For Vet Professionals Only

Face2Vet

A Clinical Update

Volume 13 | Issue 11 | 2026



Nutritional and Management Approaches for Better Udder Health

Protect the Udder, Preserve the Profit

Dear Vets,

A healthy udder is fundamental to efficient milk production and overall success of modern dairy farming. Health and functionality of mammary gland directly influence milk yield, milk quality and farm profitability. Maintaining optimal udder health requires combined effects of strong natural defence mechanisms, appropriate nutrition and effective herd management practices.

Mammary gland possesses several physical and immunological barriers that help protect against invading pathogens. However, the effectiveness of these natural defence systems can be influenced by nutritional status, environmental conditions, milking practices, housing hygiene and physiological stress. When these protective mechanisms are compromised risk of intramammary infections increases.

Improving udder health therefore requires an integrated approach that focuses on both prevention and management. Appropriate nutritional support helps maintain immune competence and teat integrity, while proper milking hygiene, post-milking teat care, clean housing, routine monitoring and timely intervention help reduce pathogen exposure and support mammary gland health throughout the production cycle.

This issue of Face2Vet focuses on integrated udder health management in dairy animals, providing insights into the nutritional and management factors that influence mammary gland health, mastitis prevention and overall dairy herd performance. We invite you to read this issue and share your valuable experiences and insights by scanning the QR code below or reaching out to us at face2vet@intaspharma.com.

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Introduction

Udder health is a key determinant of milk quality, milk yield and dairy farm profitability. A healthy udder ensures efficient milk production, whereas udder infections result in significant economic losses through reduced milk yield, poor milk quality and increased treatment costs. Udder health is influenced by several factors, including pathogen exposure, nutritional status, immune competence, milking practices, housing conditions, environmental hygiene and overall herd management.

Deficiencies of essential nutrients may impair immune function, while poor housing hygiene, contaminated bedding, overcrowding, inadequate ventilation and improper milking practices can promote pathogen growth and transmission. In addition, environmental and physiological stress can weaken the udder's immunity, increase disease susceptibility and adversely affect milk quality, animal welfare and herd performance.

Effective udder health management requires preventive approach combining balanced nutrition with sound management practices. Adequate supplies of energy, protein, vitamins and minerals support immune function and mammary gland health, while proper milking hygiene, teat disinfection, clean housing, regular monitoring and timely disease detection help reduce mastitis risk. Together, these nutritional and management strategies contribute to improved udder health, better milk quality, enhanced animal welfare and greater dairy farm profitability.

Mammary Gland Structure and Defence Mechanisms

An intact udder structure and effective immune barriers such as teat canal, keratin layer and immune cells help prevent pathogen entry. However, when microorganisms invade the mammary gland and overcome these defences, chances of intramammary infection and mastitis increase. Therefore, udder structure, immunity and pathogen invasion play a key role in maintaining udder health and milk production.

Structural and Functional Organization of Mammary Gland

Bovine mammary gland (udder) is a specialized organ responsible for milk synthesis, storage and secretion. It consists of four anatomically separate quarters, divided into two halves by median suspensory ligament, with each quarter draining through an individual teat (Fig. 1). Each teat contains a teat cistern, teat canal and teat orifice that facilitate milk ejection during milking. Because the quarters function independently, infection in one quarter does not directly spread to others.

Mammary gland comprises two main components: parenchyma and stroma. Parenchyma contains secretory epithelial cells and myoepithelial cells organized into alveoli, functional units of milk production (Fig. 2). Secretory cells synthesize milk using nutrients supplied by an extensive capillary network, while myoepithelial cells contract in response to oxytocin during milking or suckling, moving milk from alveoli through duct system to teat.

Stromal tissue includes connective tissue, blood vessels, immune cells, adipose tissue and extracellular matrix components. In addition to providing structural support, stroma plays important roles in mammary gland development, tissue remodelling and regulation of milk-secreting cells, thereby contributing to udder productivity and health.

