

Evaluating feed additives to include in rations

Michael Hutjens for *Progressive Dairy*

Interest in feed additives will continue and be influenced by new research results, advertising and profit margins. When milk prices drop, dairy farmers may pull feed additives out to reduce feed costs. This decision can result in lost milk yield, lowered fertility and impaired immunity. The table outlines additives in categories that can assist dairy farmers, consultants, feed company nutritionists and veterinarians in deciding if an additive should be included. By definition, a feed additive is a feed ingredient added to the ration for a non-nutrient role. Examples could be sodium bicarbonate as a rumen buffer and monensin as a rumen microbial modifier. Feed additives are added in low concentrations to affect rumen, blood and tissue responses.

In the table, several additives are nutrients, such as B vitamins and trace minerals, but dairy producers and nutritionists may consider these as feed additives. Only lactating and dry cow feed additives are included (no calf or heifer feed additives). Each additive is discussed as its function, suggested level of inclusion, benefit-to-cost ratio based on milk production response versus cost to add to the ration (not including higher dry matter costs and not including fertility, health or lameness benefits), feeding strategy and recommendation [Hutjens' assessment]. Three status groups are listed below.

- Recommended: Include as needed

- Experimental: Additional research and studies are needed

- Evaluative: Monitor on individual farms and specific situations

The following additives are recommended for various phases of the gestation and lactation cycles.

- Lactating cows: Monensin, buffer pack, yeast product, silage inoculant, organic trace minerals and biotin.

- Close-up dry cows: Monensin, yeast product, silage inoculant, organic trace minerals including chromium, rumen-protected choline and DCAD balancers.

- Fresh cows: Monensin, buffer pack, yeast product, silage inoculant, organic trace minerals including chromium, rumen-protected choline and calcium boluses or supplementation. ↗



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Anionic salts and products – close-up dry cows

1. Function: Cause the diet to be more acidic, increasing blood calcium levels by stimulating bone mobilization of calcium and calcium absorption from the small intestine via the parathyroid hormone

2. Level: Reduce DCAD to -50 meq per kilogram or -5meq per 100 grams using chloride sources (calcium chloride, ammonium chloride, BioChlor, Animate, SoyChlor, NutraChlor and hydrochloric acid-treated feeds)

3. Benefit-to-cost ratio: 10:1

4. Feeding strategy: Feed to close-up dry cows two to three weeks before calving, adjusting dietary calcium levels to 100 grams (partial acidified) to 150 grams per day (full acidified). Raise dietary magnesium levels to 0.4%.

5. Status: Recommended

Aspergillus oryzae

1. Function: Stimulate fiber-digesting bacteria, stabilize rumen pH and reduce heat stress

2. Level: 3 grams per day

3. Benefit-to-cost ratio: 6:1

4. Feeding strategy: High-grain diets, low rumen pH conditions, under heat stress (cows) and calves receiving a liquid diet

5. Status: Evaluative

Beta-carotene

1. Function: Improve reproductive performance with higher ovarian levels, increase fiber digestion by rumen microbes, immune response and mastitis control

2. Level: 300 milligram per day (blood levels 1.5 to 3.5 micrograms per milliliter); 500 milligrams per day (blood levels less than 1.5 micrograms per milliliter).

3. Benefit-to-cost ratio: Not available

4. Feeding strategy: In early lactation and during mastitis-prone periods

5. Status: Experimental

Biotin

1. Function: Improve hooves by reducing heel warts, claw lesions, white-line separations, sand cracks and sole ulcers, and increase milk yield through metabolic routes as a B vitamin source

2. Level: 15 to 20 milligrams per cow per day (feed for six months to one year for hoof improvements)

3. Benefit-to-cost ratio: 4:1

4. Feeding strategy: Herds with chronic foot problems may require supplementation for six months before evaluation, beginning supplementation at 15 months old.

5. Status: Recommended

Calcium propionate

1. Function: Increase blood glucose and calcium levels

2. Level: 120 to 225 grams (feeding); 450 grams (drenched)

3. Benefit-to-cost ratio: Not available

4. Feeding strategy: Feed seven days prepartum to seven days postpartum, when blood beta hydroxybutyric acid (BHBA) are in subclinical or clinical range or until appetite responds. Drench cows immediately after calving.

5. Status: Recommended in a drench package

Cationic salts and products – lactating cows

1. Function: Increase the cation balance in the diet to maintain blood electrolytes (potassium and sodium) under heat stress conditions

2. Level: Raise the DCAD to +350 meq per kilogram or +35 meq per 100 grams using sodium and potassium carbonate-based buffer

3. Benefit-to-cost ratio: Not available

4. Feeding strategy: Feed to lactating cows when cows are under heat stress to maintain dry matter intake and performance. Adjust dietary potassium levels to 1.8% and 0.50% sodium.

