Danish Pig Production

Soybean meal for weaners

Report 796
September 24, 2007

Hanne Maribo & Jes Callesen
Danish Pig Production

Abstract

The effect of increasing the inclusion rate of toasted soybean meal on the productivity of weaners (above 9 kg) was investigated. It was also investigated whether dehulled toasted soybean meal could be used as an alternative to toasted soybean meal.

The pigs were transferred to the trial when they weighed more than 9 kg and finished when they weighed approx. 30 kg. The start weight averaged 10.1 kg and the finish weight averaged 29.3 kg. The pigs were fed one diet through the entire trial period.

The trial comprised the following six groups:

Group	Inclusion of soybean meal, %	Soybean meal source
1	10	Toasted soybean meal (crude protein content: approx. 43%)
2	16	Toasted soybean meal (crude protein content: approx. 43%)
3	22	Toasted soybean meal (crude protein content: approx. 43%)
4	27	Toasted soybean meal (crude protein content: approx. 43%)
5	10	Dehulled toasted soybean meal (crude protein content: approx. 47%)
6	26	Dehulled toasted soybean meal (crude protein content: approx. 47%)

There was a linear correlation between an increasing inclusion of toasted soybean meal and a decrease in the production value. The pigs given the highest inclusion of toasted soybean meal had a production value that was 6% lower than that of the pigs given the lowest inclusion rate. As a result of the high inclusion of soybean meal, the pigs took 1-2 days more to reach 30 kg. When including the current feed prices (spring 2007), the lower productivity is counterbalanced by a better economy, as the pigs given the highest inclusion of toasted soybean meal or dehulled soybean meal had an actual production value that was 34-35% higher than that of the pigs given 10% soybean meal because a high inclusion of soybean meal resulted in a drop in the feed price. There were no differences whether the pigs were given toasted soybean meal or dehulled soybean meal.

There was also a linear correlation between the inclusion of soybean meal and the frequency of treatments for diarrhoea. When the inclusion of toasted soybean was increased by one percentage unit in the interval 10-27%, the frequency of treatments for diarrhoea increased by 0.04 days per pig. There were no differences in the frequency of treatments for diarrhoea regardless of whether the pigs were given toasted soybean meal or dehulled soybean meal. There was no effect on mortality.

If health and productivity are analysed in one index, it is seen that, with the same feed prices, the production value drops slightly when the inclusion rate of soybean meal increases, but due to the large differences in feed prices between the groups, the increased costs are still paid.

It is concluded that pigs above 9 kg are able to produce optimally on a diet in which soybean meal constitutes a large part of the protein sources. It is recommended to investigate gradual increases in the inclusion of soybean meal taking into regard the health level of the herd in question. Furthermore, pigs should be given a gradual transition of 5-7 days from diet 1 to diet 2 with a content of high soybean meal.

Background

Soybean meal is the cheapest and most important protein source in pig production. There is therefore both an environmental and a financial incitement to find the best way to utilize soybean meal. Soybean meal is typically only included in limited amounts in the first diet for weaners (6-9 kg) because of fear of diarrhoea problems. However, new trials have demonstrated that diets containing a high inclusion of soybean meal (instead of expensive protein sources such as fishmeal and protein concentrates) do not increase the risk of post-weaning diarrhoea or reduced productivity in the weaner period (1,2,3). Put differently, arguments are good for offering weaners a diet with a high inclusion of soybean meal to reduce the feed costs. When soybean meal is the only protein source (besides grain) in the first diet, it is impossible to meet the standards for all essential amino acids. This is possible in diet 2 (9-30 kg) where, together with fishmeal, soybean meal typically constitutes the protein sources. However, fishmeal is significantly more expensive than soybean meal. The feed price may potentially decrease if soybean meal is used as the only protein source in the feed. It is relevant to clarify the effect of increasing the inclusion rates of soybean meal in diet 2 on the pigs' production results and the production economy.

Toasted soybean meal differs from dehulled soybean meal in that it contains hulls. Hulls are not easily digested and contain, among other things, fermentable oligosaccharides that are believed to interfere with the digestion of the pig. If the price of dehulled soybean meal is max. 11% above the price of regular soybean meal, it is financially an advantage to select dehulled soybean meal. The Danish feedstuff industry has entered into an agreement with their suppliers that, as of autumn 2007, toasted soybean meal will no longer be available in Denmark. At the start of this trial, both products were available, and it was therefore relevant to clarify the effect on productivity of both types of soybean meal in diet 2 for weaners.

The aim was to establish the effect of increasing inclusion rates of soybean meal (dehulled and not dehulled) in feed for weaners weighing more than 9 kg. The effect was measured on daily gain, feed conversion and health.

