# Different **encapsulation techniques** lead to varying levels of nutrient bioavailability

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Encapsulated nutrients are gaining popularity and provide consistent, reliable, and cost-effective alternatives to traditional feedstuffs. This trend has led to an influx of encapsulated product into the market. As with any new product category, some are better than others. To choose the right product and get the most for your money, just ask a few simple questions.

Lipid encapsulation has proved to be a valuable tool for protecting nutrients from degradation during processing, storage and digestion and making them available for absorption by the animal. Over the last years, many new encapsulated nutrients have entered the market. These products, and the processes that create them, differ greatly in design, technology, and unfortunately, performance.

High quality encapsulated nutrients can provide nutritionists with a great deal of flexibility to improve rations while reducing costs. However, all encapsulated products are not created equal. To make the most of the ingredient investment, nutritionists, veterinarians, and producers should recognize differences between the various encapsulation technologies. This will allow users to make informed decisions about which product(s) will be most cost effective in the ration.

Lipid encapsulation is an effective rumen protection technology across a range of different nutrients. However, lipid encapsulation is a generic term and differences exist between products. These differences are due to:

- The starting form and inclusion rate of the nutrient;
- The coating system utilized; and
- The manufacturing process used to produce the lipid encapsulate.

There are two main types of lipid encapsulation technology: true encapsulation and matrix encapsulation. A matrix encapsulation suspends the active nutrient within a fatty acid matrix (Figure 1) while a true encapsulation contains a layered coating of fatty acids applied around the outside of the nutrient to form a protective barrier (Figures 1 and 2).

***An effective encapsulation must provide:***

1. Durability,
2. Rumen protection, and
3. Intestinal digestibility.

If any of these functions are compromised, then the product will fail to deliver the nutrient as intended.

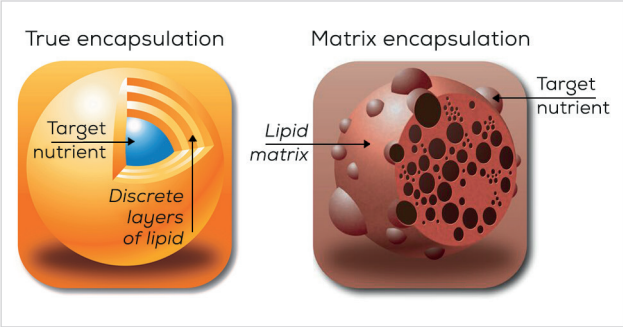


*Figure 1. Illustration showing the differences between a matrix encapsulation and a true encapsulation.*

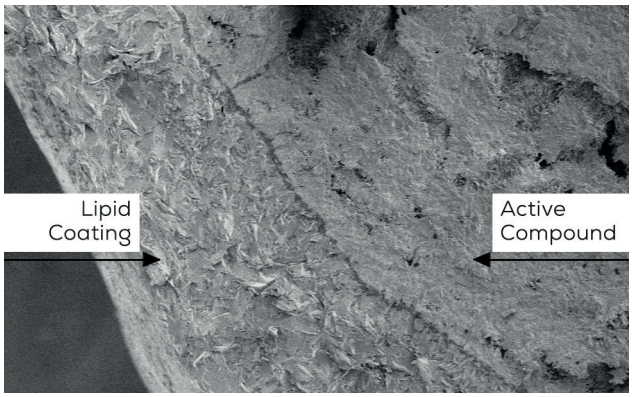


*Figure 2. Micrograph of a true encapsulated nutrient demonstrating the layers of lipid coating surrounding the outside of the active compound to create a protective barrier.*

## DURABILITY

Durability is the ability of an encapsulated nutrient to maintain integrity during handling, storage, and mixing. Abrasion of the protective coating, cracking, fracturing or particle size reduction can all reduce the amount of nutrient delivered to the animal.

Another often overlooked factor that can affect coating integrity is temperature. Lipid encapsulates are not robust enough to withstand the temperatures and pressures associated with pelleting. High temperatures designed to gelatinize starch and deliver a harder pellet will melt lipid encapsulates, adversely affecting nutrient payload protection. In addition, the pressure associated with pelleting can crack or fracture encapsulates, further degrading nutrient protection.

A less obvious and often overlooked issue is freeze-thaw stability of lipid encapsulates. When lipid encapsulates are frozen and then thawed the coating can expand and contract. The micrograph in Figure 3 demonstrates the damage that occurs to an encapsulated product's coating during a freeze/thaw cycle if the product is not designed to be stable under freezing and thawing conditions. Notice cracks that develop in the coating's surface which allows moisture and rumen microbes to enter the coating and degrade the encapsulate, thus greatly reducing the product's efficacy.


