Classes & Types of Teat Dips

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Outline

- History of teat disinfection
- What are dips comprised of
- Classes of teat dips
- Types of teat dips
- Methods of application
- Environmental conditions
- List of proven dips – NMC paper
- Storage
- Carriers

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History

1900's	50's	60's	70's	80's	90's	00's
Dilute pine oil as disinfectant- 1916	Research from Guelf shed light on positive impact from disinfecting teats	Udderwashes - dilute iodine with water	Teat dip use increases - more dip used than udderwashes	Automated spraying of teats	Foam dips introduced	Increase in chlorine dioxide, hydrogen peroxide as dips
	Reduced bacterial load in liners when teats disinfected	Iodine as teat dip	New classes of disinfectants - Quaternary ammonia, bleach, Chlorhexidine	Powdered dips introduced	Barrier dips introduced	
	Teats washed with water and rag	Low pH of first iodine dips - irritating to teats	Quaternary ammonia irritating to teats and leaves residue in milk that inhibits cheese cultures from growing	Teat conditioner - emollients, pH and teat carriers		
	Inclusion of household dish soap and cleaning agent		Chlorhexidine most successful of new classes of dips			

What are teat dips designed to do?

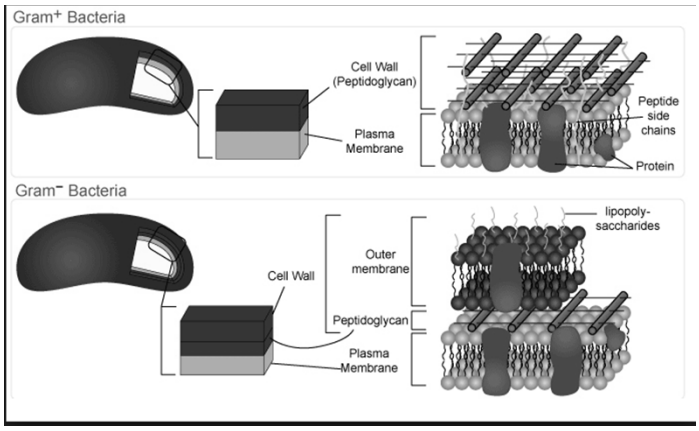
- Disinfect teat and provide teat skin conditioning agents
- What is the difference between disinfecting and sanitizing?
  - Disinfect: to destroy or inactivate bacteria and fungi
  - Sanitize: to reduce microorganisms to levels considered safe by established parameters
- Disinfect the skin of the teat and teat end or disinfect the manure and organic matter on the teat?
  - Dips are designed to disinfect the teat skin not manure on the teat
  - Disinfect the wrinkles, crevasses and cracks in teat skin
- Teat dip is not a wash/cleaning solution
  - Dips do contain surfactants but the surfactants are designed to clean the teat skin
  - If teats are dirty they need to be cleaned prior to disinfecting
  - If teat dip is used to moisten organic matter and remove organic matter from the teat then the teat itself must be disinfected after the organic removal
    - Dipping the teat again

Bacterial reduction and time

- Goal of teat dip is at least log-3 reduction in bacteria count
  - 3 log reduction is 1,000 time less bacteria or 99.9% reduction
  - Thus the less bacteria on a teat at the start the lower the overall bacteria on a disinfected teat
- 1,000,000 cfu/ml starting and log-3 reduction leads to 1,000 cfu/ml
- Is time important in terms of time to achieve log-3 reduction?
  - Time is not as important as the reduction itself
  - Most dips are evaluated for log reduction at 30 and 60 intervals, thus given proper timing for the milking routine puts more emphasis on ending bacteria count or log reduction versus the time to ending bacteria count

Bacteria and disinfection by oxidation

- Single cell
- Single loop of DNA – no nucleus
  - May contain plasmid which is genetic material that could make bacteria antibiotic resistant
- Cell wall made of proteins
- Proteins comprised of Amino Acids
- Oxidizing agents remove an electron from an amino acid in the cell membrane
- Cell membrane no longer can produce proteins to maintain cell wall
- Cell wall falls apart and the result is death of the cell



What is in a teat dip

- Germicide/Disinfectant: Compound that kills bacteria; antimicrobial
- Surfactant: Wetting agent; cleaning and penetrating organic matter on teat skin
- Complexing agent/Solvent: Chemical substance(s) designed to interact with a another substance to create a solution
- Emollient: Skin conditioner or teat skin health aid
- Sealant: Film forming agent; teat end protectant
- Carrier: Substance used to hold product in suspension; usually H2O
- Colorant: Additive used to improve visibility of disinfectant