5. Status: Recommended

Choline (rumen-protected)

1. Function: A methyl donor to minimize fatty liver formation, improve insulin effectiveness and to improve fat mobilization leading to improved milk yield and reproductive performance

2. Level: 15 grams per day

3. Benefit-to-cost ratio: 3:1 (when fed as rumen-protected)

4. Feeding strategy: Feed two weeks prepartum to three weeks postpartum to cows experiencing ketosis, weight loss and high milk yields

5. Status: Recommended

Chromium

1. Function: Stimulate dry matter intake and milk yield by increasing insulin sensitivity and managing blood glucose levels

2. Level: 0.5 ppm of the total dry matter intake (controlled by FDA)

3. Benefit-to-cost ratio: 10:1

4. Feeding strategy: Feed to close-up dry cows, fresh cows and early lactation cows.

5. Status: Recommended

Enzymes (fibrolytic)

1. Function: Increase fiber digestibility by reducing fiber (adding cellulase and xylanase enzymes) and dry matter intake

2. Level: Not clearly defined (enzymatic units per unit of feed dry matter)

3. Benefit-to-cost ratio: 2:1

4. Feeding strategy: Increase fiber digestibility, treated 12 hours before feeding, spray-on product more effective when applied to dry diets, part of a silage inoculant product and response may be diet-specific.

5. Status: Experimental

Enzymes (starch-amylase)

1. Function: Amylase-based enzymes can improve total tract starch digestibility and improve milk yield and feed efficiency

2. Level: 300 kNU per kilogram dry matter intake. One kNU = approx. six "Ceralpha Units" using the Megazyme International amylase assay.

3. Benefit-to-cost ratio: 3:1

4. Feeding strategy: Improve starch utilization, reducing starch levels and replacing with lower-cost rumen-fermentable carbohydrate sources

5. Status: Experimental

Essential oil compounds (cinnamon oil, clove oil, garlic oil and others)

1. Function: Improve rumen fermentation by reducing protein deamination, increase propionate production, increase feed efficiency and/or improve hydrogen status

2. Level: 0.5 to 1.5 grams per cow per day (higher levels may have a negative impact)

3. Benefit-to-cost ratio: 7:1

4. Feeding strategy: Increase propionate production in the rumen and feed efficiency

5. Status: Experimental

Immune stimulation (OmniGen AF – brand name)

1. Function: Affect immune function as measured by changes in neutrophil activity including migration via L-selectin, phagocytosis, oxidative burst reactions leading to lower SCC, higher milk yield related to immunity improvement and reduce HBS or bloody gut losses.

2. Level: 56 grams per day

3. Benefit-to-cost ratio: 7:1 early lactation; 3:1 for entire lactation

4. Time period: Dry-off to 60 days postpartum

5. Status: Experimental

Magnesium oxide

1. Function: Alkalinizer (raises rumen pH), increases uptake of blood metabolites by the mammary gland, raising fat test and a magnesium ration source

2. Level: 45 to 90 grams per day

3. Benefit-to-cost ratio: Not available

4. Feeding strategy: With sodium-based buffers (ratio of 2 to 3 parts sodium bicarbonate or sodium sesquicarbonate to 1 part magnesium oxide)

5. Status: Recommended (source of magnesium and in buffer packs)

Monensin (brand name Rumensin)

1. Function: Improve feed efficiency for lactating cows, reduce ketosis and displaced abomasums in transition cows by shifting rumen fermentation, and microbial selection. Milk yield may increase 2.2 pounds per day. Control cocci in calves and heifers.

2. Level: 11 to 22 grams per ton of total ration dry matter consumed (250 to 400 milligrams per cow per day); lower levels in calves and heifers

3. Benefit-to-cost ratio: 5:1

4. Feeding strategy: Feed to dry cows (reduce metabolic disorders) and lactating cows (feed efficiency) while monitoring milk fat to evaluate optimal levels of monensin.

5. Status: Recommended

Niacin (B3, nicotinic acid and nicotinamide)

1. Function: Coenzyme systems in biological reactions, improve energy balance in early lactation cows, control ketosis slowing weight loss, reduce heat stress and stimulate rumen protozoa

2. Level: 3 to 5 grams of rumen-protected niacin. One gram of rumen-protected niacin replaces 8 grams of rumen-unprotected niacin.

3. Benefit-to-cost ratio: 3:1

4. Feeding strategy: Dry cows with body condition scores over 3.25 and ketotic-prone cows mobilizing body fat. Do not feed lactating cows allowing for mobilized body resources in early lactation, allowing NEFA as an energy source.

