DETERMINANTS OF QUALITY IN SOYBEAN MEAL AND ITS RELATIONSHIPS TO FEED PERFORMANCE

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Presented at the

INTERNATIONAL CONFERENCE ON ANIMAL NUTRITION 2003

3-5 March 2003 Hotel Putra Jaya Marriott,
Kuala Lumpur, Malaysia

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Abstract

The quality of soybean meal is usually determined by measuring its protein, crude fiber and moisture content. Urease activity and KOH Protein Solubility (KOHPS) is used to determine whether the soybean meal is optimally processed. Recently Protein Dispersibility Index (PDI) was suggested as a better indicator for optimum processing. In vitro/vivo digestibility has been recommended as an indicator of amino acid availability. However recent studies has shown that the actual performance of various soybean meals in non-ruminant feeding can vary substantially despite having similar proximate analysis, urease activity, KOHPS and digestibility. Other studies on various feed stuffs has also shown that available nutrients especially certain amino acids such as lysine and cystine can be much lower than indicated by digestible nutrients.

The challenge is to find analysis methods that can accurately predict the actual performance of the soybean meal in animal feeding.

Introduction

Soybean meal is used as a protein source in animal feed. It is usually traded as a commodity in the feed industry based on specifications listed in the table 1. Protein, fat, fiber, moisture, urease activity, trypsin inhibitor and protein solubility as well as in vitro and in vivo digestibility are used for determining the quality of soybean meal.

Table 1: Trading specifications for Soybean Meal

Parameters	Percent composition	
	Non-dehulled	Dehulled
Protein, %	42.5 – 44.0	46.5 – 48.0
Moisture, %	12.0 – 12.5	12.0 – 12.5
Fiber, %	7.0 max	3.5 max
Delta pH	< 0.2	< 0.2
KOHPS, %	>72.0%	> 72.0

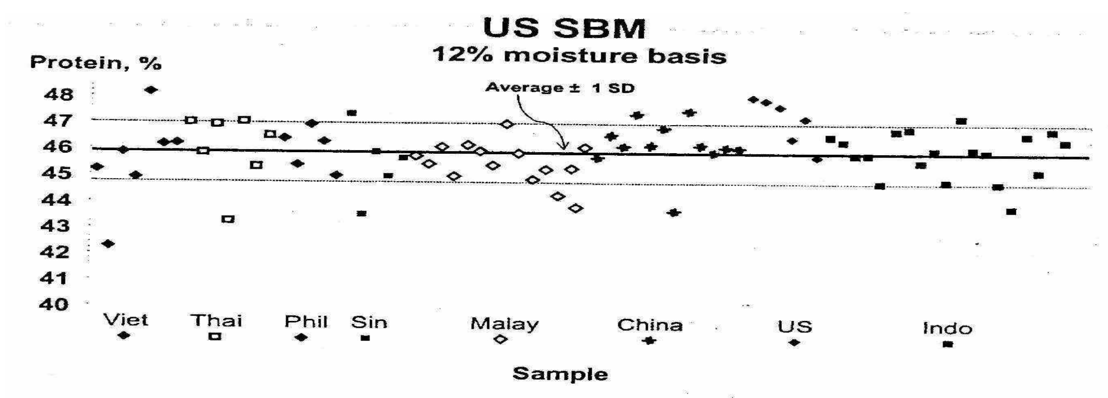
Soybean meal quality is dependent on proper processing. Over processing can reduce both the digestibility and the availability of amino acids especially lysine and cystine. The reduction in protein quality is due to the combination of the destruction of these amino acids and the reduced availability of those amino acids that is not destroyed. Under processing can leave intact anti nutritional factors such as protease inhibitors which will cause moderate to severe growth depression.

Quality Determinants

Crude protein is the nitrogen content of the soybean meal multiplied by a factor of 6.25. Several methods are used to determine nitrogen content in the feed. The commonly use method is Kjeldahl. However this method provides inconsistent protein results as shown by the protein collaborative study carried out by American Soybean Association in 1998 in figure 1. The results show that protein results can vary from 42% to 48% using the Kjeldahl method from laboratory to laboratory. Another accepted method is Nitrogen Combustion or Dumas method. This method is accurate but the initial investment in equipment is high. Table 2 shows that the combustion method frequently gives higher readings than the Kjeldahl method.

Figure 1: Variation in crude protein analysis from different laboratories.

