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Bypass Protein and Bypass Fat for Better Milk from Dairy Cows

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A dairy cow's rumen alters most of what she eats before her own digestive system ever sees it. That arrangement is excellent for fibre digestion but awkward for a high yielder, because valuable amino acids and fatty acids are broken down along the way. Bypass protein and bypass fat are feeds treated so that a part of the nutrient escapes this breakdown and is absorbed further down, in the small intestine. This article explains how the two work, what the published trials actually report about the milk response, and how a dairy farmer should decide whether either one is worth the money.

Introduction

Whatever a cow eats first enters the rumen, a large fermentation chamber holding bacteria, protozoa and fungi. These microbes digest fibre that the cow cannot handle on her own, and while doing so they build their own body protein out of the nitrogen and energy present in the ration. When they later pass into the small intestine they are digested there, and the cow absorbs their amino acids. So a large share of the protein that finally reaches the udder was never the protein we placed in the manger. This system serves a cow giving eight or ten litres a day very well. It comes under strain when the same animal is asked for thirty. During the first two or three months after calving, the udder needs amino acids and energy faster than rumen fermentation can supply them, and appetite recovers slowly. The cow cannot simply eat her way out of the gap. Nutritionists therefore asked a different question. Instead of feeding a larger quantity, can we change the route a nutrient takes through the digestive tract? Bypass protein and bypass fat came out of that question. Both rest on a single idea, which is to shield a chosen nutrient from microbial attack in the rumen so that it reaches the small intestine in a more useful form.

What is bypass protein?

Bypass protein, properly called rumen undegradable protein (RUP), is the share of feed protein that escapes breakdown in the rumen and moves on to the abomasum and small intestine. The remainder, rumen degradable protein (RDP), is cut into peptides, amino acids and ammonia, which the microbes take up and use for their own growth. The amino acids a cow finally absorbs therefore come from two sources, digested microbial cells and undegraded feed protein. The sum of the two, after allowing for digestibility, is what nutritionists call metabolizable protein. Its quality counts as much as its quantity, because milk protein is built from a balanced set of essential amino acids rather than from crude protein as such. This is the point at which a familiar sales claim falls apart. Raising RUP does not reliably raise milk yield. Microbial protein has a better amino acid balance than most feed proteins, so pushing RDP too low starves the microbes and the herd loses more than it gains [5]. A recent review of protein evaluation systems went further, reporting that the contribution of RUP is often overestimated compared with microbial protein, and that energy intake predicted milk protein yield better than metabolizable protein intake did [2].

How protein is protected, and where it goes wrong

Heat treatment is the oldest and still the commonest method, since controlled heating lowers protein solubility and slows microbial breakdown. Roasting, expeller processing and extrusion all work on this principle. A few feeds resist naturally, which is why maize gluten meal, fish meal and distillery by-products carry high escape values without any treatment at all. Formaldehyde and tannin treatments have also been used, and single amino acids such as methionine and lysine are sold in coated form. Every one of these methods carries the same risk. Surviving the rumen is only half the job, because the protein must then be digested in the small intestine. Heat a soybean meal too hard and it becomes so tightly bound that intestinal enzymes cannot open it, and the amino acids leave in the dung. A good supplement is not the one with the highest escape value. It is the one with the best combination of escape and intestinal digestibility. Where the shortage is one particular amino acid rather than protein in general, a coated amino acid is the cheaper answer. A meta-analysis covering fourteen studies and 623 cows found that rumen protected methionine improved milk protein and milk fat percentage, with useful responses in the range of about 7.5 to 12.5 g of metabolizable methionine per day [6].

What is bypass fat?

Energy is usually the first thing a freshly calved cow runs short of. Grain will supply it, but too much starch pulls rumen pH down and invites acidosis. Fat carries more than twice the energy of the same weight of carbohydrate, so it looks like the obvious alternative. Plain oil, however, creates its own problems. Free unsaturated fatty acids coat fibre particles and disturb the fibre digesting bacteria. The microbes also attack the oil itself, first splitting it by lipolysis and then saturating the released fatty acids by biohydrogenation, so what reaches the intestine is no longer what was fed. Bypass fat, also called rumen protected fat or inert fat, is built to avoid this. Calcium salts of long chain fatty acids are the best known form. The salt stays largely intact at rumen pH and separates in the acid conditions of the abomasum, releasing the fatty acids where they can be absorbed. Prilled fats made from highly saturated fatty acids remain solid at rumen temperature and are inert for that reason. Among the available forms, calcium salts are the least degradable in the rumen, have the highest intestinal digestibility, and supply some calcium as well [1]. Once absorbed, the fatty acids are burnt for energy or taken up by the udder for milk fat. There is a second benefit that is easy to overlook. When fat meets part of the energy demand, more glucose is spared for lactose synthesis, and lactose largely decides the volume of milk.

What the feeding trials actually show

Fat supplementation works, but the size of the response varies a great deal from herd to herd. The most widely quoted analysis of this question screened 59 papers and used 38 of them, containing 86 separate comparisons. The average gain was about 1.05 kg of milk per cow per day. The authors were careful to add that the results were heterogeneous, meaning the spread between studies was too wide for the average on its own to predict what any single herd will do. Cows that ate more dry matter on the fat supplemented ration responded better than those that did not [3]. Indian experience has been more encouraging. A review of bypass fat feeding in this country reported milk yield increases in the region of 5.5 to 24 per cent, together with better recovery of body condition and improved reproductive performance after calving, and an extra return of roughly Rs 12 to 40 per animal per day at the prices of that period. The same review suggests keeping total ration fat near 4 to 6 per cent of dry matter, drawn in roughly equal parts from natural feed, oilseeds and bypass fat [1]. The fatty acid profile matters as much as the quantity of fat. Palmitic acid tends to support milk fat percentage, while generous amounts of unsaturated oil can do the opposite, because incomplete biohydrogenation in the rumen produces intermediates that suppress milk fat synthesis in the udder [4].