Materials and methods

The trial was conducted at Experimental Station Grønhøj. The pigs were transferred to the trial when they weighed more than 9 kg and finished when they weighed approx. 30 kg. The start weight averaged 10.1 kg and finish weight averaged 29.3 kg. The pigs were given one diet in the entire trial period (diet 2).

Pigs that at weaning weighed less than 8 kg were given a starter diet for the first week, and then gradually switched to diet 2 the following week, which was the actual trial diet. Pigs that at weaning weighed 8-9 kg gradually switched from the starter diet to diet 2 in the first week post-weaning and were then given diet 2. Pigs weighing more than 9 kg at weaning were given diet 2 immediately. All pigs were given 2500 ppm zinc

oxide prescribed by the vet the first 14 days post-weaning regardless of weight. Zinc oxide was mixed manually in the feed.

The trial comprised six treatments (groups) with 645 pigs per treatment split among 59 blocks/replicates (totalling 3871 pigs). The trial design is shown in table 1.

Table 1. Trial design, % content of protein ingredients

Group	**1**	**2**	**3**	**4**	**5**	**6**
Toasted soybean meal (approx. 43% crude protein)	10	16	22	27		
Dehulled toasted soybean meal (approx. 47% crude protein)					10	26
Fishmeal	6	4	2	-	6	-
Potato protein concentrate	4	3	1	-	4	-

Feed

The diets used in all six groups complied with the nutrient standards for pigs weighing 9-30 kg (4). The barley/wheat ratio in the diets was 1:5 regardless of the inclusion rate of soybean meal. The potato protein concentrate/fishmeal ratio was also the same in the diets for groups 1-3 and 5 (7:10). In groups 1-4, the content of toasted soybean meal gradually increased from 10% to 27%. The lowest content of soybean meal was 10% (group 1) as there are no diets in practice with a content lower than this. Groups 5 and 6 included dehulled soybean meal in a low and high inclusion, respectively. Ingredients and feed prices are shown in Appendix 1.

All diets were formulated to have the same nutrient content. The diets contained 149 g digestible crude protein per FUgp, and the standard for essential amino acids was met in all diets. The tryptophan content was formulated to 2.2 g digestible per FUgp (15% above the standard) to make it possible for the pigs to achieve optimum productivity. The established tryptophan standard is slightly lower than the level giving maximum productivity to take the economy into consideration (4). There was a total content of valine of 7.35 g digestible per FUgp (5% above the standard) when the diet for group 5 was formulated without the addition of synthetic valine, but with the lowest content of dehulled toasted soybean meal. In order to maintain the same amount of valine in all diets, valine was added to the diets in groups 1, 2, 3, 4 and 6.

The feed was produced at Aarhusegnens Andel and was pelleted and heat-treated at minimum 81°C. All diets were analysed for content of energy, crude protein, crude fat and all amino acids.

Recordings

Daily gain, feed conversion, mortality and treatments for diarrhoea were recorded. Productivity was recorded at pen level.

Production value

The production value based on an average of the last five years' weaner prices (September 2001 - September 2006) was calculated as: (kg gain × DKK per kg gain) ÷ (number of analysed FUgp × DKK per FUgp). The production value was calculated for each pen. The value of gain was DKK 5.94 per kg and was calculated on the basis of the average start and finish weight of the trial. The prices of the last five years were:

Price of a 7 kg pig:	DKK 200 per pig, ± DKK 8.50/kg
Price of a 30 kg pig:	DKK 340 per pig, + DKK DKK 4.90 per kg (15-30 kg) / ÷ DKK 5.06 per kg (30-40 kg)
Diet 1:	DKK 2.72 per FUgp
Diet 2:	DKK 1.47 per FUgp

The loss of a dead pig was calculated to DKK 212 per pig, and the loss of a culled pig was set to DKK 106. The price of one day of treatment for diarrhoea was set to DKK 1 and covers the cost for medication only.

Actual production value

The calculation of the actual production value included an average current price for pigs based on the last five weeks (weeks 26-30, 2007) and a feed price based on the prices of ingredients in the spring 2007. The price of the diet is shown in Appendix 1.