Table 2. Comparison of crude protein determination by Kjeldahl and Nitrogen



Combustion (Soon Soon Oilmills unpublished data)

Sample marks	Protein %	
	By Kjeldahl	By Combustion
Raw Soybean	35.2	35.9
Non dehulled SBM	43.7	44.7
Dehulled SBM	46.6	47.8

Protein Dispersibility Index (PDI) was recently suggested as a better method for distinguishing the quality of soybean meal for feed use. The suggestion is that over processing soybean meal binds the more reactive amino acids such as lysine and cystine with sugars and other reactive compounds rendering them insoluble and becoming nutritionally unavailable. Unfortunately our own studies and those of Saio et al shows that PDI drops quite quickly with time especially at higher storage temperatures. Figure 2 shows the effect of various storage temperatures on the PDI of soybean meal. This effect is probably due to the aggregation of protein making them insoluble but presumably still available nutritionally to the animal.

Protein Solubility in Potassium Hydroxide solution (KOHPS) has been used for the detection of under processed and over processed soybean meal. Study of Araba and

Dale has concluded that KOHPS in excess of 85% or less than 70% indicate under processed or over processed soybean meal. However our own research shown in figure 3 and Figure 4 demonstrate that there is no correlation between KOHPS with either urease activity or PDI. This would seem to indicate that KOHPS is not a good indicator of under processing.

Trypsin Inhibitor Activity (TIA) is a direct measurement of trypsin inhibitors in soybean meal. It is a critical performance parameter due to the ability of trypsin inhibitor to inhibit protease activity in vivo thus slowing growth. Value below 5mg/g TIA is recommended. While TIA is a good indicator of under processing and the overall presence of anti nutritional factors, it cannot be used to predict over processing of soybean meal. The disadvantage of this method is that it is difficult to perform and is time consuming.

Figure 2: Effect of storage temperatures on the PDI of soybean meal (Soon Soon Oilmills unpublished data)

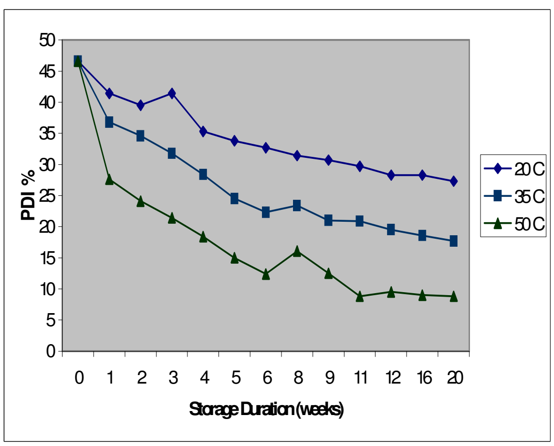


Figure 3: Correlation between PDI% and KOHPS% (Soon Soon Oilmills unpublished data)

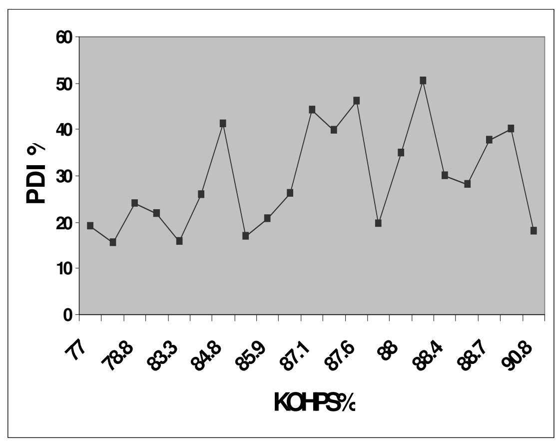


Figure 4: Correlation between delta pH and KOHPS% (Soon Soon Oilmills unpublished data)

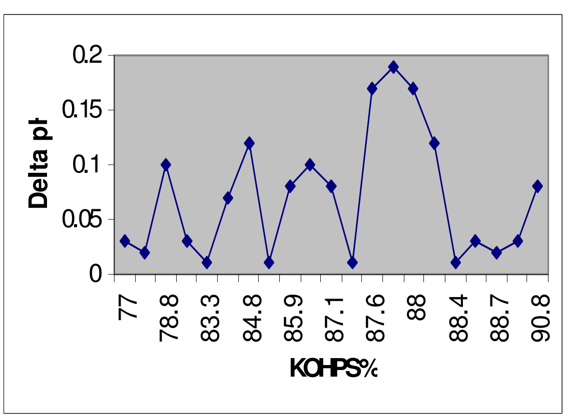
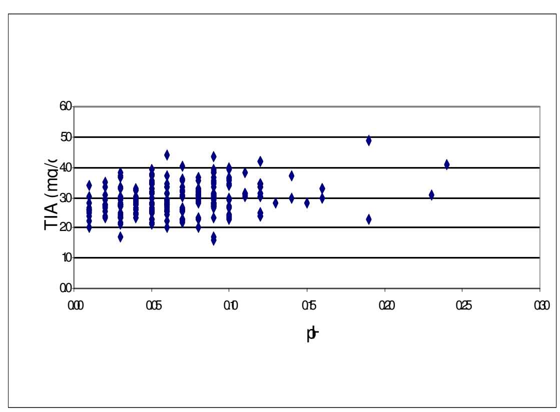


