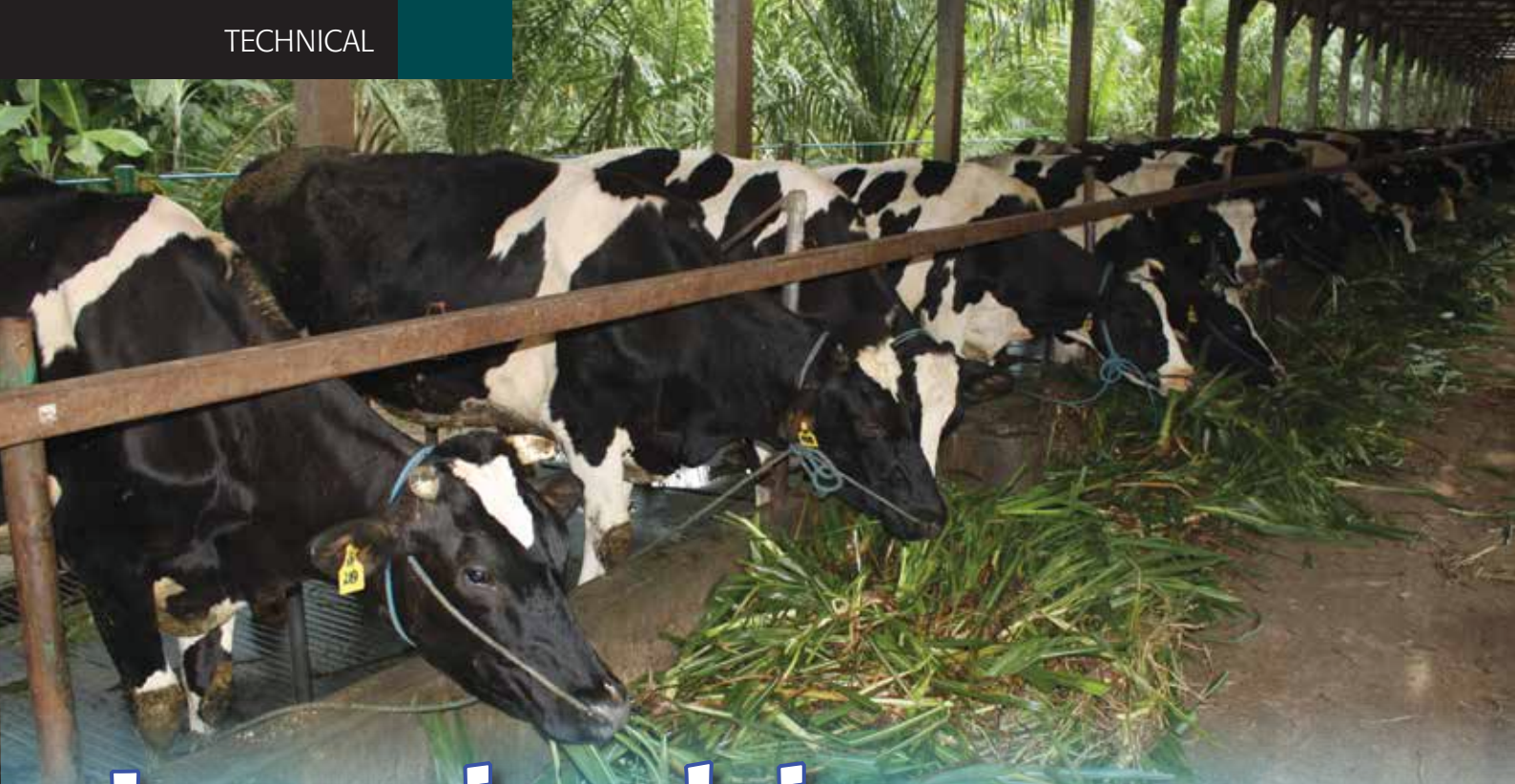

Improving dairy cow performance with rumen protected amino acids

Utilising rumen protected amino acids in feed rations permits dairy producers to better meet the specific amino acid requirements of the animal. This allows cows to reach their optimum potential for milk production and improve farm profitability, writes Dr. RAZAQ BALOGUN*.