NonylPhenol Ethoxylates (NPE's)

- NPE are common nonionic surfactants in teat dips
  - NPE's are being banned in many countries
- Numerous mammalian toxicity studies have determined that NPE's are not a concern to human safety
  - Mimic estrogen and may lead to reproductive disorders
  - Some believe they are linked to early onset puberty

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Emollients

- Aloe Vera: moisturizer; aid in healing minor skin injuries
- Allantoin: prevents chapped, chafed and cracked skin from wind burned skin
- Glycerin: humectant; absorbs moisture from air and deposits on teat skin
- Lanolin: occlusive; provides a protective barrier around teat skin to prevent evaporation of natural water from epidermal layer; replaces sebum and restores normal moisture balance of teat skin
- Propylene glycol: humectant; absorbs moisture from air and deposits on teat skin; removes moisture from air even at low humidity
  - Anti-freeze – however it keeps teat skin wet for 2-6 hours and may freeze if conditions are severe
- PVP: film forming humectant; at 80% humidity will absorb > 50% of weight in water

pH

- What role does pH play in the development of disinfectants?

- Low pH leads to more stable storage of product
- Low pH leads to softening of teat tissue and possible irritation
  - Irritation from low pH is based upon the acid used to lower pH
- pH from 2.7 – 12 (chlorine dioxide to bleach)
- Iodine - pH of 6 – 8.5 is acceptable for teat health; however, in the case of iodine a pH of 8.5 would cause the decomposition of iodine (I^2) to iodide (I^-), which is non-germicidal

Viscosity

- Most are close to a water like consistency
- Lower viscosity dips are better for spraying or foaming
- Higher viscosity dips result in a thicker layer of dip on the teat and teat end
- Increased viscosity

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Teat dip disinfectant market share

Germicide	Action	Percent of market
Iodine	Oxidative	65
Chlorhexidine	Non-oxidative	10
Chlorine dioxide	Oxidative	10
Peroxide	Oxidative	10
Bleach	Oxidative	2
Other	Non-oxidative	3

DeLaval estimates

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Classes of teat dip

- Iodine
- Chlorine dioxide (Acidified Sodium Chlorite)
- Chlorhexidine
- Hydrogen peroxide
- Sodium hypochlorite
- Powdered teat dips

Iodine

- Most common teat dip
  - >60% of market share
- Oxidizing, fast acting disinfectant against:
  - Bacteria, virus, fungi and spores
- Iodine dissolved in water with detergents or surfactants and the resulting solution is an iodophor
- Nearly all iodine is in the complexed but unbound form – not antimicrobial
- Uncomplexed iodine or free iodine provides the antimicrobial activity by oxidizing
  - Free iodine is usually 6 – 12 ppm
- Surfactants and detergents as complexing agents remove natural protective oils from the teat skin this teat conditioners are added
- 0.5% iodine is equal to 5,000 ppm titratable iodine – pre dip
- 1% iodine is equal to 10,000 ppm titratable iodine – post dip

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Iodozyme

- High concentration of free iodine
  - 80 – 100 ppm free iodine
- Quick kill given high concentration of free iodine
- Iodozyme is 0.15% titratable iodine
- Glycerin as emollient
- pH 5-6

Chlorine dioxide - CLO_2

- Two part dip
  - Combination of sodium chlorite and acid (lactic acid)
- Concentration 0.32%
- Broad spectrum antimicrobial: Gram-, Gram+, molds, yeast and viruses
- Does well under organic load
- Teat tissue
  - Some believe CLO_2 exfoliates dead skin
  - Other disagree and believe CLO_2 softens and hydrates cracked or dried skin – prevents hardening
    - Softened keratin and skin tissue is then easier to physically remove when prepping cows
    - Physical and abrasive action of drying the teats leads to the desquamation (shedding) of the outer layer of skin
  - Whatever you believe CLO_2 has an impact on teat condition

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Hydrogen Peroxide

- Oxidizing action
- May be combined with lactic acid – sheds outer layer of skin for improved teat health
- 0.5 – 1% hydrogen peroxide
- Not as effective under high organic load

Chlorhexidine

- Active against Gram-, Gram+ and some viruses
- Precipitates cytoplasmic proteins and macromolecules
- Concentration 0.35 - 0.5%
  - Research has shown that ≥ 0.5% chlorhexidine is needed to be efficacious
- Gentle on teat tissue
- Heavily contaminated dip with *Serratia* and *Pseudomonas* can survive in chlorhexidine

