A Global Organization for Mastitis Control and Milk Quality

Guidelines for Evaluating Teat Skin Condition

This document describes procedures required to determine the effects on teat skin condition of products applied as a disinfectant or a teat treatment. The guidelines were developed by the NMC Research Committee.

Introduction

The teats of the dairy cow are affected by the milking process (5), the general environmental conditions on the farm (4) and by any agent applied to the teats (1). Treatment of teats may include components to prevent or ameliorate environmentally-induced problems, to treat skin infections or physiological problems, or to aid in preventing new intramammary infections by disinfecting skin.

Comparative trials of products for regulatory approval and development of treatment regimens to improve teat skin health require appropriate tests and measurements. Guidance on such trials, their design, parameters to be investigated, conduct and means of evaluation are described.

Making Observations

Machine milking creates changes in teats that are best observed on removal of the milking cluster, usually within 30-60 seconds (3). Some longer-term changes (e.g. of the teat orifice) may also be observed best after milking. However, teats may be bathed in milk during milking such that the skin is moisturized and any changes in skin condition are masked. To examine the specific effects of the environment and teat treatments, it is best to observe teats prior to milking and teat cleaning. However, if assessing the effects of a barrier teat disinfectant, the product may need to be washed off and the effects of the full teat preparation taken into account.

Teats may vary in color within cow and within a herd according to breed and to breeding. Black teats obscure most changes in teat color induced by machine milking or any hypersensitivity in response to environmental factors or treatments. Black teats often appear to have drier skin since minor flaking is more obvious on a black than on a pink background. Teat skin condition scoring must take this into account. Most teats have some non-pigmented areas that should be the primary examination areas.

Any part of the teat may be affected, so observations should include the whole barrel and orifice. The cow is the unit exposed to all variables likely to be tested, except in split udder trials. On practical grounds, in making assessments during milking time it is acceptable to score only one fore and one hind teat, usually those closer to the observer. However, to ensure an appropriate sample of cows and teats are screened, use both sides of a milking parlor, or another method of examining left and right side teats equally.

When assessing teat condition, record all lesions observed. Few lesions and no infections should be found if good husbandry is being applied. Identification of any lesions should be rare in routine teat condition monitoring in developed dairy industries.

Scoring should be made with the aid of a light source, because it is dark under the cow (the type of light, LED or filament lamp, will affect the apparent teat color). Using gloved hands, examining all teat surfaces and record the data immediately. This is best done by an assistant or on audio tape. Scoring should record cow number, teat and only non-normal conditions. Conditions to be scored are described below and listed in Table 1.

Identification of conditions must be made by a trained and experienced observer. Professional training is available and should be accompanied by self and mutual assessment periodically by paired observers. During assessments of teat condition, observations are best made by comparisons between teats of any one udder and between cows in the milking string, usually of similar age and stage of lactation. Cows within seven days post-partum should always be disregarded, unless a defined part of the study. Inclusion or exclusion of cows with fewer than four functional teats or with clinical mastitis should be on the basis of possible bias to the observations being made.

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Usually any condition to be observed will occur with a very low frequency, unless faults occur in the udder management of the cows such that they are subject to recent and dramatic changes in environment or treatment.

Suggestions for a threshold of observations or acceptable difference between teats should be set prior to starting any trial or scoring. This requires consideration of the type of trial being conducted, e.g. to show superiority, non-inferiority or bio-equivalence. Guidance is available from the appropriate regulatory authorities when products are being tested for licensing purposes. Otherwise, for guidance on samples sizes and power of the study, see (8).

Parameters to Observe

Some examples of teat condition are given in Figure 1. A wide range of examples is provided in the Teat Condition Portfolio CD available from NMC (www.nmconline.org).

Table 1. Conditions and Scores for Teat Skin

Parameter	Condition	Score*
Color	Normal and pink	N
	Red and irritated	R
Skin dryness	Smooth	N
	Slightly rough	SR
	Very rough	VR
Chaps	None	N
	Minor	M
	Severe/Extensive	SE
Cutaneous damage	Suckling	S
	Insect	I
	Abrasions	A
	Cuts	C
	Sunburn	SB
	Frostbite	FB
Hyperkeratosis (callosity)	Thickness: - none	N
	- slight	ST
	- moderate	MT
	- thick	TT
	- extreme	ET
	Roughness: - none	N (0)†
	- rough	R (1/2)
	- very rough	VR (≥3)

* The letter used as a symbol is usually the first letter of the descriptor, N=normal
† Numerical value is from Ref. 8 for comparison

