Review of the nutrient content of Australian feed ingredients: Development of an Australian feed ingredient database

by Dr Amy F Moss
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Foreword

In Australia, feed represents the primary cost of chicken meat production. Formulation of cost-effective diets that meet nutritional requirements is critical and therefore, being able to accurately determine these specifications of feed ingredients requires considerable accuracy.

The compilation of a database of feed ingredients will primarily assist Australian meat chicken nutritionists in diet formulation. It will also be a useful resource to other members of the Australian poultry industry and poultry researchers.

The database is a compilation of the 42 most common Australian feed ingredients. An important observation from the project was that the variability of Australian feed ingredients was relatively high and this is likely to be attributed to different growing conditions across the continent including spatial and climatic variability along with differing cultivars. Understanding the origin of the feed will be important in accurately formulating diets for each stage of the chickens development. As the industry understands more and more about the exact specifications to achieve optimal Feed Conversion Ratios, having an accurate database is essential. The database is available for download here [www.agrifutures.com.au/Australian-feed-ingredients](http://www.agrifutures.com.au/Australian-feed-ingredients). The Australian Industry will benefit from this collated information as an important reference document when formulating diets for meat chickens.

This report for the AgriFutures Chicken Meat Program is an addition to AgriFutures Australia’s diverse range of research publications and it forms part of our Growing Profitability arena, which aims to enhance the profitability and sustainability of our levied rural industries.

Most of AgriFutures Australia’s publications are available for viewing, free downloading or purchasing online at: [www.agrifutures.com.au](http://www.agrifutures.com.au)

John Smith
General Manager, Research
AgriFutures Australia
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Executive summary

Recent Australian and global feed ingredient data for commonly used Australian feed ingredients has been compiled to help Australian broiler integrator nutritionists achieve more precise diet formulation, improve production efficiency, and reduce safety margins and feed costs.

This database has been compiled to assist Australian broiler nutritionists in diet formulation and as a helpful resource to the Australian poultry industry and poultry researchers. The database is available as a PDF via agrifutures.com.au/Australian-feed-ingredients.

Background

Feed represents the primary cost of broiler production, and the formulation of cost-effective diets that meet broiler nutritional requirements is critical. To ensure this objective is met, nutrient specifications of feed ingredients must be accurately determined. Due to the tight time constraints and fast pace of the industry, feed ingredients delivered to the feed mill are unable to be analysed via wet chemistry. Consequently, Near Infrared (NIR) calibrations are often used in integrated operations to estimate the nutrient composition of feedstuffs. However, these readings often end up being received as ‘historical’ data as it can be some time before they reach the nutritionist and due to practical constraints, consultant nutritionists may not have access to NIR and must rely on book values. For these reasons, Australian broiler nutritionists have expressed concern about the many nutrient specification databases with dated information or that lack Australian-specific data.

Aims/objectives

The primary objective of this database is to help Australian broiler nutritionists in diet formulation; however, the database should also be useful to other industry members and poultry researchers.

Methods used

Integrated industry nutritionists were consulted to determine the key nutrients and ingredients of interest. Data were sourced and compiled from 12 companies/databases, and further data were sourced from journal articles and published open access databases. Recent Australian and global data (in the past five years) were collected for 42 ingredients, with 102 nutrient specifications per ingredient, where all data were available. Information from the literature was sought for missing data. The mean value, sample number, standard deviation, and sample size required to predict the mean value for each nutrient specification to 90 and 95% accuracy were also collected and calculated.

