Processed soya to improve performance of broiler chickens

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Primary Audience: Nutritionists, Researchers, Veterinarians

SUMMARY

Processed soya bean meals are commonly used in piglet diets, as they are likely to contain reduced anti-nutritional factors that can be problematic when fed during phases of early development. The objective of this study was to investigate whether the inclusion of a processed SBM in the diets of broilers to 41 d, at either 7.5 or 15% at the expense of standard soybean meal, can lead to improved performance parameters. The diets were formulated to be balanced for energy and digestible lysine with all other amino acids in appropriate ratio. At almost all time points, the BWG and FCR of those birds fed the processed soybean meal diets was significantly better than the control diet, and in some cases the 15% diet was superior to the 7.5% diet. To d 41, only the FCR of the 15% diet was better than the control. When FCR was corrected for the mean BW, birds on the 7.5% diet also performed better than the control. The inclusion of processed soybean meal did not affect feed intake until d 14. Thereafter, independent of the inclusion level, intake was significantly increased vs. the control diet.

Key words: soya, lysine, feed processing, broiler, extrusion

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DESCRIPTION OF PROBLEM

Soy contains anti-nutritional factors (**ANF**) including certain storage proteins and other proteins such as trypsin inhibitors (TI) and lectins, oligosaccharides, and phytate. During the process of oil extraction and subsequent processing steps, soybean meal proteins may be denatured and their anti-nutritional properties decreased. Phytate is likely to be at least partially addressed with the ubiquitous use of phytase. Whether or not the anti-nutritional effect of phytate is removed will depend on the dose and quality of the phytase, among other parameters. However, there is suggestion that the lower these ANF the better [1, 2], and additional processing may further improve the quality of the meal, in terms of ANF. There are multitudinous reports to show that these aforementioned ANF can be troublesome for piglets, particularly during the difficult period post weaning (e.g., [3, 4]). As such, various types of processed SBM have been shown to improve performance in piglets [5, 6], and it follows that these products are, until now, mostly used in the piglet sector.

In an age in which pressure on performance in broilers is increasing, with reduction in antibiotic use, it is possible these improved ingredients have value for broilers. Furthermore, there is increasing attention paid to improving the quality of pre-starter and starter diets. We are investigating the value of these products for broilers,

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and in early diets particularly, and hypothesize that they will improve performance. This is an early study in our work to evaluate the value of processed SBM for poultry.

MATERIALS AND METHODS

Birds and Housing

One-thousand-fifty, Ross 308 male broilers were sourced specifically for the study at d of hatch. All birds were vaccinated against infectious bronchitis at the hatchery. They were housed in 1.85 m by 1.85 m floor pens, containing fresh wood shavings, with 35 birds per pen. There was one bell drinker and one tube feeder per pen. There were 10 replicate pens per treatment, and the treatment diets were randomly assigned to the pens. At the termination of the trial, birds were slaughtered by cervical dislocation. The experimental protocol met the guidelines approved by the institutional animal care and use committee.

Test Ingredient

AlphaSoy 530 is a processed soya bean meal (**PSBM**) and is described in Table 1 and [7].

Table 1. Composition of processed soya bean meal and standard soya bean meal.

Component	% Unless stated	
	Processed	Standard
Moisture	5	11
Crude protein	52.00	46.20
Lysine	2.87	2.86
Digestible lysine	2.58	2.57
Methionine	0.65	0.65
Digestible methionine	0.60	0.59
Cysteine	0.70	0.69
Digestible cysteine	0.59	
Ether extract	1.65	1.50
Crude Fibre	3.40	3.40
ADF	5.14	5.00
NDF	8.67	7.80
Ash	6.66	6.60
Calcium	0.71	0.30
Sodium	0.12	0.01
Potassium	0.90	2.14
Phosphorus	0.15	0.60
Trypsin inhibitor mg/g	1.10	1.50
Stachyose	2.87	–
Raffinose	1.12	–
Glycinin	5.50	–
Beta-conglycinin	0.35	–

Treatments

There were 3 treatments based around a wheat corn soya control diet (Tables 2 to 4). Treatments 2 and 3 were formed, respectively, by adding AlphaSoy to the diet at 7.5 or 15% (using the matrix shown in Table 1), and reformulating the diet to be equivalent to the control metabolizable energy and digestible lysine with other amino acids in the appropriate ratio to lysine. Birds were fed in three phases, 0 to 14, 15 to 28, and 28 to 41 days.