Figure 5: Correlation between TIA and delta pH (Soon Soon Oilmills unpublished data)



Urease activity is used as an indirect indicator of the presence of anti nutritional factors such as trypsin inhibitor which would suggest that the soybean meal is under processed. The recommended value is 0.02 to 0.2 delta pH. While it has some value for detecting the under processing of soybean meal, it can not be used for detecting over processing. However in our own studies as shown in figure 5, there is no correlation between urease activity (delta pH) and TIA for soybean meal within the range of 0.01 to 0.20 urease activity (delta pH).

In vivo and in vitro amino acid digestibility has been suggested to be a good indicator of the nutritional value of soybean meal. This is currently the acceptable criteria for amino acid nutrient value in feed formulation. However earlier studies by Batterham et al and Parsons et al have shown that the availability of amino acids especially lysine and cystine can be substantially lower than as measured by in vivo digestibility. A recent study commissioned by the ASA shows that the in vivo amino acid digestibility of various soybean meal were almost the same except for cystine. (Table 3)

Table 3: In vivo poultry digestibility of lysine, methionine, and cystine of various soybean meal (unpublished data by Wiseman and Clarke – courtesy of ASA)

SBM Source	Description	Digestible lysine (%)	Digestible Methionine (%)	Digestible Cystine (%)
WismaMitra Sunter	SBM USA (dark)	88.1	88.6	76.9
	SBM USA (light)	90.4	91.1	81.3
	SBM India	88.8	89.2	75.7
Basilisa P.Reas	SBM brazil dehulled	86.0	87.8	74.7
Soon Soon	SBM dehulled	89.9	89.8	78.3
Khun Rungthip	Indian SBM	90.3	91.1	80.2
	SBM local bean	88.8	89.8	77.1

The metabolizable Energy (ME) / Digestible Energy (DE) of different soybean meal with similar specifications can differ substantially as demonstrated by Douglas & Parsons et al recently (Figure 6). The Digestible Energy (DE) was substantially influenced by the source of soybean meal with the value ranging from 2816 to 3104 Kcal/kg dry matter. Since ME/DE has a big influence on animal feed performance, it is unfortunately that there is no easy method to measure this. Furthermore there is no agreement among nutritionists on the ME/DE of soybean meal. For example the ME value from various sources of dehulled soybean meal for poultry is shown in table 4.

Figure 6: Ileal DE of various sources of soybean meal

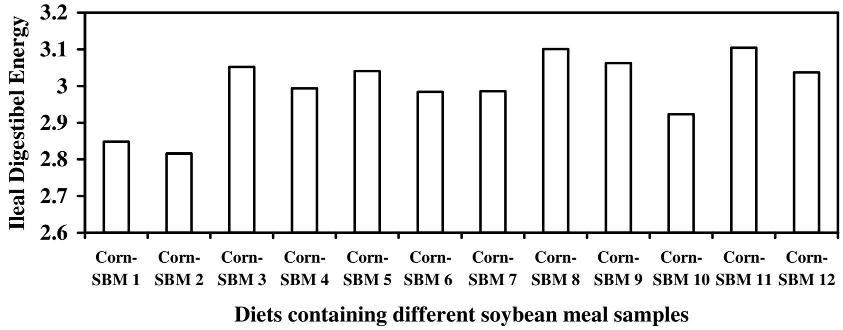


Table 4: Metabolizable Energy of soybean meal

Reference source	Dehulled SBM ME (Kcal/kg)
NRC	2440
Feedstuffs	2475
Rhodimet	2460
ASA	2525

Relationships Between Analysed Results and Actual Feed Performance

Our company has developed a new soybean meal which we call High Efficiency Soybean Meal. Although the analysed specifications and measured in vivo amino acid digestibility of this soybean meal is essential similar to other soybean meal, actual animal trial conducted by us and several other parties here demonstrated a significant improvement in animal performance when using this type of soybean meal.

