

Protein quality and kinetics

Protein quality is not only about how much protein is digested. It is also about how fast and where amino acids are released and absorbed in the small intestine. In animal nutrition, this is often described as protein kinetics.

Protein kinetics

Protein kinetics describes how quickly protein is broken down and how amino acids are absorbed in the small intestine. It explains how fast and at which place in the digestive tract protein is digested, absorbed, and enters the blood.

This is important because both the speed and the place of absorption influence how well the animal can use the protein. Normally, protein ingredients are judged by their crude protein level and amino acid digestibility. Digestibility only shows how much protein is left at the end of the small intestine. It does not show how fast the protein is digested or where absorption happens.

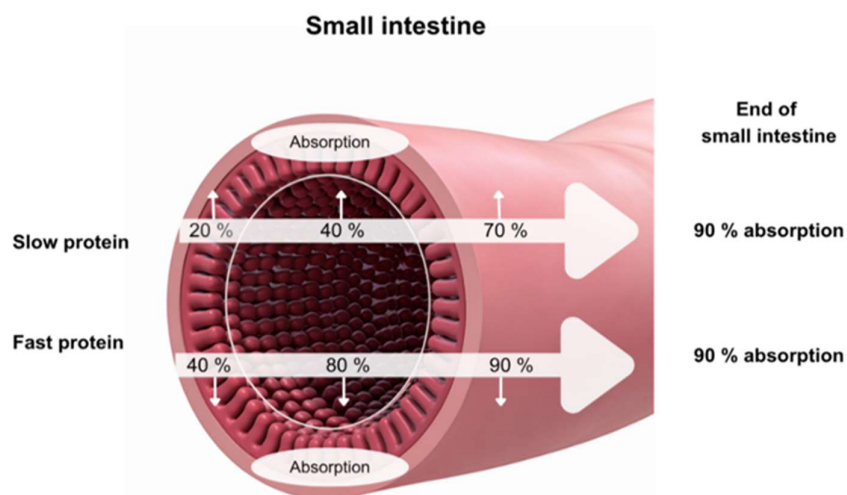


Fig1. Differences in absorption percentages between slow and fast protein in the digestive tract.

Speed of protein digestion is important

Protein digestion works best in the jejunum, the first part of the small intestine. Here, intestinal cells have enough glucose to use as energy. This allows them to absorb amino acids very efficiently. As a result, more amino acids enter the bloodstream and fewer are used as energy. Further down the intestine, in the ileum, less glucose is available. Because of this, intestinal cells use more amino acids as an energy source. This means fewer amino acids are available for growth.

After a meal, the level of insulin-like growth factor (IGF) rises quickly. IGF helps amino acids to be used for building body tissue. When protein is digested and absorbed faster, more amino acids are available at the right moment. This improves protein use, growth, and feed efficiency.

Fast proteins therefore lead to better nitrogen retention and less nitrogen loss. Protein kinetics give a better indication of protein efficiency than digestibility alone.

Fast proteins are beneficial

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Fast protein digestion means that protein is broken down early in the small intestine. This allows amino acids to be absorbed at the same time as energy from starch digestion. Good timing between energy and amino acids improves protein use and feed efficiency. Research shows that fast-digesting protein sources support better growth than slow proteins. Slow proteins are more often wasted. Kinetics of protein absorption helps categorize the protein fraction according to its speed of absorption. Four categories can be defined as very fast, fast, slow and resistant along the digestive tract. (Figure 2).

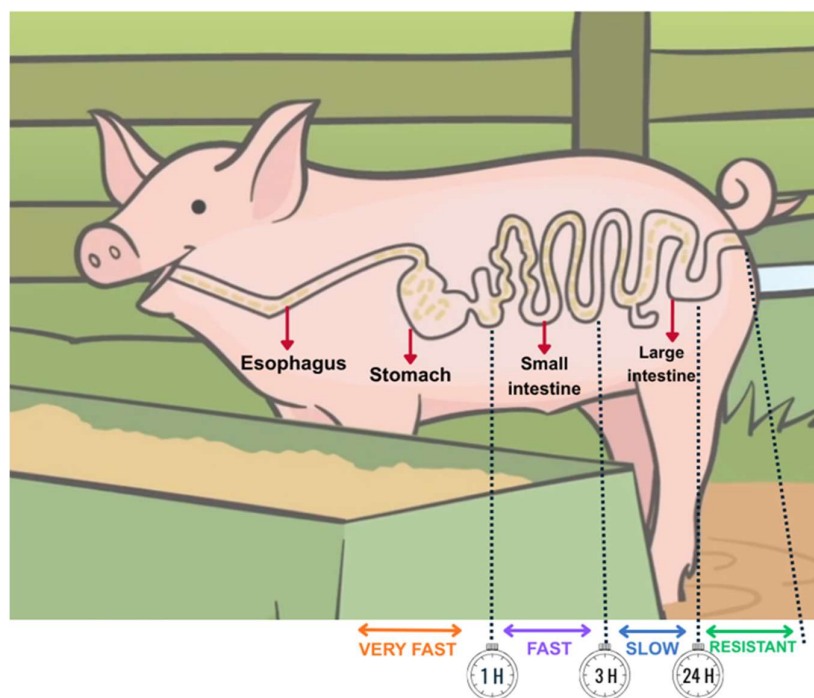


Fig. 2. Kinetics of protein absorption.