Supplementing ruminant animals with rumen protected amino acids (RPAA) to balance amino acids is becoming widely accepted among nutritionists. This is because there is increasing evidence of their benefits in replacing expensive protein feeds, ability to lower crude protein in the diet and therefore reduce ration cost, and positive production responses, especially in dairy cows. Several reviews on the role of amino acids also suggest that apart from being a building block for tissue and milk protein, they also play other functional roles in disease mitigation, immune response and reproduction. Amino acid supplementation of dairy cows has offered more precise nutrition of protein and allows the manipulation of dairy cow diets. It is increasingly becoming necessary to minimise the environmental impact of excess nitrogen in the diet of ruminants by targeting and supplying specific amino acids that may be limiting in the diet. Methionine and lysine, respectively, are often regarded as the most limiting amino acids, and studies have shown that supplementing ruminants such as dairy cows with RPAA results in improved production responses.

Amino acids and encapsulation technology

Kemin has developed an effective encapsulation technology that combines rumen protection of the specific amino acids, lysine or methionine, and their maximum release in the small intestine for uptake and utilisation. Kemin employs a spray freeze encapsulation technology for its rumen protected

Figure 1: Electron micrograph of LysiPearl showing its stability through the gastrointestinal tract of cattle.

(A) Pre-rumen (B) Post-rumen (C) Post-digestive tract

lysine (LysiPearl) and methionine (MetiPearl). This spray freezing technology uses liquid nitrogen for solidification of a hydrogenated palmitic fatty acid matrix in which the amino acid of interest is embedded. The progressive release of amino acids from Kemin's Pearls using a proprietary in *vitro* technology is shown in Figure 1. The Pearls are still reasonably intact post rumen and were totally disintegrated at the end of the digestive tract demonstrating protection in the rumen followed by almost complete release and absorption of the amino acid in the small intestine.

The concept of metabolisable protein

Metabolisable protein (MP) is the amount of digestible protein that is absorbed in the small intestine and available to the animal for tissue and milk protein synthesis. Contrary to this, crude protein is the proximate amount or concentration of protein that is present in the diet and it is subject to various digestive changes in the gastro intestinal tract before reaching the small intestine. Therefore the amount and quality of MP in terms of amino acid profile becomes critical to the performance of a dairy cow. The concept of the 'ideal protein' for animal performance is about matching animal requirements for amino acids with supply from the diet.

Metabolisable protein consists primarily of:

(i) microbial protein (MCP), resulting from microbial degradation of degradable protein in the rumen (RDP) into ammonia and the subsequent incorporation of ammonia for microbial protein synthesis;

(ii) rumen undegraded protein (RUP) is the portion of dietary protein that escapes microbial degradation in the rumen and flows into the small intestine; and

(iii) a small amount of endogenous protein, which is from sloughed off intestinal epithelial cells.

The contributions of MCP is suggested to be around 55% for a 25 litre/day cow and decreased to 45% for a 45 litre/day cow, and it is affected by the amount of RDP and fermentable energy in the rumen. This suggests that the requirement for RUP will increase with increasing milk production. The amino acid profile of MCP is close to ideal for milk production and growth. On the other hand, the amino acid profile of dietary RUP can vary depending on the quality and digestibility of the dietary crude protein. Therefore the quality of feed proteins and their digestibility will affect the amount of MP flow and absorption in the small intestine. So both feed and animal factors will affect MP supply and therefore the performance of ruminants. If variation in the quality of RUP using targeted amino acid supply from RPAA source can be minimised, you can improve production and increase profitability of a dairy cow.

Balancing amino acids

As indicated earlier, the quality and quantity of MP can determine the performance of dairy cow. Therefore, the amount of RUP and MCP (both making up most of the MP) reaching the small intestine and their amino acid profile are important. While predicting dairy cow production using MP, it has been shown that to improve the efficiency of use of MP, there is a need to also consider the ratio of the limiting amino acids. Lysine and methionine are the two essential amino acids considered to be limiting in the diet and their concentrations are measured as a percentage in the MP (ie MP-lysine and MP-methionine). It is important to note that MP includes both essential and non-essential amino acids. Depending on the computer model used, it is suggested that the ratio of lysine to methionine should fall in the range of around 2.8 to 3.12. Table 1 shows the recommended optimal MP-lysine and MP-methionine and the ratio in various computer models available commercially. The differences in the predicted values are due to different mathematical constants applied. However, the consensus is to stick to one model and fine tune its application using field observations.

Benefits of rumen protected amino acids

The benefits of supplementing dairy cows with RPAA are well established in the literature. The ability to target specific amino acids is the biggest advantage of supplementation with RPAA as it allows predictable delivery of the targeted amino acid to the duodenum of the cow. Given the specificity required for balancing amino acids, encapsulation technology offers better and controlled manipulation of diets to achieve optimum performance.