The following figures and charts 7-17 demonstrate the superiority of this new type of soybean meal in various poultry trials.

The results of the trials using identical nutrient specifications show that soybean meal quality can have a very big impact on animal feed performance. The maximum performance difference is seen in breeder / layer feed and in broiler feed with lower nutrient density. In high nutrient density broiler feed the difference in performance is lower due to genetic limiting growth rates and FCRs. Therefore the performance of different soybean meal can be very different even if all existing commonly used analysis methods including in vivo amino acid digestibility show that they are similar.

Figure 7 : Body weight of broiler trial carried out by Dr Neoh SB and Dr. Raghavan

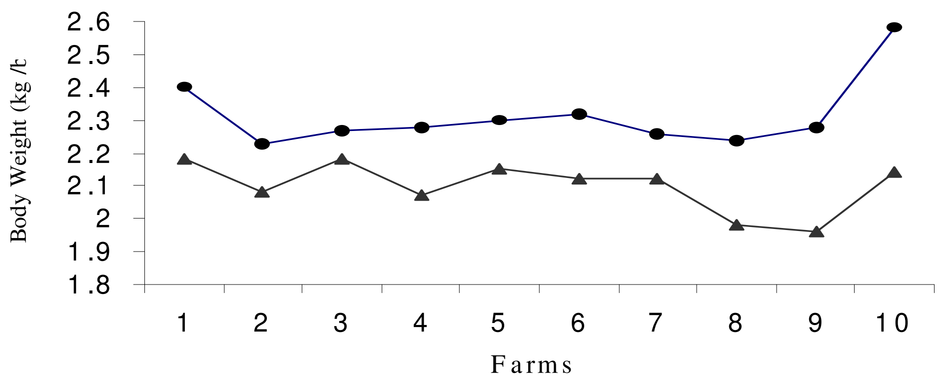


Figure 8 : FCR of broiler trial carried out by Dr Neoh SB and Dr. Raghavan

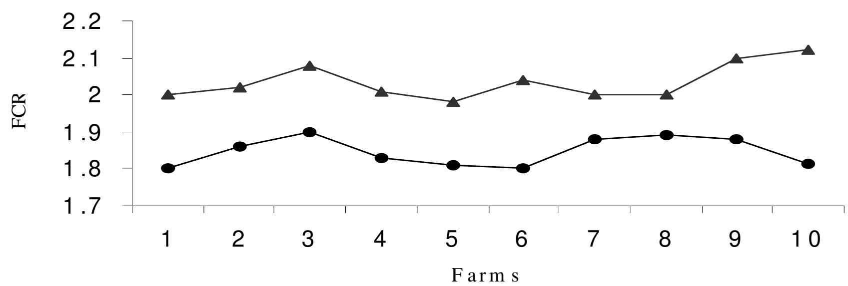


Figure 9 : Production rate of layer trial carried out by Dr. Neoh SB and Dr. Raghavan

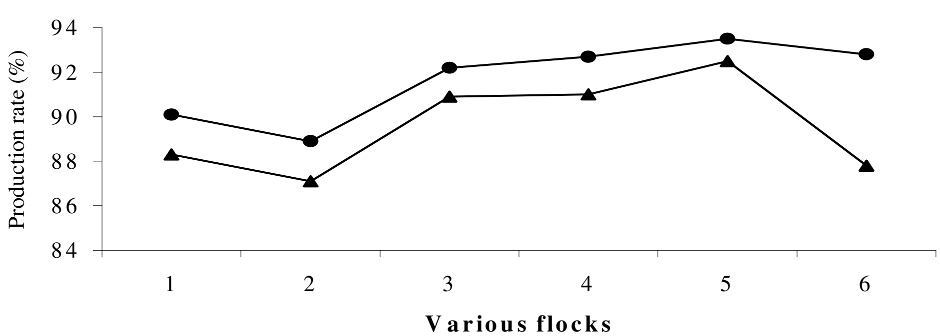


Figure 10 : Egg size distribution of layer trial carried out by Dr. Neoh SB and Dr. Raghavan