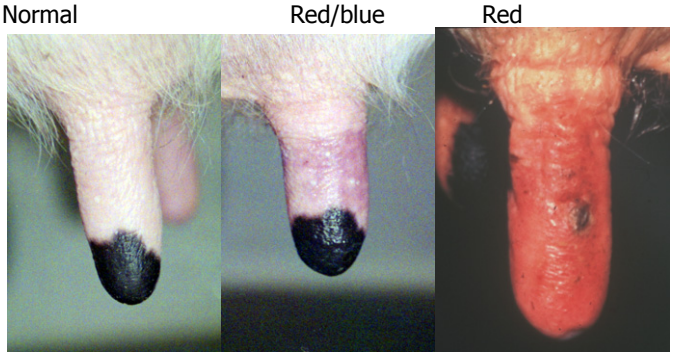
Color

Pink areas should be compared for reddening due to local irritation. This may be general or on specific areas. When general, it may be caused by response to chemical agents. This may also be true on specific areas if the reaction is in response to a combination of effects, e.g. UV enhancement of chemical effects. When found, the areas affected should be noted as the areas or patterns of distribution within and between groups of cows. This may guide in identifying the cause. Irritation in response to a teat product usually occurs within two to seven days of first use. Occasionally, the milker may also show signs of skin irritation, most prominently on skin, on the inside of fore-arms and on the face. Any color change caused by irritation, whatever the source, is of concern.

Figure 1. Examples of Teat Condition

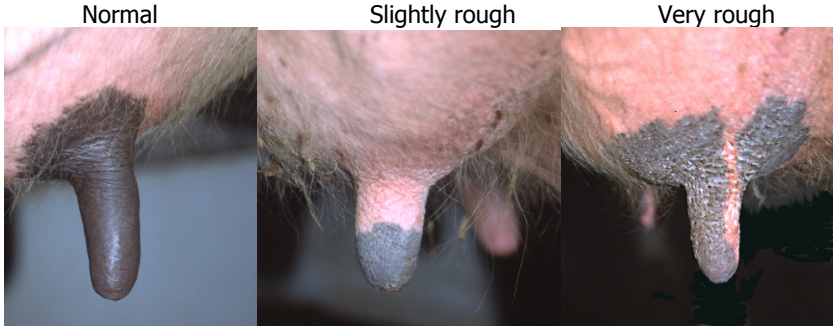
Color

Normal | Red/blue | Red



Dryness

Normal | Slightly rough | Very rough

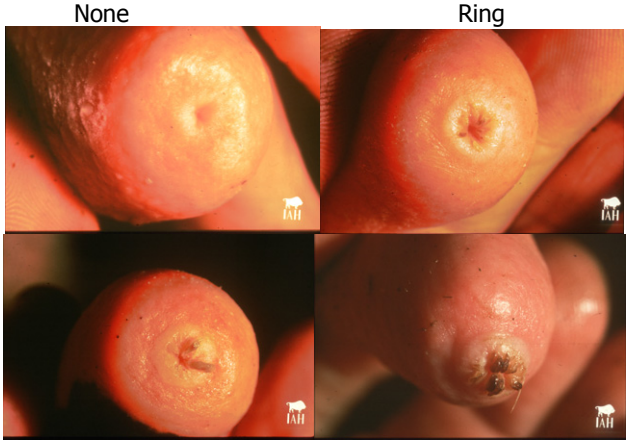


Chaps

Normal | Minor | Extensive

Hyperkeratosis

None | Ring



Moderate | Extreme

Skin dryness
Estimation of dryness may be significantly biased if only assessed visually, because black teats always appear drier. It is better scored by a friction test. Wearing surgical (latex) gloves, the examiner should drag finger and thumb along the teat barrel with light pressure. Skin may easily be determined as

- Smooth (S), fingers glide over the surface;
- Slightly rough (SR) with some drag of the latex; or
- Very rough (VR) when the latex puckers.

Chaps
Teat chaps should be scored for extent (minor and severe/extensive) and position (usually proximal, distal or at the orifice). The extent may indicate duration of the problem. Chaps present as horizontal cracks, but not vertical cracks, open or scabbed, follow the natural transverse folds of the shrunken teat. They may occur more obviously on the anterior surfaces of front teats and posterior surfaces of hind teats. The effects of a poor climatic environment on abraded teat skin induce chaps. Usually this is excessive drying of wet teats, often caused by cold drafts and winds. Poor housing or pasture may mean that mud abrades the teat and is a primary problem. Strip grazing of brassicas, e.g. kale in autumn/winter, is a well-reported risk factor although this may involve irritancy too. Poor liners and over aggressive teat cup removal may also cause primary trauma leading to chapping.