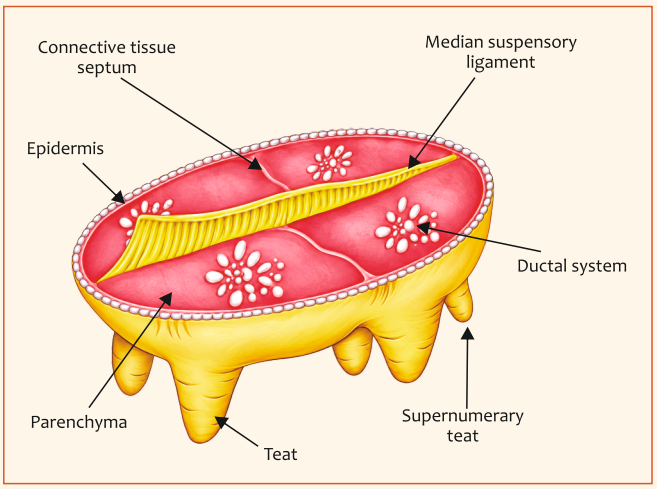


Fig. 1: Cross-Sectional Anatomy of Udder
(Nickerson and Akers, 2011)

Natural Defence Mechanisms of Udder

Bovine udder possesses a highly effective defence system that protects mammary gland against invasion by pathogenic microorganisms.

Teat Canal as First Line of Defence

- Teat canal serves as primary physical barrier between external environment and mammary gland. Teat sphincter remains closed between milkings, preventing entry of environmental pathogens and contaminants into udder.
- Damage or dysfunction of teat canal and sphincter increases risk of pathogen invasion and subsequent mastitis.

Keratin Plug and Teat-end Integrity

- Inner lining of teat canal is composed of keratinized epithelium containing keratin and lipid associated fatty acids. These substances possess natural antibacterial properties, helping to trap and eliminate invading microorganisms before they reach the mammary gland.

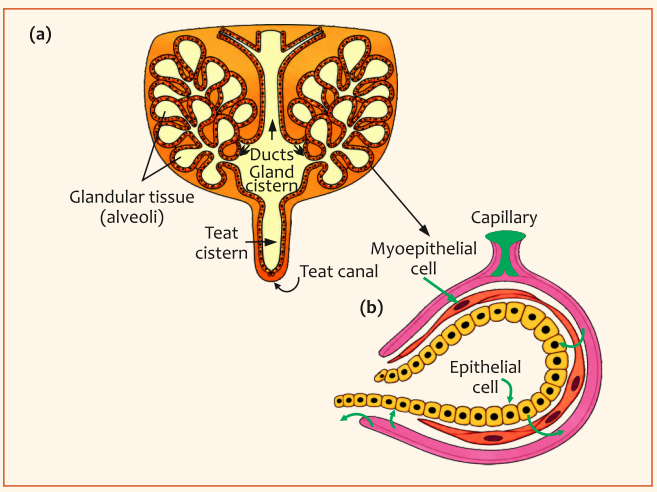


Fig. 2: (a) Mammary Quarter Structure
(ducts, cisterns, teat canal);
(b) Alveolus Cross-Section (Nickerson and Akers, 2011)

- During dry period, a keratin plugs forms within the teat canal, providing additional protection against entry of pathogen.

Cellular and Humoral Immune Defences

- When pathogens bypass the teat canal barrier, the immune system provides a second line of defence.
- Mammary epithelial cells recognize invading microorganisms through pattern-recognition receptors (PRRs) such as Toll-like receptors (TLRs) and initiate an inflammatory response.
- Macrophages are predominant immune cells in a healthy mammary gland and act as sentinel cells by detecting pathogens and coordinating immune responses. Neutrophils are rapidly recruited during infection and play a critical role in pathogen destruction through phagocytosis.
- Humoral defences, including lactoferrin, complement proteins, immunoglobulins and antimicrobial peptides, further enhance the udder's ability to neutralize invading microorganisms and limit tissue damage.