- Increased milk production in terms of litres and milk solids have been reported in lactating dairy cows, especially in the early stage of lactation ▷

◁ when nutrient demand is high. Depending on the diet, deficiencies of limiting amino acids, usually lysine and methionine can be corrected by feeding RPAA to improve milk yield and milk components.

- Because specific amino acids are targeted, RPAA offers an opportunity to reduce the cost of feed that may not be required. For example, we can reduce the cost of protein meal by reducing the amount in the diet and allowing cheaper ingredients into the least cost formulation.
- Using conventional feedstuffs to balance amino acids is challenging and can be almost impossible because other amino acids or nutrients that are not required are also supplied, leading to an over-supply of protein and therefore inefficient utilisation of protein. By supplementing with RPAA, it is more targeted and can overcome the oversupply of proteins that are not required. This will improve the efficiency of protein utilisation and improve performance.
- If RPAA are used to balance amino acid supplies and remove unwanted protein, it creates space for other necessary nutrients to be included in the diet. For example, more starch or fibre can be incorporated into the diet.
- Removing excess protein from the diet has an environmental benefit as it reduces the excretion of nitrogen into the environment while maintaining or improving milk production. In published studies, reducing crude protein in the lactating cow diet by 1% did not have any detrimental effect on milk production.

Approaches to using RPAA

Practical use of RPAA will vary depending on the commercial situation, and nutritionists are advised to have an understanding of the local circumstances including the nutrient concentrations in the cows' diet, cows' physiological status, commodity prices and milk prices to determine the best approach to supplementing cows with RPAA.

Table 1: Recommended amino acid requirements as predicted using different nutritional models.

Dietary targets of MP lysine and MP methionine and recommended ratio			
System	Percent in Metabolisable Protein		Optimal Ratio
	Lysine	Methionine	
CNCPS			
Before v6.1	6.68	2.4	2.78
V6.1	6.97	2.53	2.75
CPM-Dairy			
V3.0.10*	7.46	2.57	2.9
NRC			
Original release#	6.8	2.29	2.97
V1.19**	6.83	2.28	3

*Whitehouse *et al.* 2009, **Whitehouse *et al.* 2013, #Schwab *et al.* 2009

On top application

This involves adding RPAA to an existing diet to meet requirement in order to increase animal performance. This is often used to bridge a deficiency of particular amino acids that are limiting production. The economic significance of this approach will depend on the prices of other feedstuffs and milk price.

Reformulation approach

This involves manipulating the diet composition, which often requires the removal or reduction of a particular feedstuff with the addition of specific RPAA. The objectives of reformulation are to reduce ration cost by removing or reducing the amount of expensive feedstuff like protein meals while maintaining or even improving performance, improving efficiency of nitrogen utilisation, and creating space for other nutrients such as starch and fibre that may be required to optimise performance.

Conclusions

The interest in precision feeding of amino acids to ruminants is increasing and the development of technologies to improve the protection of amino acids from rumen degradation is helping to stimulate this interest. Encapsulation technology has offered ruminant nutritionists flexible options of protected lysine and methionine that offers optimum protection in the rumen while maintaining maximum release and digestibility in the small intestine.

Several studies have shown the benefits of supplementing RPAA to lactating cows in terms of improving milk production by meeting specific amino acid requirement (on-top approach). Rumen protected amino acids can also be used to reformulate diet to improve the efficiency of nitrogen utilisation by reducing excess nitrogen in the diet and reducing nitrogen excretion. This often reduces ration cost and therefore can improve financial returns.

It is clear that feeding rumen protected amino acids offers the dairy farmer the opportunity to increase herd performance and profitability. It is important to note that feeding RPAA is not exclusive as its success also depends on optimising rumen function by ensuring that there is adequate rumen degradable protein and fermentable energy to drive microbial protein yield. So the take-home message is to optimise the management of feeding dairy cows and use RPAA to improve the efficiency of nitrogen utilisation and provide an opportunity to reduce ration cost and improve farm profitability. ■

*Dr. Razaq Balogun (razaq.balogun@kemin.com) is Technical Services Manager (Ruminant, Asia Pacific) for Kemin Industries. A list of references is available from the author. Certain statements may not be applicable in all geographic regions. Product labeling and associated claims may differ based upon regulatory requirements.