Supplying animals with very fast and fast digestible protein sources rich in free amino acids and small peptides will help them absorb and use those nutrients easily. This is particularly of interest when applied to the diets of young animals as their digestive tract is not yet mature. Young animals like piglets need a lot of protein for fast growth, but their digestion is not fully developed. Fast proteins supply amino acids more easily and support healthy development.

Measuring protein kinetics

Most of the time protein kinetics are measured in vitro. There are several in vitro assay methods available: dialysis cell method, pH-drop and pH-stat methods, immobilized digestive enzyme assay (IDEA) and computer-controlled method. These methods are employed for the evaluation of protein quality, mainly of human foods. To measure protein kinetics it is necessary to use a 2-step model to simulate the gastric and small intestinal phases.

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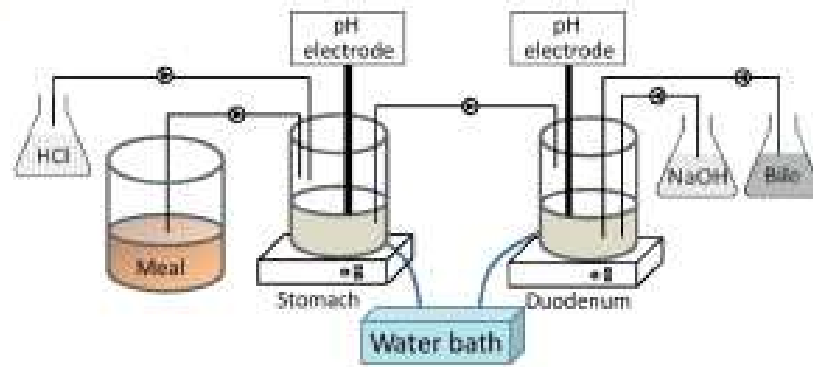


Fig. 3. Schematic view of an in vitro digestibility set-up.

Years ago Joosten - young animal nutrition developed two protein concentrates: FMR Omega 3 and JPC 56. Both products are used in feed for young animals due, among other things, to their high digestibility. In 2019, the digestibility was measured in vivo at the

University of Illinois. The crude protein digestibility was for the FMR Omega 3 96.3% and for the JPC 56 99%. Also the digestibility of the amino acids was measured and compared with South America Fishmeal. In Fig.4 the digestibility of the amino acids (SID) are shown.

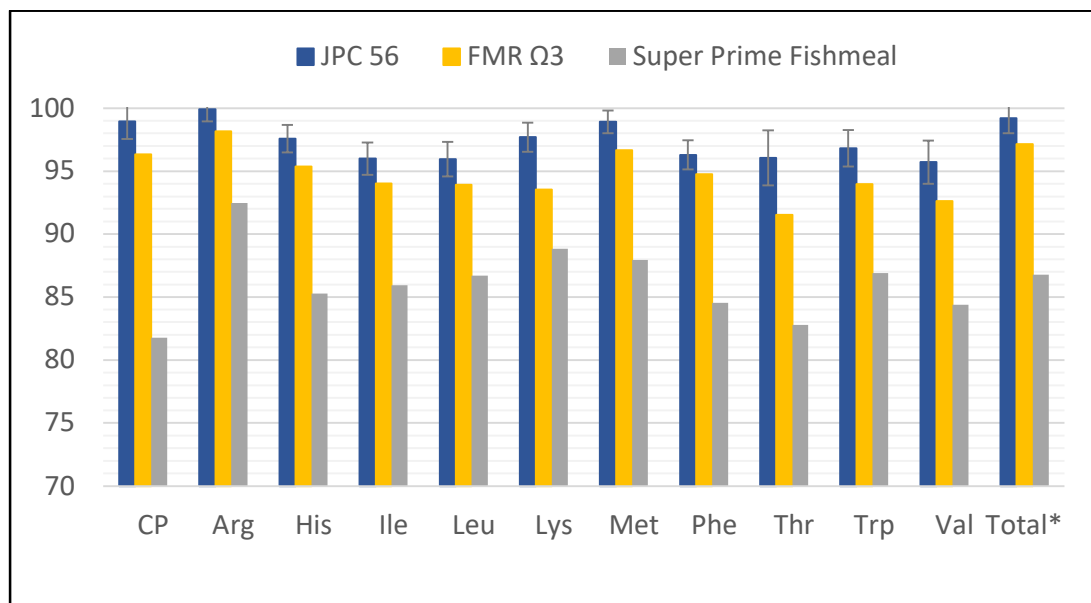


Fig. 4. Digestibility of amino acids (SID).

These digestibility values indicate that the protein kinetics of these two products are fast. However, Joosten YAN also decided to perform an in vitro trial to measure the protein kinetics.

The following in vitro method was used.