Results and Recommendations

A database was constructed containing recent Australian and global data on 42 common Australian feed ingredients. One of the main observations is that the standard deviation or variability of the Australian data was quite high, particularly in relation to the global data. While we have some excellent data, it is clear that our vast continent brings challenges in consistency as the wide variation of environments, climates, growing methods, cultivars, etc. all likely contribute to this variation. This is problematic because the Australian data is almost as variable as the global data, but contains a fraction of the number of samples. Thus, the accuracy of predicting the true mean of the population is poor for many ingredient nutrient specifications. However, the present data may be quickly enhanced by ensuring all data provided presents the number of samples or standard deviation, which is critical for assessing the extent of variation in our feed ingredients and, thus, the level of uncertainty in diet formulations.
There are three key recommendations from this project:

i) Increase the amount of recent Australian nutrient data, where possible. In particular, areas of high variation, lacking mean values or standard deviations include non-starch polysaccharide measurements, minerals (particularly digestible calcium), digestible amino acids and starch (in some cereals, such as triticale, sorghum, corn, oats).

ii) Focus strongly on improving our sampling methodology and reporting practices in industry and research to ensure an accurate representation of the nutrient content and variability in Australian feed ingredients.

iii) Continue to capture new data (with mean, sample number and standard deviation) and progressively backfill older data (and add missing descriptive data, where possible) to make it more robust so that this resource can continue to compile and deliver relevant information to nutritionists and researchers.

Implications for relevant stakeholders

The objective of this project was to directly address the expressed need from broiler integrator nutritionists to compile and assess recent nutrient specifications. By compiling and assessing the variation in current Australian and global feed ingredient nutrient specifications, it is clear that some lack recent Australian data, particularly sample numbers and standard deviations. Thus, not only does this project deliver a useful resource for Australian poultry nutritionists, industry and researchers, it shows where focus should be placed. However, to be useful to industry in the long term, it is essential that the database continues to expand and be regularly updated, so it can provide relevant information and highlight areas for further research or change.
Introduction

Feed represents the primary cost of broiler production, consequently the formulation of cost-effective diets that meet broiler nutritional requirements is critical. To ensure this objective is met, nutrient specifications of feed ingredients must be accurately determined. Due to the tight time constraints and fast pace of the industry, feed ingredients delivered to the feed mill are unable to be analysed via wet chemistry. Consequently, NIR calibrations are often used in integrated operations to estimate the nutrient composition of feedstuffs. However, these readings often end up as ‘historical’ data because it can be up to a month before they reach the nutritionist, As a result they are not available at the time of diet formulation and in addition consultant nutritionists often do not have access to NIR and must rely on book values. As such Australian broiler nutritionists have expressed concern because many nutrient specification databases contain dated information or lack Australian specific data.

Variability and uncertainty in feed ingredient specifications is a challenge for the poultry industry as wider safety margins must be applied to formulations to ensure the minimum nutrient requirements of poultry are met. However, increasing safety margins raises diet cost, which compromises profitability. Therefore, improving the certainty of the specifications used for dietary ingredients will reduce diet cost. Additionally, it has been shown that the normal amount of variation in poultry diets may lead to practical problems. A 10,000 observation simulation of the non-phytate phosphorus (NPP) content of feed formulated to a ‘minimum’ 0.45% NPP level by Pesti et al. (2020) reveals that due to the sum of the variation in the ingredient NPP content, the actual dietary level may range anywhere from 0.25% to 0.69%. It was calculated that the variation found in a practical broiler diet is enough that 12.9% are expected to have less than 0.40% NPP, and 12.8% are expected to have more than 0.50% NPP. Thus, the normal levels of variation within industry may be enough to induce leg issues, such as phosphorus rickets or tibial dyschondroplasia. Finally, nutritionists use databases that come from various sources; however, cross-checking all figures in a database is tedious and costly, and the determination and use of some nutrients have been constantly evolving.

A compilation and review of recent Australian and global feed ingredient data for commonly used Australian feed ingredients will help Australian broiler integrator nutritionists achieve more precise diet formulation and improve production efficiency, and reduce safety margins and feed costs.
Objectives

The prime objective of this project is to directly address the expressed need from broiler integrator nutritionists to compile and review recent nutrient specifications provided by source companies, including Adisseo, Ajinomoto, Cootamundra Oilseeds, DuPont, Evonik, Poultry Hub, Novus, Premier Nutrition, and RCI. Data obtained and included in the database, and assessment were from open access databases Feed Grain Partnership, Brazilian Tables, Feedipedia, and INRA. Furthermore, this compilation compares Australian and global data on feed ingredients to determine the extent of variation and identify areas that are particularly lacking sufficient Australian data. By compiling and assessing the variation in current Australian and global feed ingredient nutrient specifications, nutritionists may improve the accuracy of their formulations. Source companies and researchers may be aware of nutrients and ingredients where recent data is lacking.

