given at different times in different systems. If creep feed is fed from about one week of age (system one), the foal starts to get nutrients elsewhere more quickly and thus relies less on its dam's milk. Because of that, maximum milk yield occurs earlier and the total amount of milk produced is reduced to match what the foal needs.

If creep feed is not fed until week six (system two), then the foal relies longer on its dam's milk, so the foal's demands on the mare will be greater. Therefore, maximum lactation yield occurs later on and the total amount of milk produced is greater.

Because of this relationship between creep feeding and lactation, the nutrition of lactating mares must be taken into account when you start creep feeding foals. The mare producing less milk (system one) will not require as much food as the mare producing more milk (system two).

In wild ponies, lactation continues for 10-11 months. At that point, the mare's milk normally dries off and she rejects the foal a few weeks before the next foal is due to be born. This gives the mammary gland about four weeks to recover and time to begin secreting colostrum in readiness for the new foal. If the mare is not in foal again, the foal might still suckle up to 18 months of age.

From the graph "Milk Production Over Time" (above right), it is evident that by six months, the amount of milk secreted has declined considerably, to less than that produced at the birth of the foal. Therefore, at that time, the foal must be obtaining a significant amount of nutrients from sources other than milk. Weaning at six months, therefore, especially if the foal is creep fed, can be practiced with very little detrimental affect to mare or foal providing the foal is in good health. Weaning at this stage allows the foal's diet to be controlled more easily as he is now totally reliant on what man provides. Foals can now be segregated into groups for feeding, handling, etc.

Additionally, the mare has a chance to recover and redirect her efforts into the next foal she might be carrying. She will also be available for work.

It is also more efficient in terms of feeding for the mare to stop producing milk at six months and for the foal to get all his nutrients from forage and/or concentrate feed rather than feed the mare.

The total milk yield in the average Thoroughbred mare is 520-780 gallons (2,000-3,000 liters) or 0.5-0.8 gallons (2-3 liters) per 220 pounds (100 kilograms) of body weight in larger horses and 11 pounds per 220 pounds of body weight (5 kg per 100 kg body weight) in ponies. This compares to a total lactation milk yield in the average dairy cow of 1,820 gallons (7,000 liters).

Milk Quality

Not only does the amount of milk produced vary with the stage within the lactation curve, but the quality and composition of milk also change. In general, the quality of milk reflects the requirements of the foal and provides energy and the "building blocks" for growth and development.

One of the major changes in composition is clear in very late pregnancy and during the first 12 hours after birth, when colostrum is produced. From 12 hours onward, only normal milk is produced.

Colostrum contains a high concentration of proteins called immunoglobulins. The initial protein concentration of milk is high at 13.5%, compared with 2.7% during the main lactation period. Within 12 hours of parturition, this high protein level declines since immunoglobulins are no longer evident in the milk. These immunoglobulins carry antibodies, and it is via these that the foal attains its immunity to infections once it has suckled colostrum.

Such passage of antibodies, and therefore immunity, is very important in mammals such as the mare which have a relatively thick placenta that limits the passage of these antibodies to the foal when it is still in the uterus. If the foal is to survive, it is essential that he receives adequate colostrum.

In addition, the colostrum must be fed in the first 24 hours of life, as only for the first 24 hours is the digestive system of the foal permeable to complete protein molecules (immunoglobulins). After 24 hours, this ability to absorb whole protein molecules is altered and irreversibly lost. This also helps keep bacteria from invading the bloodstream and causing septicemia. From that time onward, the foal cannot take advantage of the antibodies in colostrum. As proteins, they are then broken down like all other proteins by the enzymes in the foal's gut into their component amino acids and absorbed as such.

The concentrations of the main components of milk during the main lactation are given in "Normal Milk Composition" at right.

The components of milk remain approximately at these levels for the majority of lactation. Slight changes, however, do take place with lactose (sugar) levels remaining relatively constant, but lipids (fats), proteins, calcium, and phosphorus declining slowly throughout the remainder of lactation. So in general, the concentrations of all components of milk decline with time. This is nature's way of encouraging the foal to seek nourishment elsewhere by slowly decreasing that available through milk, thus weaning the foal off slowly.

Nutrients Found in Milk

"Comparing Milk Composition" (above right) illustrates how mare's milk differs from that of other mammals. This difference is significant when feeding orphan foals or foals which need additional support in the form of bottle feeding.

The components of milk for a particular species match the requirements of that species' young; therefore, the components of milk vary. It is, therefore, not advisable to feed the milk of one animal to the young of another. For example, if a foal is fed cow's milk, the fat and protein concentration of cow's milk is too high and the lactose is not high enough. As a result, the foal does not get the energy it requires and digestive upsets such as diarrhea occur. It is important, therefore, to use formulated orphan foal diets if mare's milk is not available.

Fat

Mare's milk is less fatty than other mammals. Fat is present in milk as globules, which exist as an emulsion with milk and contain a high concentration of short-chained fatty acids.

Protein

As discussed earlier, immunoglobulins are the major protein content of the initial milk produced. During the main part of lactation, proteins are present as caseins and whey proteins.

Caseins, which are unique to milk, form a clot with the enzyme rennin under the influence of the stomach's acid pH (this reaction is used in cheese making). The clot formed improves the absorption of proteins by the gut. In addition, calcium and phosphorus attach to the caseins in relatively high concentrations, thus increasing the concentration of those important minerals that can be carried in milk and also improving their digestion.

Whey proteins are found in the grey/white fluid that remains after the caseins have clotted (this can be seen in cheese making and was historically fed to pigs). Whey proteins can be divided into those specific to milk and those that are found in both milk and blood. Milk-specific whey proteins in the mare are an excellent source of essential amino acids (amino acids that the horse's body cannot make for itself). They are also an integral part of the enzyme involved in the formation of lactose.

The second type of whey proteins, those found in milk and blood, are the major protein of colostrum--the antibodies that were discussed earlier.

Lactose

Lactose is the sugar or energy component of milk. Unique to mammals, each lactose molecule is in essence two molecules of glucose. Normal enzyme digestion in the foal's gut readily breaks down lactose into glucose and thus provides the foal with readily available energy.

It is interesting to note that by nine to 12 months of age, the young horse's digestive system loses this ability to split lactose into glucose, and in the older horse it can only be broken down by microbial fermentation in the hindgut. Hence, feeding milk pellets to older youngsters is of limited benefit with regard to being a readily available energy source.

Although our present knowledge of equine lactation is limited, information from other species studied in more detail (such as the cow) allows an appreciation of the principles of the production of equine milk. Application of this knowledge should enable us to appreciate how important lactation is and to manage the lactating mare and her foal to the advantage of both.

How Mare's Milk Compares to Other Species

Species	Total Solids (%)	Fat (%)	Casein Protein (%)	Whey Protein (%)	Lactose (%)
Human	12.4	3.8	0.4	0.6	7.0
Cow	12.7	3.7	2.8	0.6	4.8
Goat	13.2	4.5	2.5	0.4	4.1
Sheep	19.3	7.4	4.6	0.9	4.8
Horse	11.2	1.9	1.3	1.2	6.2

Normal Mare's Milk Composition

Component	Percent (%)
Water	89.0
Protein	2.7
Lactose	6.1
Fat	1.6
Ash (minerals, vitamins, etc.)	0.6
Total	100.0

Readers are cautioned to seek the advice of a qualified veterinarian before proceeding with any diagnosis, treatment, or therapy.