Bleach

- Solutions such as laundry bleach
- pH > 11 and are hard to mix with conditioners
- Use as a teat dip violates federal regulations
  - Bleach is federally approved as a sanitizer and not as a disinfectant
- Drying affect on teat skin
  - Recently on-farm mixing of bleach and glycerin
- Use as a teat disinfectant is not recommended

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Summary of teat dip germicides

Germicide	Germicide concentration	pH	Price	Pathogens controlled	Comments
Iodine	0.25 - 1.0%	4 - 6.5	Moderate to high	all mastitis causing bacteria, fungi, viruses and bacterial spores	
Chlorhexidine	> 0.5%	5 - 8	Moderate	most Gram+ and Gram- and some viruses	
Chlorine dioxide	0.32%	2.7 - 4	Moderate to high	Gram +, Gram-, molds, yeast and viruses	two-part mixture; 24 hour shelf life when mixed
Peroxide	0.5 - 1.0%	5.0	Low to moderate	most Gram+ and Gram- bacteria	
Bleach	4.0%	> 11	Low		must dilute; most bleach 6.25%

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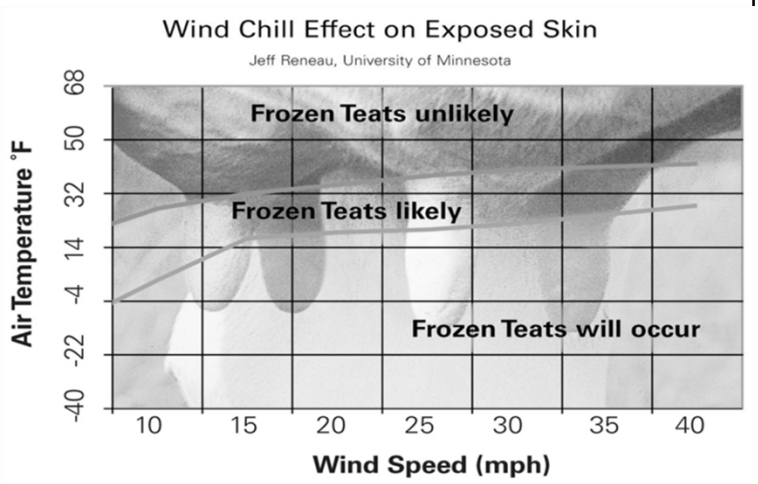
Dairymaster – Super Cow Teatfoam

- Super Cow Teatfoam is a Polyhexamethylene biguanide (PHMB)
  - Common antiseptic in wound dressings
- Efficacy tested at Teagasc in Ireland
  - Reduced Staph aureus by 90% in 30 sec.
- Used as both a pre and post dip
  - Dip, spray or foam
- Limited data on product

Powdered dips

- Powdered dips is designed to absorb or remove moisture from the teat
- Used when cold temps and wind create adverse conditions for teat health
  - Little conditioning or disinfecting affect on teat skin
- All about the drop of dip at the teat end when there are drafty conditions
- Dip teats with normal liquid dip and then blot dry before leaving milking area



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Disinfecting wipes

- Quaternary ammonia
  - Denature cell proteins and alter cell membrane permeability leading to cell disruption
    - Serratia and Pseudomonas have been known to survive in dip cups
- Nisin – antimicrobial protein synthesized by *Lactococcus lactis*
  - Ruptures cell wall (Lytic action on phospholipdis of the cytoplasmic membrane)

Organic

- National Organic Program (NOP)
- Iodine and Hydrogen peroxide are allowed
  - Chlorhexidine allowed if iodine and peroxide not working
- Lanolin and glycerin allowed
- "Inert or other" substances in teat disinfectants are the concern for organic certification
- Soap and water is allowed as long as soap does not contain antimicrobials

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Barrier dips

- Barrier dips form an acrylic or water soluble polymer around the teat
  - More difficult to remove barrier from teat as compared to conventional dip
- Barrier dips usually take > 10 minutes to dry
  - Sticky/tacky and manure solids
- Viscosity of barrier dips
  - Previous data has suggested that more viscous dips, like barriers are not able to move as far into the teat canal (capillary action) as conventional dips and this may be the reason that some barriers have not been proven as efficacious as conventional dips (Nickerson et al, 1990)
  - Other studies have shown that barriers reduce the bacterial load at the teat canal as compared to undipped teats (McArthur et al., 1984)
- When to use a barrier
  - Targeted to wet, muddy, extreme conditions (dry lots in rainy season) – hot, humid
  - Very successful in 80's to control environmental pathogens
    - Barrier – consider housing and bedding