This database will be presented ‘in print’ PDF version and has the potential for a web-based app to facilitate broader use of the database throughout industry. The long-term objective of this project is to continue building on the present version of the database to create a strong nutrition resource spanning multiple years of data for Australian industry and researchers.
Methodology

This project compiled recent Australian and global data into a database of nutrient specifications for commonly used feed ingredients in the Australian poultry industry. Initially, integrated Australian broiler nutritionists were consulted to identify the most common feed ingredients and key nutrients for consideration in the database. All nine nutritionists surveyed rated information on digestible P, digestible Ca, and fibre (all fractions) as important because of the lack of data for these specifications.

Following the determination of the feed ingredients and nutrients of interest, data were sourced and compiled from 12 companies/databases, and further data were sourced from journal articles and published open-access databases. Data were collected for 42 ingredients, with 102 nutrient specifications per ingredient, where all data were available. Most data are recent (in the past five years), except for some older data where information was lacking. The mean value, sample number (N) and standard deviation (SD) was collected for each nutrient specification. From these data, the overall mean, total sample number, and average standard deviation reported was calculated for both Australian data and global data. The sample size required to predict the mean value for each nutrient specification to 90 and 95% accuracy was also calculated. The sample size required for an accurate estimation of the mean of a population was determined from the standard deviation from the dataset – the ‘sub population’:

\[ N = \left( \frac{Z \times SD}{E} \right)^2 \]

Where: N is the sample size; Z, or Z-score = 1.96; SD is standard deviation, which is the average calculated from the dataset; and E, the margin of error, is calculated as +/- 5 and 10 percentage units. For example, if dry matter = 884 g/kg = 88.4%, a margin of error of 1 percentage unit is equal to 0.884.

Further calculations used in the database are described below.

Net energy was calculated from the following equation (Choct 2019) in all databases that contained the information required:

\[ NE \ (MJ/kg) = 0.808 \times AMEn \ (MJ/kg) - 0.017 \times CP \ (%) + 0.031 \times EE \ (%) \]

Where: NE is net energy (MJ/kg); AMEn is nitrogen-corrected apparent metabolisable energy (MJ/kg); CP is crude protein (%); and EE is ether extract (%).

Phytate was calculated from the following equation in all databases that measured the amount of phytate-P in feedstuffs:

\[ \text{Phytate} \ (g/kg) = 3.546 \times \text{Phytate-P} \ (g/kg) \]

This equation is derived from the fact that the atomic mass of phytate divided by the atomic mass of phytate-P (6 phosphorus atoms) is equal to 3.546. Thus, the proportion of phytate in a diet is 3.546 times the proportion of phytate-P in the diet.
Variation in the database

There are substantially more global samples than Australian samples in the database. Comparatively, the number of samples for some Australian ingredients is quite low. For example, Figure 1 shows the mean number of samples reported in the database for Australian and global data, for each ingredient containing crude protein (35 ingredients). The average number of Australian samples is 135 per ingredient, with 18 out of 35 ingredients having less than 5 samples contributing to this mean.

![Figure 1: Total sample number of 35 feed ingredients for Australian (dark grey) and global (light grey) data.](image)

Being a relatively small percentage of the global population, Australia is bound to have a fraction of the samples compared to global data. However, compared to global samples, the standard deviation of Australian samples is remarkably high (Figure 2). This highlights the challenge of our vast continent – with a wide variation of environments, climates, growing methods, cultivars, etc., the variation in our feed ingredients is quite large.