Table 1. Bypass protein and bypass fat compared at a glance

Point of comparison	Bypass protein	Bypass fat
Other names	Rumen undegradable protein (RUP), protected protein	Rumen protected fat, inert fat, escape fat
What it is for	Adds amino acids over and above what the rumen supplies	Raises energy density without adding more starch
Common forms	Heated or expeller oilseed meals, maize gluten meal, coated methionine and lysine	Calcium salts of long chain fatty acids, prilled saturated fat
What it must survive	Breakdown of protein by rumen microbes	Lipolysis and biohydrogenation in the rumen
Risk if overused	Less microbial protein, nitrogen wasted, higher feed cost	Poorer fibre digestion, milk fat depression, lower intake
Sign that it is working	Milk protein percentage holds steady or rises	Milk yield and body condition improve with no drop in milk fat

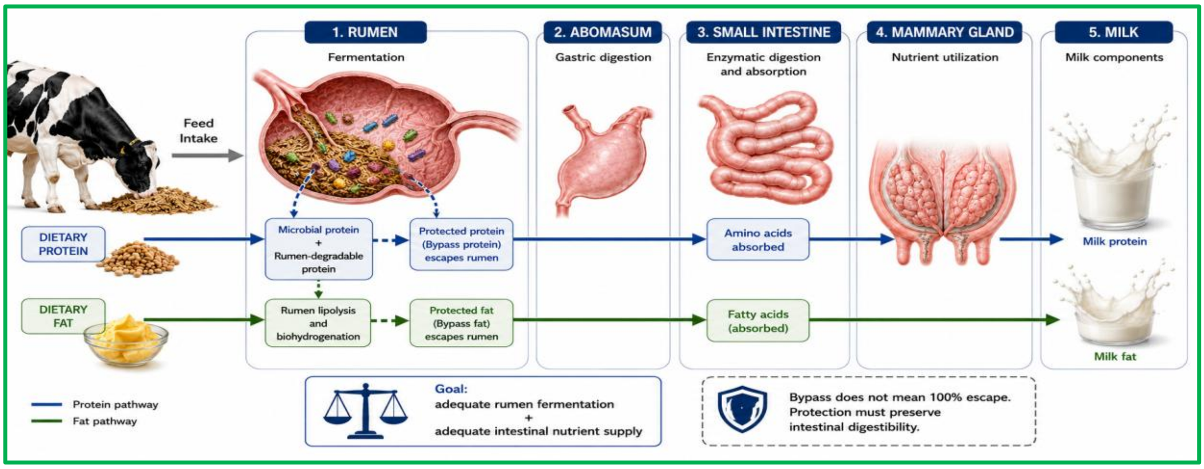

Figure 1. Route taken by protected protein and protected fat, from the manger to the milk pail.

Practical points for the dairy farmer

Start with the animal. High yielding cows in the first hundred days of lactation are the group most likely to repay a protected supplement. A cow giving eight litres on poor straw does not need bypass fat. She needs better fodder.

Correct the basic ration first. If silage or green fodder quality is poor, or effective fibre is short, no protected product will cover for it. Adequate fibre, fermentable carbohydrate, rumen degradable protein and balanced minerals remain the foundation. Bypass products sit on top of that foundation and cannot replace it.

Judge the product, not the label. Two bags both sold as bypass fat may differ in fatty acid profile, melting point and rumen stability. Two bypass protein sources may differ just as much in escape value and, more importantly, in intestinal digestibility. Ask the supplier for the fatty acid or amino acid profile and for digestibility figures, not only the crude fat or crude protein percentage.

Introduce fat gradually. A sudden inclusion depresses intake in many herds, so start with a small quantity and build up over ten to fourteen days. Keep an eye on calcium supply when feeding calcium salts, since the soap ties up part of the dietary calcium.

Work out whether it pays. The question is not whether a trial somewhere recorded a response. It is whether the extra milk, fat and protein in your own tank are worth more than the supplement costs, delivered and mixed. That calculation needs redoing every time the milk price or the feed price moves.

Then watch the cows. Milk yield on its own is a poor guide. Milk fat percentage, milk protein percentage, body condition, dry matter intake, dung consistency and the return to heat all say something about whether the ration is doing its job. A fall in milk fat soon after a fat supplement is introduced usually points to the wrong source, or to too much of it.

Conclusion

Bypass protein and bypass fat are not miracle feeds, and no farmer should buy them expecting one. They are tools for directing selected nutrients past the rumen to the small intestine, and they pay only when the ration has a real shortage for them to correct. Fed to a freshly calved, high yielding cow whose basic ration is already sound, the extra amino acids and energy usually show up in the milk pail and in the body condition score. Fed to a low yielder on poor fodder, the money simply runs away. The message for the farming community is a plain one. Get the fodder right first. Then have the ration checked so that you know which nutrient is actually limiting your cows. Buy the product that corrects that particular shortage, from a supplier willing to share the profile and the digestibility figures. Bring it into the ration gradually, keep a record of milk yield and milk fat for a month, and let those numbers decide whether it earns a permanent place in the manger.

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