



Introduction

Mastitis, or inflammation of the mammary gland, is widely considered the single-most profit robbing disease in the US dairy industry. It is critical that preventative measures, including wise application of pre- and post-milking teat dip or spray, be as effective as possible.

While numerous mastitis control products have been tested over the years, a truly notable product has emerged. This report details the formulation, mechanism of action, and clinical efficacy of EfferCept™ Sanitizing Teat Dip and Spray.

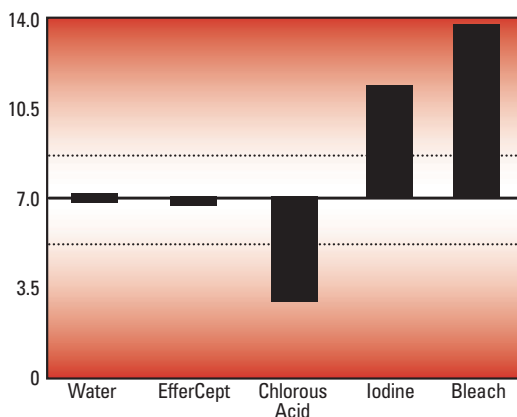
Product Description

The active ingredient of EfferCept is sodium dichloroisocyanurate (NaDCC), made available as a concentrated powder in effervescent tablet form for simplified preparation. The product is pH-buffered—formulated specifically to prevent major shifts in pH—so that it exhibits a near-neutral pH of 6.7 regardless of the concentration level.

A solution with neutral-pH is important for two reasons:

1. The prepared solution is non-caustic with minimal irritation to skin and animal tissue; see Figure 1.
2. This pH creates a high concentration (95%) of hypochlorous acid, HOCl, and a minimum concentration (5%) of the hypochlorite ion, OCl⁻. HOCl provides exceptional kill power with virtually no irritation.

Figure 1: pH comparison of teat dip products



EfferCept solution is unique among disinfectants for its near-neutral pH.

Product Description

Name	<i>EfferCept™ Sanitizing Teat Dip & Spray</i>
Active Ingredient	Sodium dichloroisocyanurate (NaDCC)
Technology Name	Activon™ Technology
Composition before Dilution	50% NaDCC, 50% Inert Ingredients
Composition after Dilution	95% HOCl, 5% OCl ⁻
Appearance	Light blue tablet
Weight	6 grams
pH	6.7
Available Active	2000 ppm at 4 tablets per gallon of water
Recommended Dilution Rates (see Table 4)	<ul style="list-style-type: none"> • Regular Strength: 4 tablets per gallon of water • Maximum Strength: 6 tablets per gallon of water
'Shelf Life' after Dilution	7-10 days

While the EfferCept active ingredient is a member of the chlorine family, it differs from other chlorine-based treatments that operate at a pH favoring the prevalence of OCl⁻ ion. Both HOCl and OCl⁻ are relatively strong disinfectants. However, HOCl offers several efficacy advantages described here.

The product's inert effervescent base provides immediate dispersion of the active ingredient. However, as HOCl is consumed during bactericidal activity, additional HOCl is released from the NaDCC molecule to maintain an equilibrium concentration of approximately 95% HOCl. In this manner, the product provides continued bactericidal action as needed.

The prepared (EfferCept) solution is non-caustic, with the same minimal irritation effects on skin and animal tissue as water

Mechanism of Action

The HOCl molecule is key to the product's demonstrated exceptional killing power against a wide range of harmful organisms. This molecule bears no positive or negative charge and, unlike the negatively charged OCl⁻ ions produced by chlorous acid/chlorine dioxide treatments or