The sample size needed to predict the mean value for each nutrient specification to 90 and 95% accuracy was calculated and presented in the database. From these calculations, it is evident that many of the feed ingredients lack enough data to predict the mean with a high level of confidence. Overall, only 13% of the Australian data compiled meets the sample number required to accurately predict the mean value within 90% accuracy, compared to 40% of global data within 90% accuracy of predicting the true mean. Thus, despite being a relatively small industry in a global context, the Australian poultry industry must work particularly hard to enhance its sample numbers to ensure our recent Australian data is accurate.

Perhaps another issue contributing to the variability calculated in the database is the lack of reporting of sample numbers and standard deviation in source data. While the mean values and numbers of samples of some Australian ingredients in source databases appear quite respectable, it is impossible to calculate the actual accuracy of the predicted mean value because no standard deviation or spread of the data is reported. The importance of the standard deviation of a feed ingredient may not be appreciated to its full extent. For example, it has been shown that the normal amount of variation in poultry diets may lead to practical problems. A 10,000 observation simulation of the non-phytate phosphorus (NPP) content of feed formulated to a ‘minimum’ 0.45% NPP level by Pesti et al. (2020)
reveals that due to the sum of the variation in the ingredient NPP content, the actual dietary level might range anywhere from 0.25% to 0.69%. It was calculated that the variation found in a practical broiler diet is enough that 12.9% are expected to have less than 0.40% NPP, and 12.8% are expected to have more than 0.50% NPP. Thus, the normal levels of variation within the industry may be enough to induce leg issues, such as phosphorus rickets. Additionally, a firm understanding of the typical spread and shape of the bell curve for a nutrient specification of a feed ingredient will enable the stochastic formulation of diets for poultry, which permits nutritionists to select the risk level they wish to accept that the diet will not meet the entered requirement. This removes the need for and uncertainty surrounding safety margins.

**Figure 2:** Mean standard deviation reported in source data (g/kg) of 35 feed ingredients for Australian (dark grey) and global (light grey) data.
Recommendations

While we have robust recent data for some nutrients and ingredients, we need greater focus on determining the nutritive value of feed ingredients to produce more reliable estimates for the mean nutrient content of recent Australian data because variation in these ingredients is relatively large. However, the current data may be quickly enhanced by ensuring all data provided by source companies presents the number of samples or standard deviation — this is critical to assess the extent of variation in our feed ingredients and the level of uncertainty in diet formulations. Thus, the quality of data could be vastly improved by simply reinforcing the importance of this information for industry practice.

There are three key recommendations from this project:

i) Increase the amount of recent Australian nutrient data, where possible. In particular, areas of high variation or that lack mean values or standard deviations include non-starch polysaccharide measurement, minerals (particularly digestible calcium), digestible amino acids and starch (in some cereals such as triticale, sorghum, corn, oats).

ii) Focus strongly on improving our sampling methodology and reporting practices in industry and research to ensure an accurate representation of the nutrient content and variability in Australian feed ingredients. Mean, sample number and standard deviation or coefficient of variation should always be reported in nutrient composition of feed ingredient databases as well as the sampling methodology used.

iii) Continue to capture new data (with mean, sample number and standard deviation) and progressively backfill older data (and add missing descriptive data, where possible) to build on the robustness of this database so that this resource continues to compile and deliver relevant information to nutritionists and researchers. This compilation should continue to highlight the importance of the variation or spread of data when considering nutrient values during formulation, to ensure the sampling methodology and reporting is improved in practice, which may allow future stochastic formulation of Australian poultry diets.
Figure 3: Example of the sample number requirements reported in the database for Australian and global wheat nutrient specifications: proximates and NSP.
Figure 4: Example of the sample number requirements reported in the database for Australian and global wheat nutrient specifications: minerals and amino acids.
Implications