Winter dips

- Higher skin conditioning packages
- Large differences in efficacy of disinfectants in these

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External teat sealant

- Physical external barrier on teat
- Imperative that the sealant stays adhered to teat
  - Possible for pathogens to colonize between sealant and teat if there is a tear in the sealant
- Apply at dry off and again 7 – 10 days prior to calving
- Used when there is excessive environmental pathogen load
- 50% of teat canals not closed by 7 days after dry off
  - 5% of teats don't close for entire dry period (Williamson et al. 1995)

Pre and post dip

- Pre dip
  - Lower concentration of disinfectant
  - Control of environmental pathogens
  - Low skin conditioners
  - Surfactants for disinfecting skin of teat
  - 50% reduction in new IMI when pre dipping as compared to udder washing with use of a paper towel
- Post dip
  - Higher concentration of disinfectant
  - Control of contagious mastitis causing organisms – milk residue on teat after milking
  - Protect teat end until teat end closes after milking
  - High level of skin conditioners
  - Reduces new IMI from specific mastitis causing organisms by 50 – 95%

Teat dip compatibility – pre and post interaction

Compatibility between classes of teat dips

Pre-dip/Post-Dip	Ambicin N	Chlorhexidine	Chlorine Dioxide	Dodecyl Benzene Sulphonic Acid (DDBSA)	Fatty Acids	Iodine	Peroxide	Quaternary ammonium	Sodium hypochlorite
Ambicin N	YES	YES	☠	YES	YES	?	☠	YES	☠
Chlorhexidine	☠	YES	☠	☠	YES	?	☠	YES	☠
Chlorine Dioxide	☠	☠	YES	☠	YES	YES	?	☠	YES
Dodecyl Benzene Sulphonic Acid (DDBSA)	YES	☠	☠	YES	YES	YES	☠	☠	☠
Fatty Acids	YES	YES	?	YES	YES	YES	?	?	YES
Iodine	☠	?	YES	YES	YES	YES	?	?	?
Peroxide	☠	☠	YES	☠	YES	?	YES	☠	YES
Quaternary ammonium	YES	YES	YES	☠	?	YES	?	YES	☠
Sodium hypochlorite	☠	☠	YES	☠	YES	YES	YES	YES	YES

YES = Pre and Post-dips are compatible

☠ = Pre and post-dips should not be used together

? = Only when pre-dip is removed prior to milking

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Application

Method of application

- Dip cup
- Foam
- Spray
- Automated sprayer

- Typical usage 8 ml or 0.25 oz/application
  - Ex: 100 cows 2x = 100 oz/day or ¾ gal.
  - Ex: 1,000 cows 3x = 12 gal.

Dip usage

	oz./use
Dip (cup-min)	0.15
Dip (cup-max)	0.4
Foam (min)	0.08
Foam (max)	0.8
Thrifty dipper	0.16
Thrifty dipper and foam	0.08
Spray (min)	0.3
Spray (max)	0.5
Automated spraying (min)	0.65
Automated spraying (max)	1

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Dip cup

- Dip coverage is excellent with a cup as long as cup size matches teat size
  - Dip covers the entire surface of the teat
  - Dip to cover at least ¾ of teat barrel
- Dip usage comparison
  - Dip cup < spray or automatic sprayer
  - Dip cup < > foam
    - Depends upon dip
- Thrifty dipper

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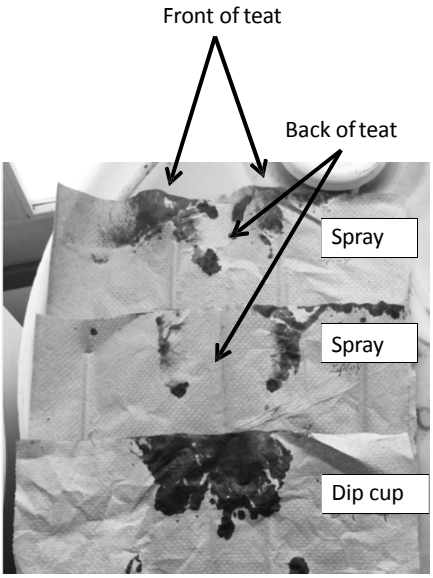
Spray

