

# Chemical composition, protein quality and nutritive value of commercial soya bean meals produced from beans from different countries

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**S**oya bean meal is the most important source of protein and indispensable amino acids in non-ruminant diets worldwide. The chemical composition, protein quality and nutritive value of commercial soya bean meal depend on numerous factors, including seed variety, environmental conditions during growing, harvesting and storage of the beans, and the procedure used for oil extraction.

A meta-analytical approach was taken to quantify the relationship between the country of origin of the beans (Argentina, Brazil, the United States [US] and India) and the chemical composition, protein quality, and nutritive value of soya bean meal. The data set used was obtained from 18 published papers from 2002 to 2018, which included a total of 1 944 soya bean meal samples. The data was analysed using a mixed model with country of origin of the beans as a fixed effect and the study as a random effect.

The origin of the beans had consistent and significant effects on most of the chemical variables of the corresponding soya bean meal. The Brazilian soya bean meal had more crude protein (CP), neutral detergent fibre (NDF), raffinose and iron but less sucrose, stachyose and K contents than the US or Argentinian soya bean meals ( $P < 0,05$ ). Per unit of protein, lysine, methionine, threonine and cysteine concentrations were greater for the US and Argentinian meals than for the Brazilian and Indian meals ( $P < 0,05$ ).

The protein dispersibility index (PDI), KOH solubility (KOH) and trypsin inhibitor activity (TIA) were lower for the Brazilian and Argentinian meals than for the US and Indian meals ( $P < 0,05$ ). TIA was

positively correlated with PDI ( $r = 0,712$ ;  $P < 0,001$ ) and KOH ( $r = 0,886$ ;  $P < 0,001$ ). Also, a significant relation was observed between PDI and KOH ( $r = 0,614$ ;  $P = 0,001$ ). Urease activity, however, was not correlated with any of the protein quality traits studied. Within the range of CP values (418 to 500g/kg) studied, a decrease in crude fibre increased ( $P < 0,01$ ) the CP content of the soya bean meal.

**When formulating feed, most feed mill managers and nutritionists use a matrix for soya bean meals based on its CP content, which is independent of other characteristics of the beans.**

The country of origin of the beans affected the chemical composition and nutritive value of the soya bean meal. Consequently, matrices with different nutrient compositions should be used for soya bean meals of different origins in the formulation of diets for non-ruminant animals.

### Importance of geographical region

Soya bean meal is the most common protein source in non-ruminant diets, with the US, Brazil, Argentina and India being the most important exporting countries. When formulating feed, most feed mill managers and nutritionists use a matrix for soya bean meals based on its CP content, which is independent of other characteristics of the beans.

Westgate *et al.* (2000) and Karr-Lilienthal *et al.* (2004), however, reported that factors such as bean genotype, type of soil, environmental conditions during growing, harvesting seasons and storage affect the proximal analyses of soya beans. Moreover, the geographical area of production of the soya beans might affect the protein quality and nutrient content of the corresponding soya bean meal (Grieshop *et al.*, 2003; Ravindran *et al.*, 2014; García-Rebollar *et al.*, 2016; Lagos and Stein, 2017).

The feed compound industry, however, has paid little attention to the influence of the country of origin of the beans on the chemical composition, amino acid profile and protein quality of the soya bean meal (Pfarr *et al.*, 2018).

### Evaluating the protein fraction

Trypsin inhibitors (TI) are the most important group of antinutritional factors (ANF) present in raw beans. These ANF are inactivated by heat, which allows the use of increased levels of soya bean meal in animal feeding. Excess heat, however, increases the incidence of Maillard reactions, which reduces the digestibility of lysine and other amino acids and the nutritive value of the soya bean meal (Fontaine *et al.*, 2007; González-Vega *et al.*, 2011).

As the analyses of TI and Maillard reactions are tedious, time consuming and expensive, indirect methods such as urease activity (UA), PDI and protein solubility in KOH are preferred by the industry to indirectly evaluate the quality of the soya bean meal's protein fraction. It is important to note, however, that urea is not an ANF in pigs and poultry; in fact, its

presence in soya bean meal does not affect animal productivity.

However, urease, an enzyme present in raw beans, is inactivated by heat at a rate that resembles that of TI (Balloun, 1980; Waldroup *et al.*, 1985). Consequently, high UA values are indicative of under-processing and an excess of TI remaining in the meal. UA does not have negative values and, consequently, values close to zero might indicate either adequate processing or overcooking of the meal.

Because of its low cost, however, UA is the method preferred by the soya bean crushing industry to evaluate the quality of the soya bean meal's protein fraction. The PDI and KOH methods are used to estimate the solubility of the soya bean meal's protein fraction and, indirectly, its denaturation – high values are indicative of under-processing and low values of over-processing of the meal (Araba and Dale, 1990; Parsons *et al.*, 1991; Serrano *et al.*, 2013).

### Meta-analysis approach

The meta-analysis procedure is used as a statistical tool to compare the chemical composition and nutritive

value of any particular ingredient. The technique combines data from independent studies conducted under variable conditions and allows the statistical analysis of published data with greater analytical power (St-Pierre, 2001; Sauvant *et al.*, 2008). Consequently, the meta-analysis approach facilitates the transformation of research results into applicable knowledge by taking into account the unavoidable heterogeneity among studies.

The research reported herein studied the influence of the origin of the beans (Argentina, Brazil, the US and India) on the chemical composition, protein quality and nutritive value of commercial soya bean meals collected from 18 independent published papers, using the metanalytical approach.

### Conclusions of the study

The country of origin of the beans affects the chemical composition, protein quality and nutritive value of the corresponding meals. On average, Brazilian meals had more CP, NDF and raffinose than the Argentinian and US meals, whereas the Indian meals show the highest ash, raffinose and NDF content. US meals had more sucrose and stachyose but less raffinose and more

indispensable amino acids per unit of protein than Brazilian and Indian meals, with Argentinian meal being intermediate. The US soya bean meal had higher TIA, KOH solubility and PDI than the Argentinian and Brazilian soya bean meals.

Data from the meta-analysis suggests that the chemical composition, protein quality and nutritive value of soya bean meals depend on the country of origin of the bean.

The information provided suggests that the range of PDI, KOH and TIA values recommended by the industry to evaluate the quality of the protein fraction of commercial meals of different origins should be considered very carefully. Despite its lower CP content, the energy content for poultry and swine was similar or even higher in the soya bean meal from the US than the soya bean meal from Brazil, suggesting higher protein digestibility of the US meals.

TIA was positively correlated with PDI and KOH. No correlations were found between UA and any of the other protein quality indicators studied, confirming that UA values are not an accurate prediction of the quality of the protein fraction of soya bean meals currently available in the market.

Data from the meta-analysis suggests that the chemical composition, protein quality and nutritive value of soya bean meals depend on the country of origin of the bean. Consequently, different matrices should be used in feed formulations for commercial soya bean meals obtained from beans of different origins. 🌱

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