5. Status: Recommended (rumen-protected niacin)

Organic trace minerals (copper, selenium and zinc)

1. Function: Increase immunity, reduce oxidative stress, hoof improvement and enzyme roles

2. Level: Replace 25 to 30 percent of total zinc and copper minerals in the ration; all-organic selenium to dry cows.

3. Benefit-to-cost ratio: Not available

4. Feeding strategies: Supplement to dry cows, transition cows and early lactation until confirmed pregnant.

5. Status: Recommended

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Prebiotics (non-viable probiotics)

1. Function: Stimulate bacterial growth or reduce bacteria growth that can reduce animal performance. Examples include inulin (stores carbohydrates), oligofructose, yeast cell wall products, MOS products, butyrate (0.16 gram per liter of milk), lactoferrin (2 milligrams per milliliter of colostrum)
2. Level: Varies by product and brand
3. Benefit-to-cost ratio: Not available
4. Feeding strategies: Feed to calves and animal exposed to undesirable bacteria in the digestive tract
5. Status: Experimental

Probiotics (bacterial direct-fed microbes or DFM)

1. Function: Produce metabolic compounds that destroy undesirable organisms, block intestinal attachment of pathogenic bacteria, provide enzymes improving nutrient availability or detoxify harmful metabolites
2. Level: Not clearly defined
3. Benefit-to-cost ratio: Not available
4. Feeding strategy: Feed to calves on liquid diet, transition cow rations, high levels of rumen-fermentable starch/carbohydrates and during stress conditions
5. Status: Experimental for cows; recommended for milk or milk replacer-fed calves

Propylene glycol and glycerol

1. Function: Source of blood glucose, stimulate an insulin response and reducing fat mobilization
2. Level: 300 to 500 milliliters per cow per day
3. Benefit-to-cost ratio: Not available
4. Feeding strategy: Drench cow after calving when signs of ketosis are observed.
5. Status: Recommended

Silage bacterial inoculants

1. Function: To stimulate silage fermentation, reduce dry matter loss, decrease ensiling temperature, increase feed digestibility, improve forage surface stability and increase VFA (lactate) production
2. Level: 100,000 colony-forming units (CFU) per gram of wet silage. Recommended bacteria include *Lactobacillus plantarium*, *Lactobacillus buchneri*, *Lactobacillus acidilacti*, *Pediococcus cereviseai*, *Pediococcus pentacoccus* and/or *Streptococcus faecium*.
3. Benefit-to-cost ratio: 3:1 (nutrient recovery) to 7:1 (milk improvement)
4. Feeding strategy: Apply to corn silage, haylage and high-moisture corn; when field conditions with low natural bacteria counts (first and last legume/grass silage and frost-damaged corn silage); and under poor fermentation conditions.
5. Status: Recommended

Sodium bentonite

1. Function: A clay mineral used as a binder of mycotoxins, shifts VFA patterns, slows rate of passage and exchanges with mineral ions
2. Level: 450 grams per day (rumen effect), 110 grams for mycotoxin effect
3. Benefit-to-cost ratio: Not available
4. Feeding strategy: With high-grain diets, loose stool conditions, presence of mold, low fat test and cattle consuming dirt.
5. Status: Evaluative

Sodium bicarbonate/sodium sesquicarbonate (buffer)

1. Function: Increase dry matter intake, source of positive DCAD under heat stress conditions and stabilize rumen pH
2. Level: 0.75% of total ration dry matter intake
3. Benefit-to-cost ratio: 5:1
4. Feeding strategy: Diets high in corn silage (over 60% of total forage intake), wet rations (over 55% moisture), lower-fiber ration (less than 28% NDF), finely chopped forage (over 50% in the bottom Penn State particle box), pelleted grain mixtures, slug feeding of concentrates and under heat stress conditions.
5. Status: Recommended

Yeast culture and yeast

1. Function: Stimulate fiber-digesting bacteria, stabilize rumen environment and utilize lactic acid
2. Level: 10 to 120 grams depending on yeast culture concentration
3. Benefit-to-cost ratio: 4:1
4. Feeding strategy: Two weeks prepartum to 10 weeks postpartum, calf starter feeds and during off-feed conditions and stress periods
5. Status: Recommended

Yucca extract

1. Function: Decrease urea nitrogen in plasma and milk by binding ammonia to the glycofraction extract of *Yucca shidigera* plant and improving nitrogen efficiency in ruminant animals.
2. Level: 800 milligrams to 9 grams per day (depending on source)
3. Benefit-to-cost ratio: Not available
4. Feeding strategy: Cows with high BUN and MUN levels
5. Status: Evaluative

Zeolite (sodium aluminosilicate)

1. Function: Binds minerals in the ration including calcium (used in close-up rations), magnesium, phosphorus and other potential minerals. It can also bind mycotoxins.
2. Level: 125 to 250 grams as a mycotoxin binder; 500 grams for binding dietary calcium (10 grams of zeolite may tie up 1 gram of calcium)
3. Benefit-to-cost ratio: Not available
4. Feeding strategy: Feed when risks of aflatoxin may affect milk levels secreted in milk and to close-up cows to stimulate blood calcium levels as an alternative to DCAD products listed above
5. Status: Experimental

Zinc methionine

1. Function: Improve immune response, enzyme co-factor, harden hooves and lower SCC.
2. Level: 9 grams per day
3. Benefit-to-cost ratio: 14:1
4. Feeding strategy: To herds experiencing foot disorders, high somatic cell counts and wet environment
5. Status: Recommended