Pathogenesis of Intramammary Infection

Intramammary infection develops when pathogenic microorganisms overcome the natural defence mechanisms of mammary gland. Progression of infection involves pathogen entry, establishment within mammary tissues, activation of host immune response and subsequent damage to milk-secreting tissues (Fig. 3).

Pathogen Entry through Teat Canal

- Teat canal is the primary route of pathogen entry into mammary gland. Normally, teat sphincter, keratin lining and teat canal integrity provide effective protection against bacterial invasion.
- However, teat-end injuries, incomplete teat canal closure after milking, poor milking hygiene, failure of keratin plug formation during the dry period and environmental contamination can compromise these barriers, allowing pathogens to enter udder.

Colonization and Inflammation

- Following entry, pathogens multiply within the nutrient-rich milk environment. Mammary epithelial cells detect invading microorganisms through PRRs, triggering the release of inflammatory mediators.
- This response recruits neutrophils and macrophages to eliminate pathogens, resulting in inflammation and elevated somatic cell counts (SCC).

Impact on Milk Synthesis and Udder Tissue

- Inflammation disrupts mammary epithelial function and damages the blood-milk barrier, leading to reduced milk synthesis and altered milk composition. Decreased lactose and casein concentrations, increased SCC and leakage of blood derived proteins into milk are common consequences.
- Chronic inflammation may cause permanent damage to milk secreting tissues, reducing udder functionality, milk yield and overall herd productivity.

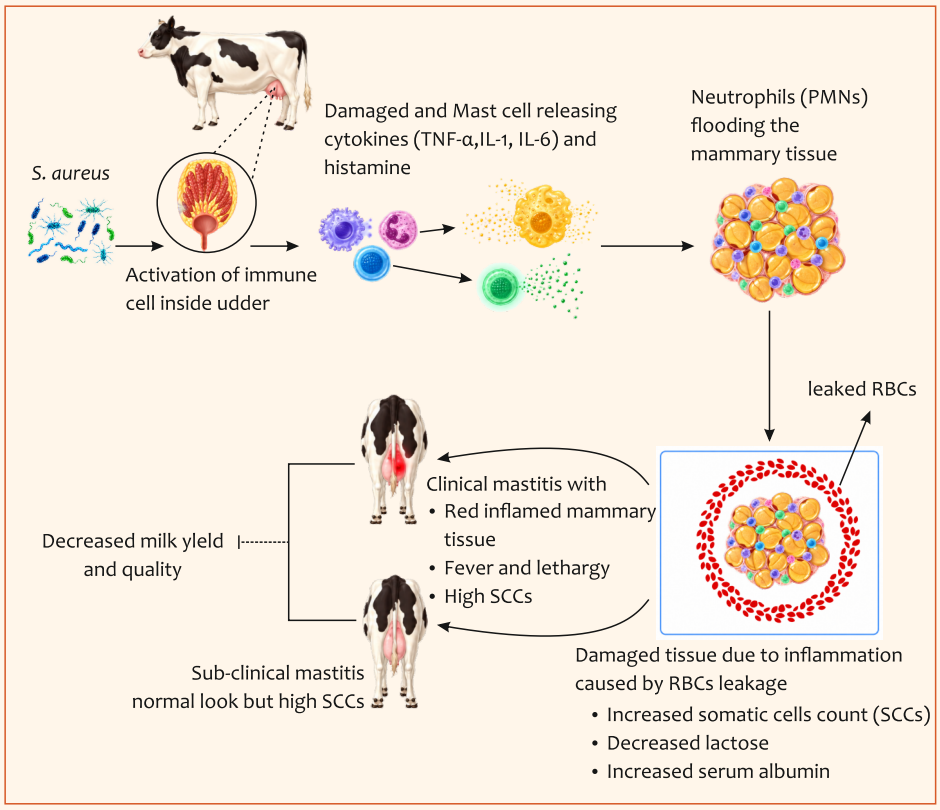


Fig. 3: Pathogenesis of Intramammary Infection (Ahmad *et al.*, 2026)

Mastitis

Mastitis is an inflammation of mammary gland, most commonly associated with bacterial infection. Based on presence and severity of clinical signs, mastitis is broadly classified into clinical, sub-clinical and chronic forms (Table 1).