Price of a 7 kg pig:	DKK 198 per pig, ± DKK 8.85 per kg
Price of a 30 kg pig:	DKK 338 per pig, ± DKK 4.68 per kg
Ingredient prices, feed, spring 2007	**DKK / 100 kg**
Soybean meal (toasted):	153
Soybean meal (toasted, dehulled):	172
Fishmeal:	770
Potato protein concentrate:	850

Statistics

The production value calculated at the same feed prices was analysed as primary parameter with start weight as co-variable. The first four groups with increasing inclusion rates of toasted soybean meal were subjected to analysis with a linear regression model, in which the production value, daily gain and feed conversion were tested against an increasing inclusion of toasted soybean meal. Furthermore, group 1 was compared with group 5, and group 4 was compared with group 6 to investigate whether there was any effect of the two different soybean meal sources when included in the same inclusion rates. This model was also used for analysis of treatment days for diarrhoea.

The models included block and group as variables. Data were investigated for normal distribution and prevalence of outliers, and were subjected to an analysis of variance in SAS under the GLM procedure. Significant differences are stated at 5 per cent level.

Results and discussion

Feed

The analysed nutrient content corresponded to the declared nutrient content for all diets (see Appendix 2). The amino acid valine was added to the diets in groups 1-4 and 6 to maintain the same amount in all groups, where group 5 constituted the basis for the content. The analysed and calculated content of digestible valine per FUgp in the diets was so high above the standard that it would not have been necessary to add valine to meet the standard. In the economic calculations with current prices, the price of adding extra valine is not included in the feed price. If the diets were to be formulated without the addition of valine, it may be necessary to add a bit of potato protein concentrate to the two diets with the highest inclusion of soybean meal to meet the standard (4) depending on the valine content of the soybean meal. However, this does not affect the financial gain of using a high concentration of soybean meal as the feed price can be maintained at a reasonably low level even with the addition of potato protein concentrate.

Productivity

Generally, the level of productivity in this trial was good; the daily gain averaged 502-524 g/day, and the feed conversion averaged 1.86-1.90 FUgp per kg gain from 10.1 kg to 29.3 kg. In groups 1-4, there was a linear correlation between the inclusion rate of soybean meal and the production value, the daily gain and the feed conversion. An increase in the content of toasted soybean meal of 1 percentage unit in the interval 10-27% soybean meal resulted in a reduction in the production value of DKK 0.3 per pig. An increase in the content of toasted soybean meal of 1 percentage unit reduced the daily gain by 1.7 g a day and reduced the feed conversion by 0.003 FUgp a day.

The pigs given the highest inclusion of soybean meal took 1-2 days more in reaching 30 kg. There were no differences in productivity between groups 1 and 5 or between groups 4 and 6. It is as such not better for the pigs to be given dehulled toasted soybean meal than regular soybean meal even though the inclusion rate is high. As this trial found no difference in productivity regardless of the soybean meal source, the conclusions based on increasing inclusion rates of toasted soybean meal will also apply when dehulled toasted soybean meal is used.

Table 2. Production results (10-29 kg)

Group	**1**	**2**	**3**	**4**	**5**	**6**
Toasted soybean meal, %	10	16	22	27		
Dehulled toasted soybean meal, %					10	26
Start weight, kg	10.1	10.1	10.2	10.2	10.1	10.1
Finish weight, kg	29.8	29.4	29.0	29.1	29.2	29.0
Daily gain, g	524	516	502	503	514	503
Feed intake, FUgp/day	0.97	0.96	0.95	0.95	0.96	0.96
Feed conversion, FUgp/day	1.86	1.88	1.90	1.90	1.88	1.91
Production value, same price for all diets						
Production value, DKK/pig	63.7	62.2	59.6	59.8	61.7	59.7
Index	100	98	94	94	97	94
Production value, including treatments for diarrhoea and mortality						
DKK/pig	56.6	53.9	53.6	52.8	55.9	52.7
Index	100	95	95	93	99	93

The calculation of the actual production value with the current prices demonstrates that if the inclusion of soybean meal in weaner feed is increased from 10% to 27%, the profit will increase by approx. 34-35% despite a slightly lower productivity. With the current feed prices, an increase in the inclusion of soybean meal of 1 percentage unit in the interval 10-27% toasted soybean meal will increase the production value by DKK 0.8 per pig.

A maximum price difference between dehulled and toasted soybean meal of 11% will make the use of dehulled soybean meal economically better or neutral compared with toasted soybean meal as dehulled toasted soybean meal has a higher nutrient content.

Table 3. Actual production value with current prices

Group	**1**	**2**	**3**	**4**	**5**	**6**
Toasted soybean meal, %	10	16	22	27		
Dehulled toasted soybean meal, %					10	26
Actual production value, DKK/pig	41.3	46.4	50.5	55.7	40.0	55.5
Index	100	112	122	135	97	134
Statistics were not calculated for the actual production value.						

The effect of increasing the content of soybean meal in the diets on the pigs' productivity compared with the economic value at current prices is shown in figure 1.