Table 1: Effective on various microorganisms

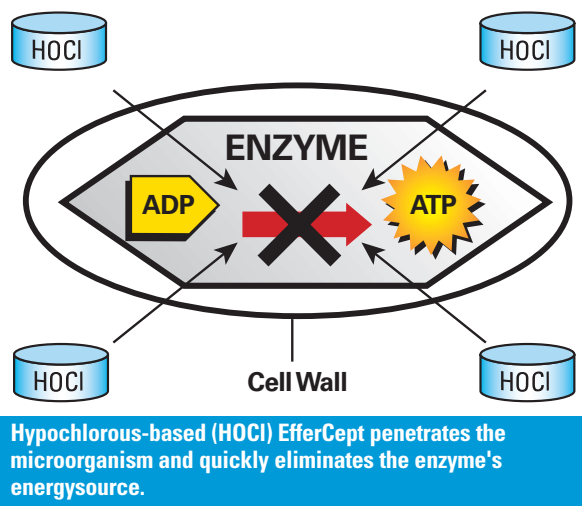
<i>Escherichia coli</i>	<i>Mycoplasma species</i>
<i>Staphylococcus aureus</i>	<i>Mycobacterium tuberculosis</i>
<i>Streptococcus uberis</i>	<i>Klebsiella species</i>
<i>Streptococcus agalactiae</i>	<i>Proteus vulgaris</i>
<i>Salmonella choleraesuis</i>	<i>Listeria monocytogenes</i>
<i>Salmonella typhimurium</i>	<i>Candida species</i>
<i>Pseudomonas species</i>	<i>Aspergillus species</i>
	<i>Many viruses</i>

The mechanism of action of the EfferCept active ingredient makes it effective against these microorganisms.

OI⁻ ions produced by iodine treatments, it is not repelled by the negatively charged bacterial cell wall. The molecule easily penetrates microorganisms (see Table 1) but does not easily penetrate animal and human skin cells.

Then, HOCl molecules within the microorganism deactivate the cell's primary energy-producing source, resulting in rapid cell death; see Figure 2.

Figure 2: Mechanism of bacterial kill



Hypochlorous-based (HOCl) EfferCept penetrates the microorganism and quickly eliminates the enzyme's energysource.

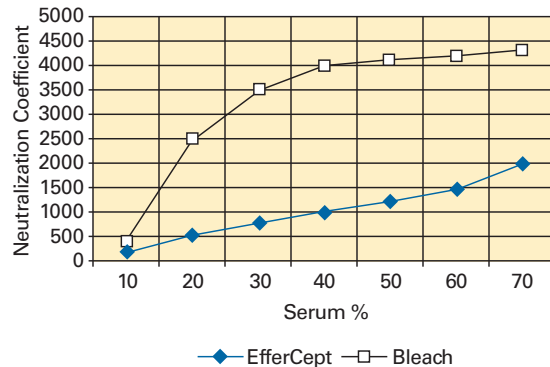
Organic Exposure Studies

The HOCl molecule also allows the product to be effective in the presence of high concentrations of organic matter such as milk, blood, and manure. Electron-demanding organic substances quickly neutralize the negatively charged OCI⁻ and OI⁻ ions

...other treatments work well under "clean" conditions, [but] they can be deactivated by organic matter...

that are the active components of other antimicrobial treatments. While these other treatments work well under "clean" conditions, they can be deactivated by organic matter that is often present.

Figure 3: Organic load test



In 30% serum, an HOCl solution of 4000 ppm exhibited similar bactericidal activity as a bleach solution of 17,000 ppm, showing it to be approximately 4 times more resistant to neutralization by the organic serum.

Laboratory work compared the activity of sodium hypochlorite (bleach) and HOCl (EfferCept) solutions, both containing various concentrations of horse serum, against pseudomonas aeruginosa. The EfferCept solution proved much more resistant to deactivation, compared to the bleach solution; see Figure 3.

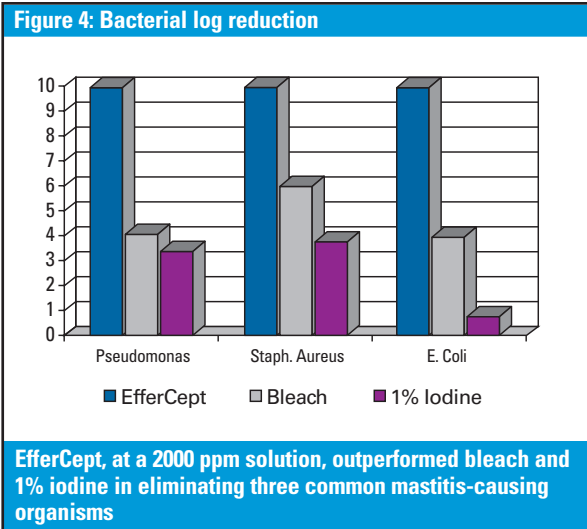
Broad Killing Power

In a comprehensive study comparing the bactericidal activity of 57 traditional teat dip formulations,¹ Clorox (bleach solution) provided the highest bacteria log reduction compared to all other active ingredient classes available at the time, including iodine solutions of 0.5% and 1.0%.