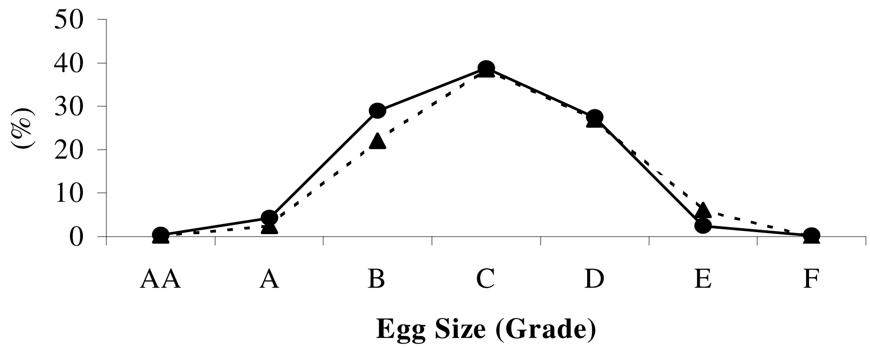


Figure 11 : Production rate of breeder trial carried out by Dr. Neoh SB and Dr. Raghavan

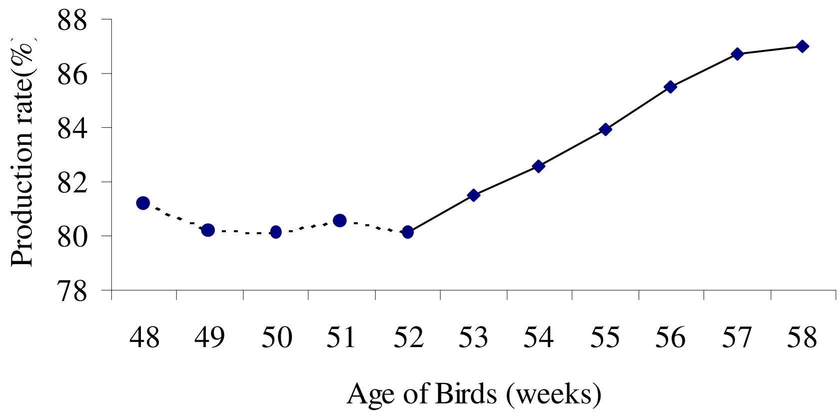


Figure 12 : Hatchability rate of breeder trial carried out by Dr. Neoh SB and Dr. Raghavan

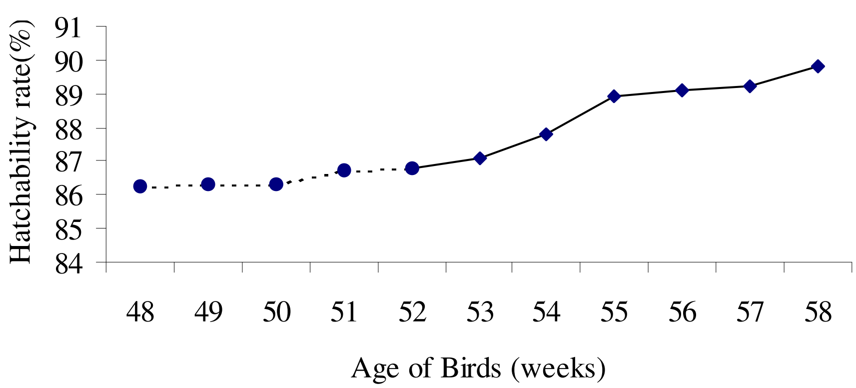


Figure 13 : Egg Mass of breeder trial carried out by Dr. Neoh SB and Dr. Raghavan

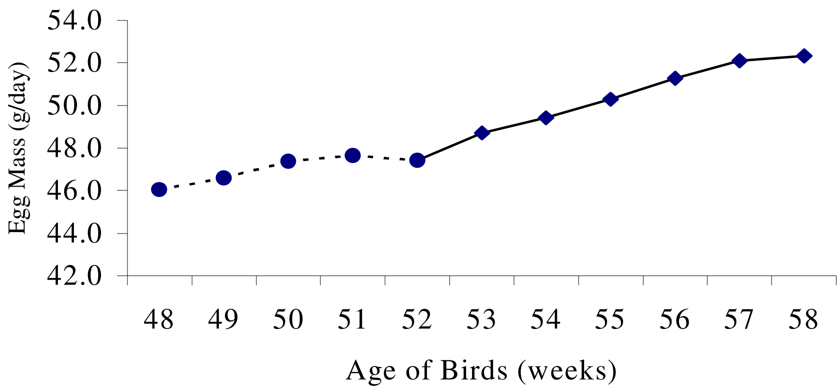


Figure 14 : Body weight, FCR and mortality rate of Broiler trial carried out by Soon Soon Oilmills at a Juru Farm