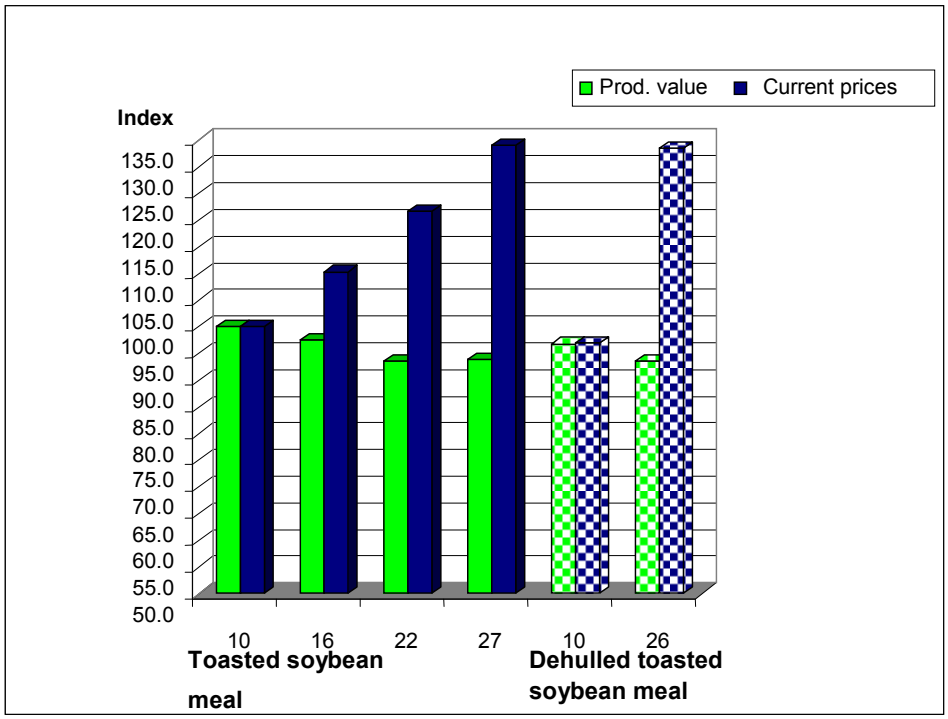

Figure 1: Production value (same feed prices, green) and actual production value (blue) based on current feed prices of the diets used.

Health

There were no differences in mortality regardless of the inclusion of soybean meal. Treatments averaged 0.9 days per pig in the entire trial period, which is very low. There was a significant linear correlation between the inclusion of toasted soybean meal in the interval 10-27% and the number of days spent on treatments for diarrhoea. A 1 percentage unit increase in the inclusion of toasted soybean meal increased the number of days spent on treatments for diarrhoea by 0.04 day per pig. There was no difference in the treatment frequency for diarrhoea whether toasted soybean meal was used or dehulled soybean meal was used. One day of treatment for diarrhoea costs approx. DKK 1 per pig. This is not included in the economic calculations. A previous trial also found that feeding with a start diet and diet 2 containing 25% and 23% toasted soybean meal, respectively, compared with a diet containing 8% soybean meal and fishmeal increased the frequency of diarrhoea treatments from 0.4 day to 1.3 days per pig in the period from weaning until approx. 30 kg.

Production value including health

Calculations of the production value with identical feed prices, including health as economic weighting, demonstrated that the production value drops by approx. DKK 6-9 when deducting the value of dead and culled pigs and the costs for diarrhoea treatments. The production value index drops slightly more when the inclusion of soybean meal increases, but the order between the groups remains the same (table 2). There is a difference of 7 index points between the lowest and the highest inclusion of soybean meal, whereas the difference is 6 index points if health is not included in the calculation. This applies regardless of whether toasted soybean meal or dehulled soybean meal is used.

Conclusion

There is a linear correlation between increasing the inclusion rate of soybean meal and a decrease in the production value. The production value of the pigs given the highest inclusion of toasted soybean meal was 6% lower than that of the pigs given the lowest inclusion of soybean meal. As a result, the pigs given the highest inclusion of soybean meal took 1-2 days more in reaching 30 kg. Inclusion of the current feed prices in the calculation (spring 2007) showed that the lower productivity was outweighed by a better economy as the pigs given the highest inclusion had an actual production value that was 34-35% higher than

the pigs given 10% soybean meal because the increased inclusion of soybean meal resulted in a drop in the feed price. There was also a linear correlation between the inclusion of soybean meal and the frequency of treatments for diarrhoea. When the inclusion of toasted soybean meal is increased by 1 percentage unit in the interval 10-27%, the number of days spent on treatment for diarrhoea increased by 0.04 day per pig. In this trial, each pig was treated for 0.9 day, which is low. There were no differences in the frequency of treatments for diarrhoea regardless of whether the pigs were given toasted soybean meal or dehulled toasted soybean meal.

