Fiber-degrading enzymes increase dairy cow milk production

Literature review examines experiments where dairy cows benefited from various enzyme combinations, doses

BY FERNANDO DIAZ

The lactational response of dairy cows fed fiber-degrading enzymes has been scarce and inconsistent. The effectiveness of fiber-degrading enzymes to improve milk production has only been observed in 30 percent of studies; however, eight experiments showed positive results.

Based on the experiments included in this literature review, the average increase in milk yield due to the enzyme addition was 5.5 lbs./day (2.6 to 13.9 lbs./day); none of these experiments reported reduction in milk yield when the cows were fed fiber-degrading enzymes. The response, however, was highly dependent on enzyme dosage, enzyme combination and the method of enzyme application to the diets.

Low dosages yield positive results

University of Delaware researchers studied the effect of a carboxymethyl cellulase (CMC) and xylanase complex at two different concentrations on milk production in lactating cows.

Surprisingly, the authors reported that enzyme treatment at low, 1,600 CMC and 7,300 xylanase units per pound of forage dry matter (DM), but not high, 4,000 CMC units and 18,200 xylanase units, concentrations improved milk production by 6.8 percent.

Similarly, supplementing a fiber-degrading enzyme mixture enhanced milk production by 3.2 percent at a low dosage rate (1.2 g/lbs of DM) in early lactating cows, but not at a higher concentration (2.3 g/pound of DM) in another study.

Enzyme activity impacts outcome

The University of Delaware results contrast with those of another experiment conducted at the University of Idaho.

Milk production was enhanced by 13.9 lbs/day in early lactation. Cows receiving an enzyme solution containing cellulases and xylanases increased production at a rate of 1.1 ml/pound of forage DM. Milk yield, however, did not increase in cows fed lower and higher amounts of enzymes (0.6 and 2.3 ml/pound of forage DM, respectively).

The lack of response at low concentrations indicates insufficient dietary enzyme activity; however, the explanation for reduced enzyme response when added at higher rates of supplementation is less evident.

Three possible hypotheses have been proposed for the lack of response when enzymes were used at high doses:

- It may be partially attributed to negative enzyme feedback inhibition by the increased concentration of a product of the enzyme-substrate interaction.
- Fermentation of sugars produced by cell wall hydrolysis may reduce ruminal pH to levels that inhibit cell wall digestion.
- It is possible that exogenous enzymes compete with the rumen population for cellulose binding sites available on feeds.

The fact that it is possible to either overfeed or underfeed enzymes makes their application complex and emphasizes the need to determine optimal concentrations of enzyme additions necessary for any given feeding situation.

Role of enzyme combinations

The source and combination of specific enzymes are also important factors in improving lactation response.

University of Delaware researchers compared the effects on milk production of two different cellulase-enzyme complexes derived from different fermentations of the same organism combined with a single xylanase-enzyme complex.

Milk production was similar for cows fed untreated forage or forage treated with the enzyme complex EA2 (3,700 carboxymethyl cellulase and 14,000 xylanase units); however, production increased by 5.5 lbs. in cows fed EB1.2 (3,600 carboxymethyl cellulase and 11,000 xylanase units).

Portion plays a part

Two studies conducted by a Canadian research group showed that the lactation response of dairy cows fed fiber-degrading enzymes depended on the portion of the diet to which the enzyme complexes were applied.

In the first study, the researchers reported an 8 percent increase in milk production in cows fed alfalfa hay cubes treated with 1 g/lbs of an enzyme supplement compared with untreated cubes. There was no response, however, in milk yield when concentrate and cubes were treated with 0.5 g per pound of the same enzyme complex.

In a subsequent experiment, milk yield was 4.6 lbs/day higher in cows fed a commercial enzyme product added to the concentrate than cows fed a control diet. However, applying the same enzyme complex to the total mixed ration (TMR) did not affect milk production.

DAIRY COW MILK YIELDS and milk components benefit from enzyme combinations.

It has been suggested that enzymes applied to a TMR immediately prior to feeding may be released into the rumen fluid and pass rapidly to the lower tract before they can be effective in the rumen. Increased postruminal digestion due to enzyme supplementation of the TMR may improve apparent digestibility in the total tract without increasing milk production.

Effects on milk components

Milk fat of cows fed enzymes increased in only three out of 19 experiments included in this literature review.

In one experiment, fat yield increased as a result of higher milk production. In another experiment, it was due to an increase in milk fat concentration. In a third study, however, higher milk fat yields in cows fed enzyme-treated diets were not accompanied by significant increases in either milk yield or milk fat concentration.

Significant increases in milk protein yield due to the addition of fiber-degrading enzyme to dairy diets were observed in four out of the 20 experiments that reported milk protein yield.

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In two other studies, milk protein content improved with the inclusion on fibrolytic enzymes; however, milk protein yield was unaffected.

Editor's note: This is the second installment in a three-part series on exogenous enzymes. ■

Martine De Graaf, Dreamstime