Measurements

Body weight and feed intake were recorded at d 0, 7, 14, 21, 28, 35, and 41. This enabled the calculation of body weight gain and feed conversion ratio. For ease of interpretation, FCR also was corrected to the mean BWG [8]. All measurements are expressed as a treatment mean on a cumulative basis, and only d 7, 14, 28, and 41 data are shown here, for brevity. Statistical analysis was performed using JMP Pro v13 [9]. Data were analyzed using a one-way ANOVA and means separated using the LSD.

RESULTS AND DISCUSSION

The performance of the birds was in line with expectation for the Ross 308 strain. The control performance was 17 g less than expectation at d 7 and 308 g greater than expectation at d 41 [10].

The cumulative effect on growth performance between d 0 to 7 and 0 to 14 is shown in Table 5. There was no effect of any of the treatments on FI to d 7 or 14. Those fed both PSBM diets had significantly improved BWG and FCR to d 7 and BWG to d 14 vs. the control ($P < 0.05$ in all cases). To d 14, the addition of 7.5% PSBM improved FCR vs. the control, and the 15% diet was significantly better again ($P < 0.001$).

The cumulative effect on growth performance between d 0 and 28 and 0 and 41 is shown in Table 6. Those fed either inclusion of PSBM had increased FI vs. the control to d 28 and 41 ($P < 0.05$). Consequently, BWG also was improved,

Table 2. Starter diet formulations (d 1 to 14).

	Control	PSBM[4] 7.5%	PSBM[4] 15%
% Unless otherwise stated			
Wheat	57.76	58.74	59.72
Soya bean meal (49% CP)	33.87	26.23	18.60
Processed soya bean meal (PSBM)	0.00	7.50	15.00
Lysine HCl	0.27	0.27	0.27
DL-Methionine	0.32	0.32	0.32
Threonine	0.09	0.08	0.07
Choline chloride solution 75% IBC	0.07	0.07	0.07
Limestone	1.33	1.27	1.21
MonoCalcium phosphate 22.7	0.95	0.95	0.96
Salt	0.16	0.14	0.12
Sodium bicarbonate	0.42	0.41	0.40
Soya oil	4.25	3.49	2.74
Phytase[1]	0.01	0.01	0.01
Vitamin and mineral premix[2]	0.50	0.50	0.50
Xylanase[3]	0.01	0.01	0.01
Analyzed composition:			
Protein	23.60	23.30	24.50
GE (MJ/kg)	16.74	16.74	16.78
Oil A	5.58	4.75	4.45
Calcium	0.99	0.89	0.95
Sodium	0.16	0.16	0.16
Moisture	11.90	11.40	10.60
Ash	6.00	5.50	5.80
Calculated composition:			
AMEn (MJ/kg)	12.70	12.70	12.70
Digestible lysine	1.24	1.24	1.24
Digestible calcium	0.95	0.95	0.95
Available phosphorous	0.45	0.45	0.45

[1,3]Phytase was Quantum Blue 5 G, and xylanase was Econase XT 25P, both ABVista feed ingredients, Marlborough, UK.

[2]Vitamin and mineral premix provided, per kg of diet, vitamin A 12,000IU, vitamin D3 5,000IU, vitamin E 50IU, vitamin K 3 mg, vitamin B1 2 mg, vitamin B2 7 mg, vitamin B6 5 mg, vitamin B12 15 mg, Nicotinic acid 50 mg, pantothenic acid 15 mg, polic acid 1 mg, biotin 200 mg, iron 80 mg, copper 10 mg, manganese 100 mg, cobalt 0.5 mg, zinc 80 mg, iodine 1 mg, selenium 0.2 mg and molybdenum 0.5 mg.