Chaps should be absent as their occurrence indicates poor teat disinfection or use of an inadequate product, usually containing too little emollient.

Animal damage
Suckling by other animals, often newly calved heifers, of herdmates is not uncommon. Damage is more commonly observed on the newly calved animal at first milking. Then the damage is usually caused by the dam's own calf. Suckling damage or significant signs of recovery should not be observed, if recently calved cows are disregarded.

The resulting lesions may be similar to chaps, but are vertical on the teat and not transverse. They are usually caused by teeth scraping the skin. Only record the presence or absence of such lesions, and note the eligibility of the animal for the trial.

Anecdotal reports have been made that, in barns, rodents may gnaw teat ends, especially if these are already damaged or wet with milk.

Insects may damage teats in several ways. Biting species, including stomoxinae, culicoides midges, sandflies and mosquitoes, may suck blood and leave puncture wounds. These wounds are enlarged by the rasping mouthparts of muscids, such as the headfly, *Hydrotaea irritans*. Other species may create larger, discrete wounds, including the excision of tissue by the yellow-jacket wasp as reported from Israel. Insect damage is not related to teat management deficiencies, except that some products may contain insect repellents or insecticides, and occurrence needs to be scored in testing their efficacy.

Abrasions and cuts
Any abrasions that occur are usually related to lying conditions and muddy/sandy soils. Very old liners may also cause limited abrasions. Cuts to teats are usually caused by hooves when cows are rising or lying down, often because the stalls are of incorrect size or hoof management is poor. On pasture, cuts are more likely to be caused by wire fencing. All herds usually contain one or more cows with some cuts or abrasions.

Weather
At least three types of weather conditions affect teat skin (4). Some consideration of previous weather and the severity of the season should be recorded, as well as the likely exposure in cow housing and transit around the farm. Cold winds on wet teats cause chaps (see above). Sun and frost cause direct effects.

Frostbite is not uncommon in very cold areas, even with a dry cold condition. The likelihood of frozen teats depends both on air temperature and wind speed. More often, frostbite may affect front teats and distally around the teat duct orifice. Frostbite may occur when a drop of disinfectant freezes on the teat end. Teats may initially appear reddened or pale. When severe, a scab forms that eventually drops off to leave a raw teat end.

Sunburn affects pink teats and is less likely in pigmented teats. Thus, some breeds rarely suffer. Sunburn occurs most often on exposed teat skin and will be directional and not affect the whole circumference of the teat. Thus, it may affect the outside of teats on one side of the udder and the inside of teats on the other side of the udder.

Teat orifice hyperkeratosis

The orifice may possess varying degrees of extraneous keratin arising from hyperkeratosis, colloquially known as callosity. For general screening, the most appropriate classification system adopts marked differences in the callosity ring in five thickness classes and whether the ring is smooth or rough (6). A more detailed scoring scheme (8) is usually required for detailed and experimental studies on teat condition. The ring is not relevant to teat conditioning trials, but the extent of roughness is important.

Hyperkeratosis may be wrongly diagnosed when barrier and high-emollient content teat disinfectants are being assessed. These products dry slowly, so that in some bedding and pasture conditions the orifice becomes covered in a sand or soil and disinfectant crust that feels and looks like orifice roughness, but such material is easily rubbed off.

Comparisons

No absolute thresholds for acceptable levels can be indicated. Trials should be conducted to determine if the amount of any teat condition changes in response to treatment. This could include deterioration or improvement in a positive control trial and improvement in response to a therapeutic agent. In many trials, noninferiority or bio-equivalence testing is required. This requires estimating the threshold of difference deemed non-significant prior to the trial starting.

Statistics

Generally, two-tailed tests may be used employing the Z-statistic, as described in the NMC protocols for efficacy testing (7). Tests should be carried out to achieve significance at the 5% level with a power of 80%. A sample size calculation must be performed to design a trial of sufficient scale to be effective. In larger trials when sample size is sufficient, then multi-layer tests examining the effect of teat position, time, parity, stage of lactation, etc. in addition to treatment may be possible using Generalized Linear Mixed Models.

More appropriate statistical methods allowing non inferiority testing are being developed (2). Usually the tests are specified by the regulatory authorities controlling product licenses.

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