Table 1: Types of Mastitis and their Effects on Dairy Production

Types	Characteristics	Clinical/Production Effects
Clinical Mastitis	Characterized by visible abnormalities in milk and udder tissue. Affected animals may exhibit swelling, redness, heat, pain and hardness of udder.	Milk with clots, flakes or pus and may appear watery. In severe cases, fever, reduced appetite, depression, dehydration and reduced milk yield may occur. It can range from mild to severe and adversely affect animal welfare and farm profitability.
Sub-clinical Mastitis	Most prevalent form of mastitis and occurs without obvious clinical signs. Udder and milk appear normal.	Characterized by elevated SCC, reduced milk yield, altered milk composition and presence of pathogens. Often remains undetected without routine monitoring and results in substantial hidden economic losses.
Chronic Mastitis	Persistent, long-standing infection of mammary gland, often associated with repeated or intermittent episodes of mastitis.	Characterized by prolonged elevation of SCC, reduced milk production, persistent alterations in milk composition and udder fibrosis. Chronic cases respond poorly to treatment and may serve as a continuous source of infection within herd.

Factors Affecting Udder Health

Udder health is influenced by a complex interaction of animal, environmental and management factors (Table 2). These factors affect cow's susceptibility to intramammary infections, severity of mastitis and overall ability of mammary gland to maintain normal function. Effective mastitis prevention therefore requires identification and management of both individual animal and herd-level risk factors.

Table 2: Predisposing Factors Contributing to Mastitis

Category	Risk Factor	Effect on Mastitis Risk
Animal Factors	Transition period stress	Metabolic stress and reduced immunity around calving increase susceptibility to infection.
	Parity and early lactation	Older and early lactation cows have a higher mastitis risk.
	Negative energy balance (NEB)	Impaired immune function reduces the ability to eliminate pathogens.
	Immune suppression	Weakened mammary defences increase clinical and subclinical mastitis incidences.
Environmental Factors	Poor bedding hygiene	Increases exposure to environmental pathogens at teat end.
	Inadequate housing	Overcrowding and poor cow comfort promote teat contamination.
	Heat stress and high humidity	Impair immunity and increase somatic cell count and infection risk.
	Flies and poor sanitation	Increase pathogen transmission and environmental bacterial load.
Milking Related Factors	Poor pre-milking hygiene	Facilitates bacterial entry into teat canal during milking.
	Inadequate post-milking disinfection	Teat canal remains partially open after milking, making it vulnerable to pathogen entry and increases risk of new intramammary infections.
	Teat-end injuries/ hyperkeratosis	Damages the teat's natural barrier and promotes pathogen penetration.

Nutritional Approaches for Better Udder Health

Nutrition plays a fundamental role in maintaining udder health. The relationship between nutrition and mastitis is primarily mediated through immunity, as optimal nutrient supply is essential for maintaining effective immune responses, preserving teat integrity and supporting mammary gland function. Nutritional deficiencies or imbalance and metabolic disorders during transition period can impair host defence mechanisms, making dairy animals more susceptible to intramammary infections.

Mammary gland relies on both innate and adaptive immune mechanisms to prevent pathogen invasion. Effective immune responses require adequate energy, amino acids, vitamins and minerals to support leukocyte function, cytokine production and tissue repair. Nutritional imbalances can impair the ability of immune cells to eliminate invading bacteria, thereby increasing susceptibility to infection.

Minerals

Minerals play a vital role in maintaining udder health by supporting structural integrity of mammary gland, enhancing immune function and strengthening animal's defence against mastitis causing pathogens (Table 3).

Energy Balance

During early lactation, dairy animals commonly experience NEB, a condition in which energy requirements for milk production exceed dietary energy intake. As a consequence, body reserves are mobilized to support lactation, increasing the risk of ketosis and other metabolic disorders. Animals experiencing NEB exhibit impaired immune function, reduced leukocyte activity and weakened udder immunity. Therefore, nutritional strategies aimed at maximizing dry matter intake and improving energy balance during transition period are essential for maintaining udder health.