[4]PSBM refers to processed soya bean meal (test material).

and in the case of 0 to 28, those fed 15% PSBM were significantly better again. In the period 0 to 28 d and 0 to 41 d, FCR was improved by the use of PSBM, but only with the 15% inclusion. However, since BWG was so dramatically improved at d 41, an indicative correction was performed to FCR, as described above. By this measure, both the 7.5 and 15% inclusions significantly improved FCR vs. the control.

There was no appreciable effect of any of the treatments on mortality or health at any point in the trial, and levels were within the expected range for this unit (data not shown).

In summary, growth performance was improved with the addition of PSBM, and in some cases, the higher inclusion rate was better than the lower rate. The most substantial impact came towards the end of the experiment with the 15% diet improving BWG by 194 g vs. the control. However, for practical and economic application, processed soya seems more suited to inclusion in (pre-) starter rations. This would depend on the individual situation, but most likely to 7 or 10 days. In this experiment, the inclusion of 7.5 and 15% PSBM in starter diets improved BWG by 8 and 9 g, respectively, and this did not appear to be via increased feed intake. Increased early BW is often a target for producers and is taken as a measure of starter diet quality. In this experiment, we cannot attribute the final growth improvement to inclusion of PS in the starter phase, because the ingredient

Table 3. Grower diet formulations (d 15 to 28).

	Control	PSBM[4] 7.5%	PSBM[4] 15%
% Unless otherwise stated			
Wheat	64.23	65.20	66.18
Soya bean meal (49% CP)	27.10	19.46	11.82
Processed soya bean meal (PSBM)	0.00	7.50	15.00
Lysine HCl	0.27	0.27	0.27
DL-Methionine	0.27	0.27	0.27
Threonine	0.09	0.08	0.07
Choline chloride solution 75% IBC	0.07	0.07	0.07
Limestone	1.16	1.10	1.04
MonoCalcium phosphate 22.7	0.85	0.85	0.86
Salt	0.13	0.11	0.09
Sodium bicarbonate	0.42	0.42	0.41
Soya oil	4.91	4.15	3.40
Phytase[1]	0.01	0.01	0.01
Vitamin and mineral premix[2]	0.50	0.50	0.50
Xylanase[3]	0.01	0.01	0.01
Analyzed composition:			
Protein	20.20	20.80	22.20
GE (kCal/kg)	16.93	16.98	16.94
Oil A	6.12	5.49	5.01
Calcium	0.91	0.74	0.80
Sodium	0.17	0.15	0.17
Moisture	11.30	11.00	10.50
Ash	5.30	4.80	5.00
Calculated composition:			
AMEn (kCal/kg)	13.10	13.10	13.10
Digestible lysine	1.08	1.08	1.08
Digestible calcium	0.85	0.85	0.85
Available phosphorous	0.42	0.42	0.42

[1,3]Phytase was Quantum Blue 5 G, and xylanase was Econase XT 25P, both ABVista feed ingredients, Marlborough, UK.

[2]Vitamin and mineral premix provided, per kg of diet, vitamin A 12,000IU, vitamin D3 5,000IU, vitamin E 50IU, vitamin K 3 mg, vitamin B1 2 mg, vitamin B2 7 mg, vitamin B6 5 mg, vitamin B12 15 mg, Nicotinic acid 50 mg, pantothenic acid 15 mg, polic acid 1 mg, biotin 200 mg, iron 80 mg, copper 10 mg, manganese 100 mg, cobalt 0.5 mg, zinc 80 mg, iodine 1 mg, selenium 0.2 mg and molybdenum 0.5 mg.

[4]PSBM refers to processed soya bean meal (test material).

was fed throughout. However, an early benefit does indicate that if the ingredient were fed only during the starter phase, an early effect may be seen. Leeson and Summers (cited in [11]), suggest that an improvement in 1 g of BW at d 7 may translate to 5 g of BW at d 45. The provision of available nutrients early on in a bird's diet also has been shown to improve gut development parameters [12], and this may have been the mechanism.