The objective of this project was to directly address the expressed need from broiler integrator nutritionists for a compilation and assessment of recent nutrient specifications. By compiling and assessing the variation in current Australian and global feed ingredient nutrient specifications, it has become clear that some areas lack recent Australian data, particularly sample numbers and standard deviations. Thus, not only does this project deliver a useful resource for Australian poultry nutritionists, industry and researchers, it also shows where effort should be focused. However, to be useful to industry in the long term, it is essential that the database is regularly updated and continues to expand, so that it can continue to provide relevant information and to highlight areas for likely further research or change.
References


Database open access data


### Database source company contacts

The authors are extremely grateful for the provision of this data by the companies listed in the database. For more details and information, contact the company representatives.

<table>
<thead>
<tr>
<th>Company</th>
<th>Representative</th>
<th>Contact details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adisseo</td>
<td>Dr Lihong Zhang</td>
<td>NIR &amp; Analytical Services Specialist <a href="mailto:lihong.zhang@adisseo.com">lihong.zhang@adisseo.com</a>; T +65 6595 1694</td>
</tr>
<tr>
<td>Ajinomoto Animal Nutrition Europe</td>
<td>William Lambert</td>
<td>Scientific Coordinator, Innovation and Customer Success Department</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:Lambert_William@eli.ajinomoto.com">Lambert_William@eli.ajinomoto.com</a>; T +33 0 1 4440 1216; M +33 0 6 7104 3237</td>
</tr>
<tr>
<td>Cootamundra Oilseeds</td>
<td>Suzanne Dicks</td>
<td>Senior Administrator-Office Manager</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:suzanne@oilseeds.com.au">suzanne@oilseeds.com.au</a>; T +61 2 6942 1311; M +61 4 4758 4211; F +61 2 6942 4862</td>
</tr>
<tr>
<td>DuPont Nutrition and Biosciences</td>
<td>Ceinwen Evans</td>
<td>Senior Global Technical Services Manager</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:Ceinwen.Evans@dupont.com">Ceinwen.Evans@dupont.com</a></td>
</tr>
<tr>
<td>Evonik Australia</td>
<td>Amy Liu</td>
<td>Senior Business Manager, Nutrition &amp; Care</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:amy.liu@evonik.com">amy.liu@evonik.com</a>; T +61 3 8581 8408; M +61 433 674 651; F +61 3 9544-5002</td>
</tr>
<tr>
<td>Feedipedia, INRA</td>
<td>Valérie Heuzé</td>
<td>Project manager, Association française de zootechnie (AFZ)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:valerie.heuze@zootechnie.fr">valerie.heuze@zootechnie.fr</a></td>
</tr>
<tr>
<td>Novus International (Australia)</td>
<td>Matthew Bekker</td>
<td>Technical Manager, Oceania</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:Matthew.Bekker@novusint.com">Matthew.Bekker@novusint.com</a>; M +61 4 1142 8909</td>
</tr>
<tr>
<td>NSP database, Poultry Hub</td>
<td>Dr Natalie Morgan</td>
<td>Research Fellow Poultry Nutrition</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:nmorga20@une.edu.au">nmorga20@une.edu.au</a>; T +61 2 6773 5829; M +61 4 8464 9526</td>
</tr>
<tr>
<td>Premier Nutrition</td>
<td>Mick Hazzledine</td>
<td>Pig Product Director</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:m.hazzledine@premiernutrition.co.uk">m.hazzledine@premiernutrition.co.uk</a>; T +44 0 77 1253 1891</td>
</tr>
<tr>
<td>RCI</td>
<td>Amy Graetz</td>
<td>Sales – Monogastric</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:sales@rci.com.au">sales@rci.com.au</a>; T +61 2 9667 0700; M +61 4 8467 2758; F +61 2 9669 0430</td>
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</tbody>
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AgriFutures Australia
Building 007
Tooma Way
Charles Sturt University
Locked Bag 588
Wagga Wagga NSW 2650

02 6923 6900
info@agrifutures.com.au

@AgriFuturesAU
agrifutures.com.au

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