Nutritional value of grain legumes

Common laboratory methods under-value protein from pea, faba bean and lupin

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Legumes Translated

Systems to evaluate protein feeds for ruminants use solubility measurements as proxies for protein degradation in the rumen. Soluble protein (nitrogen, N) is assumed to be rapidly degraded in the rumen and so likely to be used inefficiently. This practice note demonstrates that this assumption is not appropriate for pea, faba bean and lupin and has led to an under-valuing of protein from these feeds. There are large discrepancies between solubility methods, as well as the lack of relationship to measured protein degradability. This insight helps farmers and the feed industry better evaluate the protein value of these alternative grain legumes. Current feed evaluation systems, based on soluble nitrogen measurements, tend to undervalue pea, faba bean and lupin in comparison with other protein sources for ruminants. New work on protein feed evaluation systems is needed since the current systems constrain the use of these grain legumes in ruminant feeding. This information provides a foundation to industry placing a higher financial value on protein in pea, faba bean and lupin.

Protein solubility is not a reliable indicator of rumen degradability

Proteins in less commonly used grain legumes, such as in pea and lupin, are highly soluble and so the in sacco (nylon bag) technique over-estimates protein degradability because protein washes out of bags irrespective of whether it is degraded. Soluble protein from lupin seeds can escape rumen degradation. Recent work with rapeseed proteins showed that soluble proteins can be adsorbed to microbial cells or taken up directly into microbial cells. Both pathways result in more undergraded protein passing from the rumen than would be predicted from protein solubility.

Dry faba bean. Photograph: iSTOCK

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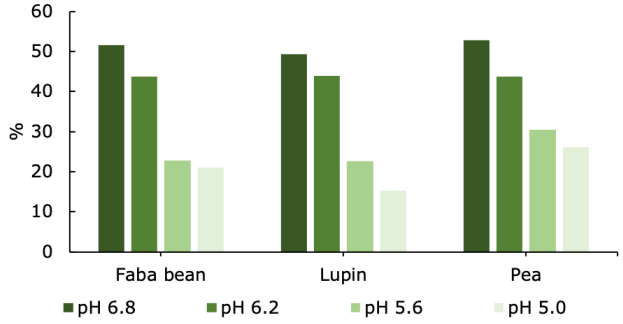

Figure 1. Measurements of N solubility (%) using buffers adjusted to different pH (de Jonge et al., 2009).

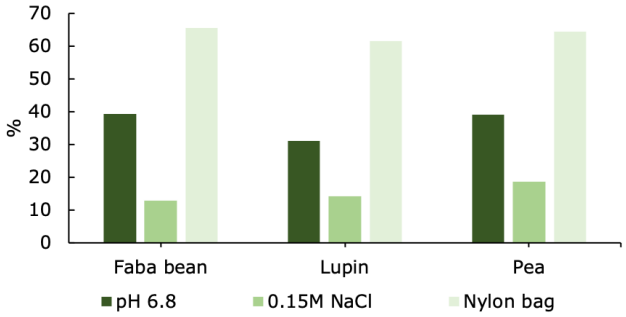

Figure 2. Estimates of N solubility (%) of grain legumes using pH 6.8 buffer, 0.15M NaCl or zero-time nylon bag incubation (Kandylis and Nikokyris, 1997).

Solubility methods produce widely divergent values for grain legumes

It has long been known that factors such as extraction time, pH, ionic strength, and temperature affect protein solubilisation and this seems to be particularly evident for grain legumes. De Jonge et al. (2009) showed that there were large effects of pH on N solubility (Figure 1), with much lower solubility at lower pH levels (5.0–5.6) that are quite common in high producing ruminants.

Given these effects, it is not surprising that there are no consistent relationships between measurements of N solubility and estimates of N degradation based on in sacco or in vitro measurements. Results from Kandylis and Nikokyris (1997; Figure 2), de Jonge et al. (2009; Figure 3) and our own results of analysis of N solubility using pH 6.8 buffer, water, or a 16-hour in vitro incubation with buffered rumen fluid (Figure 4) all confirm that N solubility methods are not an appropriate method for evaluating the nutritional value of pea, faba bean or lupin – nor for comparison with soybean meal (for which laboratory methods are more secure).

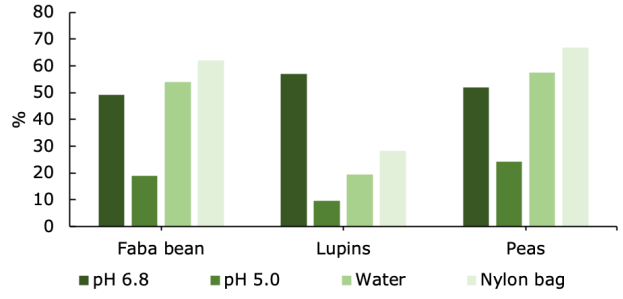

Figure 3. Estimates of N solubility (%) of grain legumes using pH 6.8 buffer, pH 5 buffer, water, or zero-time nylon bag incubation (de Jonge et al., 2009).

Key practice points

- The nylon bag technique under-estimates undegradable dietary protein (UDP) supply from grain legumes. Estimates of protein (N) degradability should not be based on in sacco (nylon bag) techniques for such highly soluble feeds.
- Significant proportions of soluble protein can pass from the rumen undegraded. This means that promising grain legumes, such as pea, bean and lupin, may have been under-valued relative to other protein sources, including soybean meal.
- Solvent characteristics, particularly pH, have a very large effect on protein (N) solubility estimates for grain legumes. Low pH (acid condition) leads to lower values for degradable protein.
- This latter effect will also occur in the rumen so that protein degradability values for grain legumes will be much less when included in diets leading to lower rumen pH (5.6 and below). This is potentially a very useful phenomenon because requirements

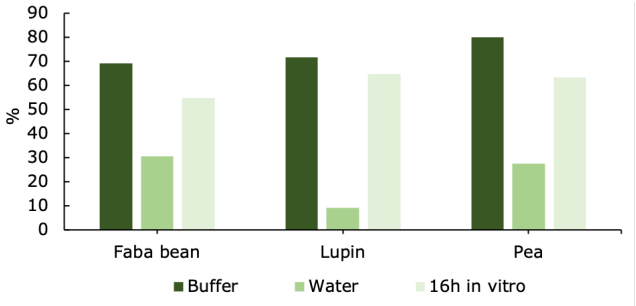

Figure 4. Estimates of N solubility (%) of grain legumes using pH 6.8 buffer, water, or 16-hour in vitro incubation (analyses commissioned in the EU Legumes Translated project).

for undegraded dietary protein are often highest in high performing ruminants that are offered higher levels of high concentrate diets, resulting in lower rumen pH. Thus, the under-estimation of protein value of grain legumes may be most pronounced when feeding the most productive ruminants.

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