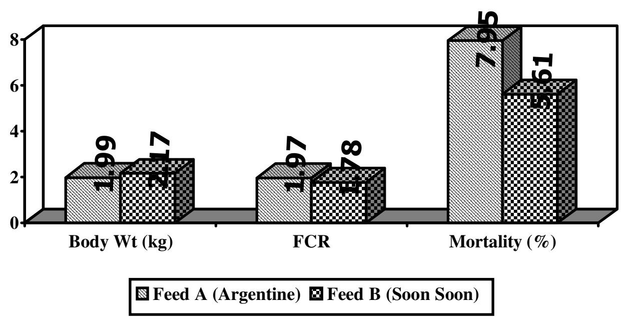


Figure 15 : Eviscerated yield % of broiler trial carried out by Soon Soon Oilmills at a Juru Farm

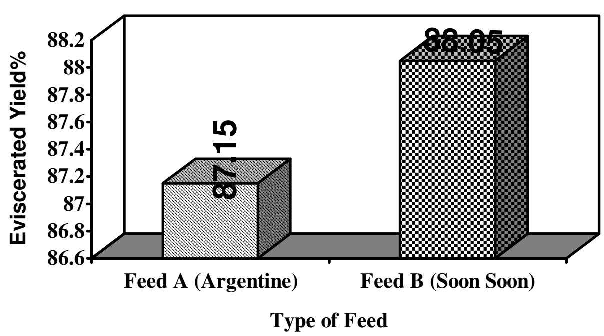


Figure 16 : Body weight (35 days) of broiler trial carried out by Soon Soon Oilmills at a Alor Setar farm

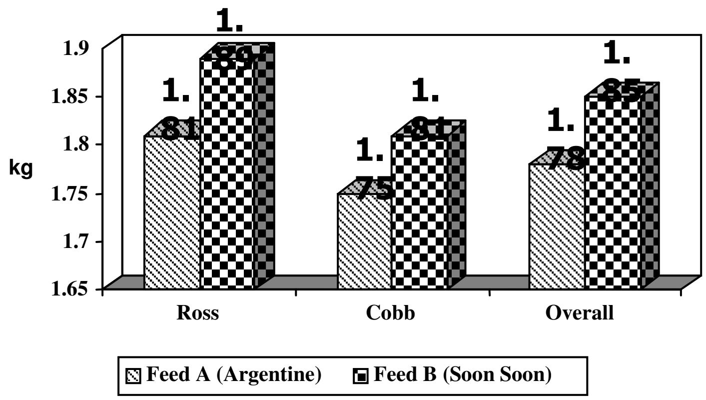
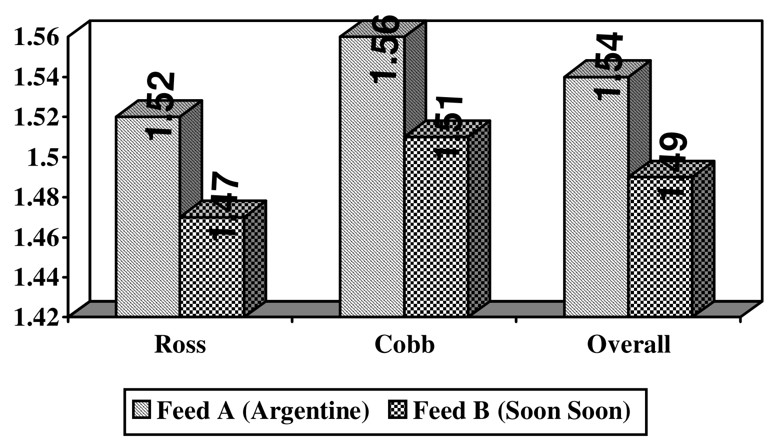


Figure 17 : FCRs of broiler trial carried out by Soon Soon Oilmills at a Alor Setar farm



Conclusion

In conclusion, PDI may indeed be a more sensitive test than KOHPS for determining the optimum processing of soybean meal. However PDI results are only meaningful if they are tested immediately after production. Therefore the best criteria for soybean meal quality is the highest PDI and the lowest TIA (Urease Activity?) as measured at the soybean crushing plant immediately after production.

In vivo and in vitro amino acid digestibility do not accurately predict actual feeding performance as total digestible amino acids is not always equal to total available amino acids.

Future Challenges

In future the challenge will be to develop relatively easy methods for predicting available amino acid and ME / DE. This may provide a way to differentiate between soybean meal of different performance.

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