Nutrition During Dry Period

Dry period represents a critical phase because it provides an opportunity to eliminate existing intramammary infections, promote mammary gland recovery and prevent the development of new infections before next lactation. Proper nutritional support including vitamins and minerals play a crucial role in maintaining udder health during dry period.

- Vitamins A and E help prevent retained placenta, while Vitamin E enhances immunity and reduces mastitis risk. Vitamin D supports calcium metabolism and proper bone and muscle function.
- Maintain a calcium-to-phosphorus ratio of 1.5:1 to 2:1 and avoid excess calcium and potassium to reduce the risk of milk fever. Trace minerals support immune function and help prevent metabolic and infectious diseases e.g., selenium plays a vital role by enhancing immune function and protecting mammary tissues from oxidative stress.
- Herbs containing antioxidant, anti-inflammatory, antimicrobial and immunomodulatory compounds strengthen natural defence mechanisms, support mammary tissue regeneration and improve udder resistance to infections during the pre-calving period.
- Vitamins, minerals and unique herbs **(Mammigard)** can be incorporated as a dry-period nutritional support supplement to help strengthen natural defence mechanisms, improve transition cow immunity and support udder health during high-risk pre-calving period.
- **Mammigard** can be supplemented @ 10 g twice a day orally for 10 days before parturition.

Comprehensive Nutritional Strategies

- Adequate nutrition plays an important role in maintaining udder health by supporting immune function, antioxidant defence and resistance to mastitis causing pathogens.
- Vitamins support neutrophil activity, epithelial health, integrity of teat, antioxidant protection and helps to reduce oxidative stress.
- Methionine protects the mammary gland against oxidative stress and supports immune defence during udder infections.
- Zinc, copper and manganese contribute to immune function, tissue integrity and antioxidant defence.
- Citrate is a key component of milk that helps maintain normal milk pH, calcium solubility, milk fluidity and udder health. During mastitis, milk citrate levels decline, contributing to calcium aggregation and udder inflammation.
- Trisodium citrate (TSC) helps to improve udder health by restoring milk citrate levels, reducing bacterial load, lowering somatic cell count (SCC) and CMT positivity and enhancing recovery from subclinical mastitis while improving milk quality.
- Live yeast helps maintain rumen function and nutrient utilization.
- A supplementation with vitamins A, D_3, E and B-complex, methionine, trace minerals (zinc, copper, manganese and selenium), trisodium citrate and live yeast **(Mammidium)** contribute to udder health through multiple mechanisms.
- **Mammidium** is supplemented @ 50 g per animal, administered orally once daily for 4 days as an electuary prepared with jaggery. It supports udder health in cases of subclinical mastitis and is also used as an adjunct to antibiotic therapy in clinical mastitis.

Management Approaches for Better Udder Health

Proper milking practices, hygienic housing, routine monitoring and effective dry cow management are essential for reducing incidence of both clinical and subclinical mastitis. By limiting pathogen exposure, preserving teat integrity and supporting immune function, these management strategies contribute significantly to maintaining optimal udder health.

Housing and Environmental Management

Housing environment plays a critical role in determining the level of pathogen exposure experienced by dairy cows. Environmental mastitis pathogens multiply in moist, dirty conditions, making environmental hygiene a key component of udder health management (Table 5).

Table 5: Housing and Environmental Management Practices for Better Udder Health

Management Area	Recommended Practice	Benefits
Bedding Hygiene	Maintain clean and dry bedding and replace contaminated bedding regularly.	Reduces bacterial contamination of teat ends and minimizes pathogen proliferation.
Ventilation and Cow Comfort	Provide adequate ventilation, proper stocking density, comfortable resting areas and sufficient space allowance.	Reduces moisture and humidity, improves cow welfare and lowers the risk of mastitis.
Heat Stress Management	Ensure adequate shade, proper ventilation, use of fans and sprinklers and continuous access to clean drinking water.	Maintains feed intake and immune function, reducing susceptibility to mastitis.