Gastric phase:

The product is treated for 1 hour at pH 3 and 39 °C with the enzyme pepsin to simulate gastric digestion.

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Small intestinal phase:

Subsequently, the pH is adjusted from pH 3 to pH 6.5. In this phase, the digestion of starch, protein, and fat is simulated by treating the sample for 2 hours at pH 6.5 and 39 °C with a mix of enzymes.

Nitrogen (N) analysis:

The dissolved fraction of the sample is considered the in vitro digested ileal protein. The digested and undigested fractions are separated by filtration. The nitrogen content is determined in the filtrate (the dissolved fraction). Using a protein conversion factor of $f = 6.25$, this is subsequently converted to protein content.

In vitro ileal protein in the study

All six submitted samples were analysed; the gastric step of 1 hour is defined as $T = 0$.

After the gastric step, an intestinal step was carried out with different hydrolysis times. This intestinal step was interrupted after the following time points:

- **T0** = 0 hours of intestinal digestion (i.e. after only 1 hour of gastric digestion)
- **T1** = 1 hour of intestinal digestion
- **T2** = 2 hours of intestinal digestion
- **T3** = 6 hours of intestinal digestion
- **T4** = 22 hours of intestinal digestion
- **T5** = 30 hours of intestinal digestion

To make a good comparison, other products were also tested in the same run. Besides the Joosten products FMR Omega 3 and JPC 56, fishmeal, soya bean meal, an enzyme-treated protein product, and a fermented protein product, both originating from Denmark, were tested. The outcome of this test is given in Figure 5.

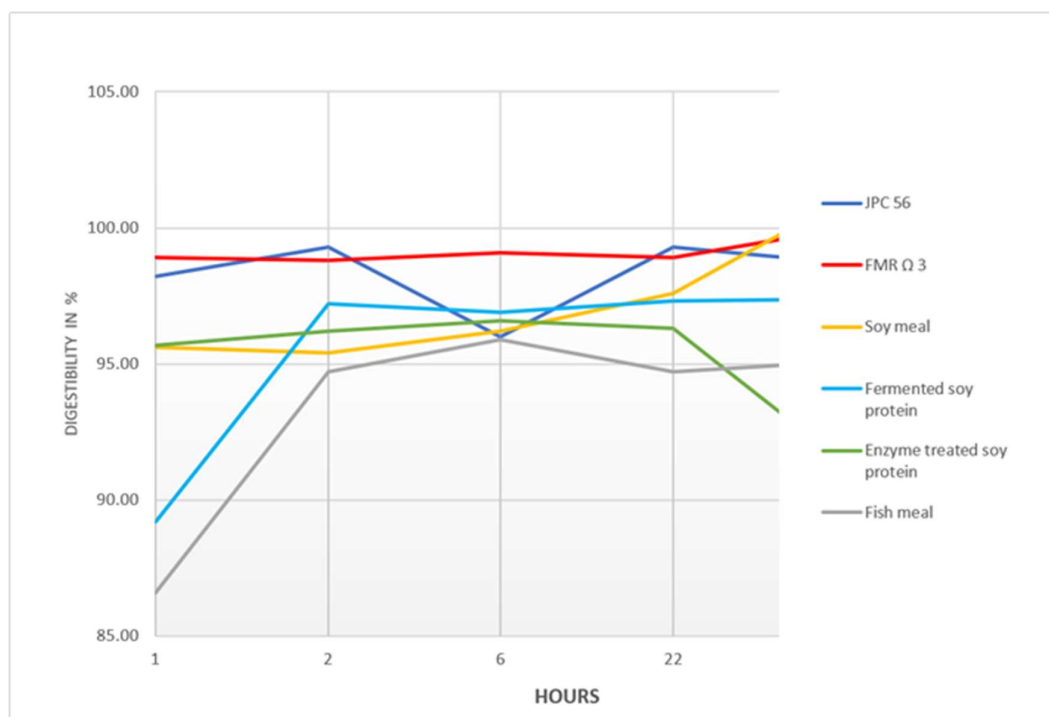


Fig. 5. In vitro ileal protein digestibility over time (%).

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In this in vitro protein digestibility and kinetics test, the Joosten protein concentrates JPC 56 and FMR Omega 3 showed the fastest protein digestion and absorption. To highlight these differences, *Table 1* presents the digestibility after one hour of digestion.

Table 1. Digestibility after one hour of gastric digestion.

Protein digestibility %	JPC 56	FMR Omega 3	Soya bean meal	Fermented soya protein	Enzyme treated soya protein	Fishmeal
	78.5	72	30.4	19.1	43.9	40

These results clearly show that JPC 56 and FMR Omega 3 are highly available protein sources that are absorbed quickly. This is especially important for young animals and animals under stress, when there is a high need for easily digestible proteins that can rapidly supply amino acids. Based on their protein digestibility and absorption kinetics, FMR Omega 3 and JPC 56 are more suitable for young animal nutrition than conventional protein sources such as soybean meal or fishmeal. They also perform better than other products that claim fast protein kinetics, such as enzyme-treated soya protein.