*Figure 3. Freeze/thaw damage to encapsulated product.*

This allows water to penetrate during storage or in the rumen resulting in a loss of nutrient protection. Figure 4 shows a diagram demonstrating the damage that can occur and the resultant loss in rumen protection if an encapsulated product is not designed to be freeze/thaw stable. The first two bars signify a product that is freeze/thaw stable and the last two bars signify a product that is not freeze/thaw stable. Some of the more established encapsulation companies have solved this issue.

## RUMEN PROTECTION

Rumen protection refers to the encapsulation system's ability to protect a nutrient from degradation in the rumen so that it can pass into the small intestine. Degradation rate is determined using time-release studies in either rumen fluid or water (both are highly correlated). Water tests simplify the analytical process since there is no interference from nutrients in the rumen fluid.

Figure 4. Freeze/thaw stability of encapsulated product

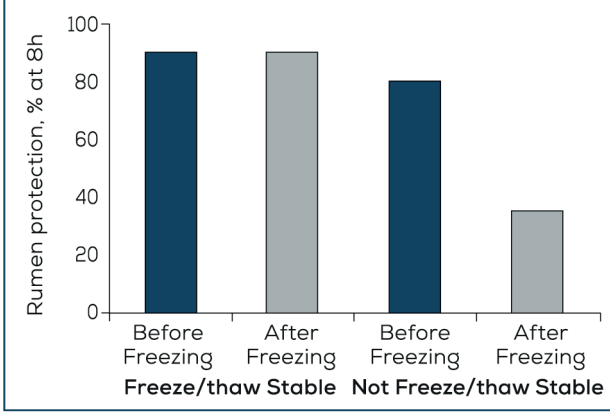


***Figure 4.*** *Freeze/thaw stability of encapsulated product.*

The key to making an efficacious encapsulation is to create a product that not only resists ruminal degradation but can then be released and digested in the small intestine.

## INTESTINAL DIGESTIBILITY

Developing an encapsulated product with a high level of durability and that resists microbial degradation in the rumen may come at the expense of intestinal digestibility. Can the product be both robust in its ability to withstand manufacturing and ruminal digestion and still have high intestinal digestibility? Yes. But only a few manufacturers have the expertise and experience to create products with all three attributes.

## BIOAVAILABILITY

Bioavailability is the sum of the previous three functions: durability, rumen protection, and intestinal digestibility and is the true measure of a quality encapsulated product. For an encapsulation technology to be truly effective, it must excel at all three functions.

## SIMPLE QUALITY TESTS

Encapsulated nutrients are gaining popularity and provide consistent, reliable, and cost-effective alternatives to traditional feedstuffs. This trend has led to an influx of encapsulated product into the market. As with any new product category, some are better than others. The ultimate measure of an encapsulated nutrient is the cost per unit of bioavailable nutrient. This is a function of the cost, durability, rumen protection and intestinal digestibility. To get the most for your money, just ask a few simple questions.

- Is the product durable enough to withstand manufacturing and storage, including freeze-thaw cycles, so that it maintains its ability to protect the nutrient in the rumen?
- Does the product deliver adequate rumen protection over a long enough period of time (approximately 5 hrs.) to ensure a high percentage of the nutrient reaches the intestine?
- Has the product been tested in vivo (in the cow) to have a bioavailability value that reflects the durability, rumen protection and intestinal absorption supported by the manufacturer's research?

Ask to see the research and quality specifications to ensure the product your considering will deliver the expected levels of bioavailable nutrient to the cow.

***About Stefano Vandoni***

*Dr. Stefano Vandoni obtained his Master's degree in Animal Nutrition and Animal Science at the University of Milan in 2003. In 2008, he obtained his PhD in Animal Nutrition and Food Safety at the Department of Veterinary Science and Technologies for Food Safety of the University of Milan, defending a dissertation on "Nutritional and technological strategies to improve beef cattle and veal calves' management". After that he continued to cooperate in the University of Milan as a Post Doc fellow till 2010, when he joined Alltech Italy as Representative Sales Manager till 2013. During these years, he was able to deepen his knowledge in ruminant nutrition, working both on business to business and directly on farm. Based on his experience and achievement, in 2014, he was promoted to Ruminant European Technical Coordinator and after one year, to Ruminant European Technical Manager.*

*Starting from April 2016, he has been working in Balchem Animal Nutrition and Health, where he is covering a position as Ruminant Technical Service Manager in Europe, Middle East and Africa and recently as Global Technical Manager for NitroShure.*