Monitoring and Early Detection

Routine monitoring enables early identification of udder health problems and facilitates timely intervention before substantial production losses occur (Table 6).

Table 6: Monitoring Tools for Early Detection of Udder Health Problems

Method	Purpose	Importance
Somatic Cell Count (SCC)	Measures the number of somatic cells in milk.	Elevated SCC is a key indicator of udder inflammation and mastitis. Bulk tank SCC can also be used to assess herd-level udder health status.
California Mastitis Test (CMT)	Simple field test used to estimate SCC in individual quarters.	Facilitates early detection of subclinical mastitis and supports timely intervention and treatment.
Mastitis Detection Strip (Bromothymol Blue - pH strip)	Rapid farm level test that detects changes in milk pH (alkalinity) associated with mastitis by observing colour changes on strip.	Enables quick and convenient detection of subclinical and clinical mastitis, supporting early diagnosis and prompt udder health management.

Milking Equipment Management

Well-maintained milking equipment is essential for preserving teat health and minimizing new infections. Recommended practices includes regular evaluation of vacuum and pulsation systems, timely replacement of liners and rubber components, a voidance of overmilking and thorough cleaning and sanitation after every milking.

Dry Period Management

During this period, teat canal closure, immune competence and environmental hygiene play important roles in determining the udder health status at calving. Key dry period strategies include:

- Use of teat sealants **(Mi Dip)** to provide a physical barrier against pathogen entry.
- Maintenance of clean, dry and comfortable housing conditions.
- Early identification and management of infected quarters.
- Appropriate dry cow therapy at the time of drying off to eliminate existing intramammary infections and to prevent new infections during dry period.

Milking Hygiene

Milking hygiene is considered one of the most important management factors influencing udder health. Since many mastitis pathogens are transmitted during milking, strict adherence to standard milking procedures is essential.

Pre-Milking Preparation

Appropriate udder preparation reduces bacterial contamination and facilitates early mastitis detection. Recommended practices includes fore-stripping to identify abnormal milk and stimulate milk let-down, cleaning visibly dirty teats, ensuring teats are completely dry before cluster attachment and using individual towels or disposable paper towels to prevent cross-contamination.

Post-Milking Teat Hygiene

Following milking, teat canal remains partially open for a period of time, making the udder more susceptible to environmental contamination and pathogen entry. Therefore, animals should ideally remain standing after milking by providing fresh feed and water, allowing sufficient time for natural teat canal closure. Effective teat care during this vulnerable period is an important component of mastitis prevention. Use of a post-milking teat dip helps maintain teat hygiene and provides additional protection against mastitis causing microorganisms.

Mi Dip is a post-milking teat dip (molecular iodine) designed for routine teat hygiene after every milking.

- Following application, **Mi Dip** forms a thin protective film on teat surface, creating a physical barrier that helps limit the entry of harmful microorganisms through the teat end during the post-milking period.
- Molecular iodine provides antimicrobial activity against mastitis causing pathogens, helping maintain teat hygiene and reduce microbial contamination of teat surface. Regular use supports udder health and helps reduce the risk of new intramammary infections.

Conclusion

Udder health is a cornerstone of profitable and sustainable dairy production, directly influencing milk yield, milk quality and animal welfare. Adequate nutrition, particularly the supply of essential vitamins, minerals and other immune-supportive nutrients, plays a critical role in strengthening udder defence mechanisms, maintaining teat integrity and enhancing resistance to intramammary infections. Equally important are good management practices, including proper milking hygiene, post-milking teat care, clean and comfortable housing, routine monitoring and early disease detection. An integrated approach that combines nutritional support, preventive udder care and sound herd management is essential for effective mastitis control and sustained udder health. Such a comprehensive strategy can improve milk quality, animal welfare, productivity and overall dairy farm profitability.

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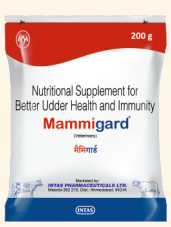
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