It is possible that the applied matrix for this ingredient was underestimated (see Table 1). When working with novel ingredients, the composition and value do need to be estimated from prior knowledge and information including those from other species, until a full evaluation is complete. It may be that, although we intended for diets to be balanced for digestible lysine, the PSBM diets were actually richer in digestible lysine than expected. Everaert et al., [13] have shown that increased protein provision in the first 7 d increased daily gain, for the same feed intake, suggesting that amino acids provided beyond sufficiency may go directly to promoting growth. Further assessment of the digestibility value of the amino acids will be needed. The diets used in this trial were not iso-nitrogenous. They were designed as such to balance for digestible lysine and to best reflect the approach taken in a commercial situation. Furthermore, we felt this allowed the most appropriate comparison, as lysine is limiting. However, it is possible that the

Table 4. Finisher diet formulations (d 29 to 41).

	Control	PSBM[4] 7.5%	PSBM[4] 15%
% Unless otherwise stated			
Wheat	69.27	70.00	72.53
Soya bean meal (49% CP)	22.10	14.51	5.58
Processed soya bean meal (PSBM)		7.50	15.00
Lysine HCl	0.23	0.23	0.27
DL-Methionine	0.21	0.21	0.22
Threonine	0.06	0.05	0.06
Choline chloride solution 75% IBC	0.05	0.05	0.05
Limestone	1.01	1.08	0.90
MonoCalcium phosphate 22.7	0.64	0.65	0.67
Salt	0.12	0.10	0.07
Sodium bicarbonate	0.44	0.43	0.45
Soya oil	5.35	4.67	3.70
Phytase[1]	0.01	0.01	0.01
Vitamin and mineral premix[2]	0.50	0.50	0.50
Xylanase[3]	0.01	0.01	0.01
Analyzed composition:			
Protein	17.80	19.20	19.80
GE (MJ/kg)	17.08	16.98	17.04
Oil A	5.77	5.95	5.09
Calcium	0.75	0.83	0.71
Sodium	0.16	0.15	0.14
Moisture	10.80	10.20	9.90
Ash	4.80	5.00	4.80
Calculated composition:			
AMEn (MJ/kg)	13.40	13.40	13.40
Digestible lysine	0.93	0.93	0.93
Digestible calcium	0.75	0.80	0.75
Available phosphorous	0.37	0.37	0.37

[1,3]Phytase was Quantum Blue 5 G, and xylanase was Econase XT 25P, both ABVista feed ingredients, Marlborough, UK.

[2]Vitamin and mineral premix provided, per kg of diet, vitamin A 12,000IU, vitamin D3 5,000IU, vitamin E 50IU, vitamin K 3 mg, vitamin B1 2 mg, vitamin B2 7 mg, vitamin B6 5 mg, vitamin B12 15 mg, Nicotinic acid 50 mg, pantothenic acid 15 mg, polic acid 1 mg, biotin 200 mg, iron 80 mg, copper 10 mg, manganese 100 mg, cobalt 0.5 mg, zinc 80 mg, iodine 1 mg, selenium 0.2 mg and molybdenum 0.5 mg.

[4]PSBM refers to processed soya bean meal (test material).

Table 5. Broiler feed intake (FI), body weight gain (BWG), and feed conversion ratio (FCR) for the cumulative phases 0 to 7 and 0 to 14 days. Data are expressed as a treatment mean per bird (10 replicates).

	7 d FI (g)	0 to 7 d BWG (g)	0 to 7 d FCR	0 to 14 d FI(g)	0 to 14 d BWG (g)	0 to 14 d FCR
Control	148	131[b]	1.14[a]	552	475[b]	1.16[a]
7.5% PSBM[1]	150	139[a]	1.08[b]	567	499[a]	1.14[b]
15% PSBM[1]	147	140[a]	1.05[b]	562	508[a]	1.11[c]
P	NS	0.004	0.012	NS	<0.001	<0.001
LSD	6.42	5.49	0.06	15.06	11.25	0.02

[a–c]Means within a row with different superscripts are significantly different ($P < 0.01$).

[1]PSBM refers to processed soya bean meal (test material).

higher crude protein in the 15% PSBM diet contributed to increased performance.

Soya contains various ANF, such as trypsin inhibitors, allergenic proteins, oligosaccharides, and phytase. There is evidence for the anti-nutritional properties of trypsin inhibitors in broilers [1, 14]. Similarly, there is much cited work to suggest the negative effect of soybean oligosaccharides in broilers [15]. The storage proteins, glycinin, and β-conglycinin are

Table 6. Broiler feed intake (FI), body weight gain (BWG), feed conversion ratio (FCR), and feed conversion ratio corrected to 3,295 g per bird (FCRc) for the cumulative phases 0 to 28 and 0 to 41 days. Data are expressed as a treatment mean per bird (10 replicates).