Yet, a subsequent university study showed that EfferCept's active ingredient, at half the concentration of Clorox, demonstrated greater bactericidal activity.² See Figure 4 for a summary comparison of bacterial log reduction resulting from traditional treatments and EfferCept.

Effective Against Mycoplasma

A Study comparing EfferCept's germicidal activity against three bovine Mycoplasma species found that EfferCept was "effective" when tested against Mycoplasma californicum, Mycoplasma bovigenitalium and Mycoplasma bovis.³



NMC Standard Challenge Protocol

In a controlled-infection clinical trial, Dr. Stephen Nickerson at the Hill Farm Research Station at Louisiana State University, Homer, LA, examined the efficacy of EfferCept as a post-milking preventative against intra-mammary infection (IMI).⁴

Following the National Mastitis Council (NMC) Experimental Challenge guidelines (formerly known as Protocol B), animals were exposed to a challenge suspension of Staphylococcus aureus and Streptococcus agalactiae daily, following the afternoon milking. After exposure, two teats of each animal were treated with EfferCept, at the label-indicated concentration of 2000 ppm (four tablets per gallon), with optional SoftGuard™ conditioner added at the rate of one ounce/gallon. The remaining two quarters remained undipped as controls.

Milk samples were collected pre-trial and weekly for culturing to determine the presence of infection. Characteristics of teat skin surfaces and teat ends were scored before and after the trial to determine effects of treatment on teat

Table 2: Summary of efficacy data in Protocol B-based clinical trial

Organism and treatment	Quarters eligible for new IMI	% Quarters with new IMI	% Reduction compared to control
<i>S. aureus</i>			
Dipped	137	7.3	69.0% (p<0.001)
Control	140	21.4	
<i>S. agalactiae</i>			
Dipped	147	5.4	63.5% (p<0.01)
Control	148	14.2	

skin condition, according to criteria established by Goldberg et al.⁵

Infection data collected during the trial are summarized in Table 2. Teat skin scoring characteristics are presented in Table 3. In a herd of 144 animals, a total of 40 new *S. aureus* IMI were confirmed: 30 in control quarters and 10 in dipped quarters. Twenty-nine new *S. agalactiae* IMI were confirmed: 21 in control quarters and 8 in dipped quarters. EfferCept reduced the infection rate for *S. aureus* by 69.0% (p<0.001) and 63.5% for *S. agalactiae* (p<0.01).

Dr. Nickerson concluded the product was “highly effective in preventing new IMI” and was as efficacious as other products currently available on the market. (A copy of the complete study report is available on request.)

Significance of Healthy Skin Condition

Soft, healthy teat skin and ends are vital to good overall udder health. A healthy teat end allows the sphincter to close tightly, keeping mastitis-causing bacteria from entering the teat canal.

Table 3: Summary of teat condition in Protocol B-based clinical trial

Mean Teat Skin Condition Score			
Before		After	
Dipped	Control	Dipped	Control
1.02	0.98	1.0	0.99

Scoring Characteristics:

- 0 Test skin has been subjected to physical injury, eg. stepped on or frostbitten, not related to the treatment; or the quarter is not lactating
- 1 Teat skin is smooth, free from scales, cracks or chapping
- 2 Teat skin shows some evidence of scaling
- 3 Teat skin is chapped. Some small warts may be present
- 4 Teat skin is chapped and cracked. Redness, indicating inflammation, is present. Numerous warts may be present
- 5 Teat skin is severely damaged and ulcerative with scabs or open lesions. Large or numerous warts are present that interfere with teat end function

Mean Teat End Condition Score			
Before		After	
Dipped	Control	Dipped	Control
1.03	1.04	1.05	1.06

Scoring Characteristics:

- 0 Test end has been subjected to physical injury, eg. stepped on or frostbitten, not related to the treatment; or the quarter is not lactating
- 1 Teat end sphincter is smooth with no evidence of irritation
- 2 Teat end has a raised ring
- 3 Teat end sphincter is roughened with slight cracks but no redness is present
- 4 Teat end sphincter is inverted with many cracks, giving a “flowered” appearance. Teat end may have old but healing scabs
- 5 Teat end is severely damaged and ulcerative with scabs or open lesions. Large or numerous warts are present that interfere with teat end function

In the NMC-based clinical trial, mean herd score before and after the trial for dipped and untreated (control) quarters was approximately 1.00, reflecting normal, smooth skin, free from scabs, cracks or chapping. Teat end condition scores showed similar results; see Table 3.