- Spraying teats may only disinfect closest surface of teat
- Proper coverage requires rotating spraying lance twice around each teat
- Towel test
  - Wrap towel around teat after dip is applied
  - No coverage on back side of teat when spraying
  - Entire teat covered with dip when using a dip cup



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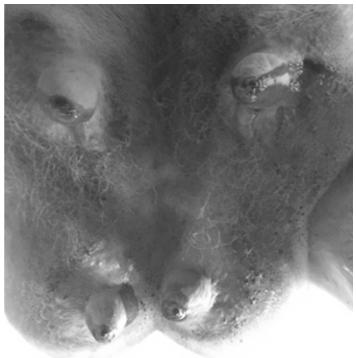
Spray - Dip coverage

- There is no dip on half the teat
  - No dip on side of teat facing the head
- No skin disinfectant
- No skin conditioning



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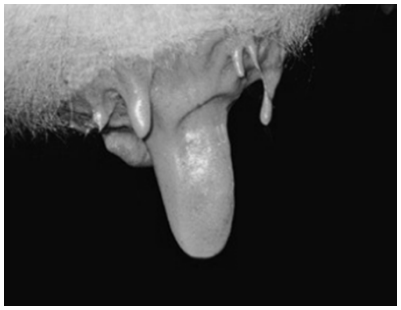
Foam

- Long contact time with teat surface
- Reduced used of chemical and water
  - This has always been stated but the viscosity and chemical makeup of the dip will impact usage
    - Ex: Low viscosity chlorine dioxide with 2% emollients: 0.08 oz/application
    - Ex: Iodozyme: 0.7 oz./application
    - Normal dip usage: oz./application



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Teat health and environment

- Cold and wind chill
  - Minimizing wind is key
  - In the winter teat condition can change in 2 or 3 days
  - Tend to see more hyperkeratosis and cracking teat skin in pointed teats as compared to flat or round teats
- Wet
  - Barrier
- Sun exposure
  - Shade and aloe vera (emollient)

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Storage

- Prevent from freezing
  - Freezing may cause separation or product to come out of suspension resulting in concentrated carriers, surfactants and emollients
  - Carriers and surfactants are what causes irritation when dips separate
    - Leads to changes in product pH
- Heat and direct sunlight
  - Keep out of direct sunlight can breakdown disinfectants
  - Store in areas where temperature is < 95 F
- Do not reuse dip containers without proper commercial cleaning of container
- DO NOT STORE TEAT DIPS NEAR WASH SYSTEM DETERGENTS AND ACIDS
- Clearly label or identify dip products with colors, letters or numbers
  - Ex: Green top dipper cup and green tape on dip barrel
- <u>Proper storage and handling</u>

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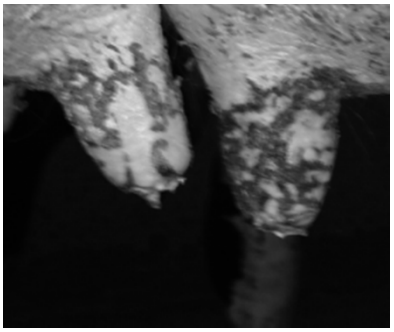
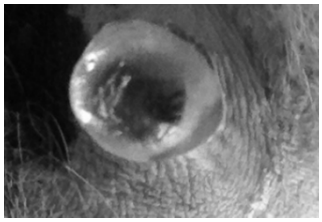
Accidental use of acid or detergent as a teat dip – improper storage





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Concentrated dip mixed on farm

- Water quality test is a must if mixing dip on farm
  - Full bacteria count of water
  - pH
  - Hardness
- Goal is to disinfect teat not the water used to mix the dip
- Ability to titrate proper concentration of dip if mixing on farm

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Proven dips

- There are so many dips on the market but few different classes of dips, thus choosing a proven dip is easy to do
- Summary of peer-reviewed teat dips
- Search for proven dips
  - Database: www.PubMed.com
  - Key words: Teat dip OR teat disinfectant AND efficacy OR prevention OR reduction
- Promote clients to choose dips that have efficacy data

What is the best teat dip?

- How do you answer this question?

- Improved or maintained IMI
- Improved or maintained SCC
- Improved or maintained skin condition
- Not harmful to the cow or the milk supply
- The teat dip that is proven efficacious and works for the producer

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Discussion

- Disinfecting and conditioning
  - All about the drop at the teat end – both as a germicide and conditioner
- Teat dip properties have a profound effect on teat condition
  - Teat condition either good or bad is usually the result of the formulation or added components and not the germicide itself

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