	0 to 28 d FI (g)	0 to 28 d BWG (g)	0 to 28 d FCR	0 to 41 d FI (g)	0 to 41 d BW (g)	0 to 41 d FCR	0 to 41 d FCRc
Control	2233[b]	1615[c]	1.38[a]	4902[b]	3183[b]	1.54[a]	1.56[a]
7.5% PSBM[1]	2305[a]	1686[b]	1.37[a]	5071[a]	3325[a]	1.53[a]	1.52[b]
15% PSBM[1]	2317[a]	1747[a]	1.33[b]	5129[a]	3377[a]	1.52[b]	1.50[b]
P	0.002	<0.001	<0.001	0.002	<0.001	0.035	<0.001
LSD	63.34	39.97	0.02	123.89	83.92	0.02	0.03

[a–c]Means within a row with different superscripts are significantly different ($P < 0.01$).

[1]PSBM refers to processed soya bean meal (test material).

commonly thought to exert allergenic effects in piglets [4] but, to the authors knowledge, there is no direct evidence for a negative effect in broilers. In reality, it is difficult to assess which, if any, of these ANF are problematic. Often, processed meals and isolates are compared to a soybean meal control. The process used to produce that test product is likely to concurrently reduce all ANF, so any effect cannot realistically be attributed to one factor. For example, Wang et al., [16] demonstrated a significant linear improvement in BWG when broilers were fed a processed, enzyme-treated SBM. However, that meal had substantially reduced agglutinin, glycinin, β-conglycinin, and TI and contained residual protease. Equally, authors have shown the *beneficial* impact of some soybean oligosaccharides [17]. The evidence against ANF in broilers is therefore unclear. Based on the evidence that is available, it is possible the result seen in the current study is due to slightly reduced ANF relative to SBM. However, the difference in some cases is small, and still, the effect of the inclusion of PSBM was dramatic. For example, using the TI values given in Table 1 to calculate the expected levels of TI in the starter diets gives a TI level of 0.51% in the control and 0.45% in the 15% PSBM diet. It is unlikely that this small difference can account for the large improvement in performance.

Finally, it is possible that an unknown factor, created during the manufacturing process, is responsible for the quality of the processed soya. For example, Fourier-transform infrared has been used to describe secondary structure changes in oil seed protein, due to heating, which partially predicted increased digestibility [18]. Fang et al., [19] have demonstrated the breakdown of protein aggregates with extrusion cooking, which also could conceivably improve digestibility.

Soyabean meal contains around 17% pectin and some residual lipid [20]. Pectin has been shown to increase in solubility and decrease in molecular weight with extrusion cooking [21], which may have gut health benefits. The oxidation of lipid, which produces off flavors, also can be reduced by the use of extrusion [22]. This may explain the increase in intake seen in the later stages of the trial.

CONCLUSION AND APPLICATION

1. Processed soya, such as AlphaSoy 530, can be used at levels up to 15% in broiler diets from 0 to 41 days.
2. A full evaluation of the material needs to be completed.
3. Based on the matrix given here, body weight gain and FCR may be improved by up to 7% and 9 points over 7 d and 6% and 6 points over 41 days.

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7. AlphaSoy 530 (AgroKorn, Videbaek, Denmark) is a processed soya bean meal (PSBM). The starting raw material is standard, imported high protein SBM from South America with a target crude protein content of 55%, on a dry matter basis. It undergoes a multistage process including, in order, conditioning with heat and steam, extrusion, drying, and grinding.

8. FCR also was corrected to the mean BWG of 3,295, assigning 1 point to 50 g of BW. For example if the BWG was 3,295 then no correction as made to the FCR. If the BWG was 3,345, then one point was deducted from the FCR. According to the breed guidelines, between d 41 and 42, the bird is expected to grow by 100 g and lose 2 points in FCR, hence assigning 50 g to one point [10].

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