The HOCl contained in the product formulation reacts with soil and fat substances, converting them to soluble salts that rinse away. This action occurs without the irritation caused by iodine- or chlorous acid/chlorine dioxide-based products. EfferCept teat dip solutions do not necessarily require the use of emollients; however, when the product is used as a post-milking dip, product literature recommends the addition of SoftGuard™ Conditioning Additive. Using SoftGuard will provide additional moisturizing that may also be helpful during extremely dry or harsh weather conditions.

Conclusions

EfferCept Sanitizing Teat Dip & Spray when dissolved in water creates a mild, non-irritating solution. The product uses hypochlorous acid to penetrate cell walls and deactivate the organism's primary energy-producing function. Other disinfectants apply an extra-cellular oxidation-reduction reaction that burns or erodes the cell wall. EfferCept also maintains its bactericidal effectiveness in the presence of organic substances such as blood, milk, and manure.

EfferCept demonstrates a better log reduction of a wide variety of harmful bacteria compared to bleach and iodine solutions. It has been proven highly effective in preventing new IMI in trials conducted according to the NMC standards. Objective teat end and skin condition scoring in the clinical trial substantiates its mildness to skin.

- ¹ Murdough, P.A. and J.W. Pankey, Dept. of Animal and Food Science, University of Vermont, *J. Dairy Sci.*, Vol.76 No.7, 1993.
- ² Saeed, A.M., Department of Veterinary Pathology, School of Veterinary Medicine, Purdue University, 1997.
- ³ R.L. Boddie, W.E. Owens, C.H. Ray, S.C. Nickerson, N.T. Boddie, *J. Dairy Sci.* 85:1909-1912, 2002.
- ⁴ Nickerson, Stephen C., Hill Farm Research Station, Louisiana State University, "Efficacy of an experimental Teat Dip Against *Staphylococcus aureus* and *Streptococcus*
- ⁵ Goldberg, J.J., P.A. Murdough, A.B. Howard, P.A. Dreschler, J.W. Pankey, G.A. Ledbetter, L.L. Day, and J.D. Day, *J. Dairy Sci.* Vol.77 1994.

Technical Review Highlights

- The active ingredient of EfferCept is sodium dichloroisocyanurate (NaDCC) in an effervescent tablet form.
- When the EfferCept tablet is added to potable water, it creates a hypochlorous acid solution (HOCl).
- EfferCept has a near-neutral pH level of 6.7 making it virtually non-irritating to human and animal skin.
- The high concentration of HOCl found in EfferCept solutions makes it effective in the presence of organic matter such as milk, blood, dirt, and manure. Tests found the EfferCept solution four times more resistant to neutralization by organic serum than bleach.
- In a National Mastitis Council Experimental Challenge, EfferCept reduced *Staph. aureus* based intra-mammary infections by 69.0% and *Strep. agalactiae* based infections by 63.5% versus the control (water).
- EfferCept's mean herd score for teat skin condition in the NMC study was 1.00, reflecting normal, smooth skin, free from scabs, cracks, or chapping. Teat end conditions showed similar results.

Table 4: Dilution rates

Strength	Dilution Rate	Usage
Regular Strength	4 tablets per gallon of water	<ul style="list-style-type: none"> • Under normal conditions • When applying as a spray** • When milking more than twice a day
Maximum Strength	6 tablets per gallon of water	<ul style="list-style-type: none"> • During first six weeks after switching from another product • During adverse weather conditions • If ground is wet or muddy • If somatic cell counts are high

****Users should consider using maximum strength dilution if using a teat dip cup which is easily contaminated with organic matter.**