If health and productivity are calculated in one index, it is seen that the production value with the same feed price drops slightly more with increasing inclusion of soybean meal, but due to the large difference in feed price between the groups, the increased costs are still covered. It is concluded that pigs from 9 kg are able to produce optimally on a diet in which soybean meal constitutes a large part of the protein sources. It is recommended to study a gradual increase in inclusion rates of soybean meal taking into regard the health level of the herd. Furthermore, the pigs should gradually switch over 5-7 days from a start diet to a diet 2 with a high content of soybean meal.

References

[1]	Callesen, J. & F. Thorup. 2004. Weaning after 26 vs 32 days (I) – effect on weaners. Report no. 663, The National Committee for Pig Production.
[2]	Callesen, J. & F. Thorup, 2005. Weaning after 29 vs 35 days (II) – effect on weaners. Report no. 722, The National Committee for Pig Production.
[3]	J. Callesen & M. Johansen, 2006. Importance of protein content and composition of feed for daily gain and post-weaning diarrhoea. Report no. 740. The National Committee for Pig Production.
[4]	Jørgensen, L. & P. Tybirk, 2006. Standards for nutrients, 13th edition, Danish Pig Production. www.infosvin.dk
[5]	Maribo, H., 2006. Weaner diets. Report no. 769, Danish Pig Production.

Participants

Technician Jens Ove Hansen

Statisticians Jens Vinther & Verne Ruby

Trial 899

Appendix 1

Composition of diet 2, %

Group	**1**	**2**	**3**	**4**	**5**	**6**
Wheat	64.74	58.01	55.11	52.68	61.16	53.70
Barley	12.15	11.61	11.02	10.54	12.23	10.74
Dehulled toasted soybean meal	**-**	**-**			**10.00**	**26.18**
Toasted soybean meal	**10.00**	**16.00**	**22.00**	**27.03**	**-**	**-**
Fishmeal, LT	**5.80**	**3.75**	**1.71**	**-**	**5.68**	**-**
Potato protein concentrate, Protastar	**5.81**	**2.63**	**1.20**	**-**	**3.98**	**-**
Vegetable fat (Scanfedt S)	1.60	2.19	2.81	3.32	1.50	2.00
Molasses	2.17	2.00	2.00	2.00	2.00	3.04
Mono calcium phosphate	0.80	0.91	1.03	1.12	0.81	1.15
Animal feed lime	1.17	1.25	1.33	1.40	1.17	1.37
Feed salt	0.32	0.37	0.42	0.47	0.32	0.47
Lysine 98.5%	0.24	0.29	0.34	0.37	0.24	0.36
Methionine 100%	0.03	0.06	0.09	0.12	0.03	0.12
Threonine 98.5%	0.04	0.07	0.10	0.12	0.03	0.09
Tryptophan 15%	0.40	0.35	0.30	0.26	0.39	0.24
Valine, 98.5%	0.01	0.05	0.08	0.11	-	0.08
Vitamin/mineral diet w. phytase	0.26	0.26	0.26	0.26	0.26	0.26
Vitamin E 25 000	0.20	0.20	0.20	0.20	0.20	0.20
Price with valine, DKK/FUgp (spring 2007)	2.08	1.99	1.88	1.80	2.04	1.74
Price without valine DKK/FUgp (spring 2007)	2.05	1.88	1.71	1.56	2.04	1.56

The following doses of vitamins were added to the diets per kg feed: vitamin A: 5720 IU, vitamin D3: 570 IE, vitamin E (DL-alfa tocoferol): 149.5 mg, vitamin K3: 2.29 mg, vitamin B1: 2.29 mg, vitamin B2: 4.58 mg, vitamin B6: 3.43 mg, pantothenic acid: 11.44 mg, niacin: 22.88 mg, biotin: 0.23 mg, vitamin B12: 0.02 mg. The feed contained the following amounts of minerals (natural content + added) per kg feed: 1.72 g sodium, 251.6 mg iron, 133.1 mg zinc, 73.5 mg manganese, 141.3 mg copper, 0.23 mg iodine, 0.32 mg selenium.

Phytase was added to the feed: 780 FYT per kg feed.

Appendix 2

Guaranteed and analysed nutrient content of diet 2

Group	1		2		3		4		5		6	
	Guarantee	Analysis	Guarantee	Analysis	Guarantee	Analysis	Guarantee	Analysis	Guarantee	Analysis	Guarantee	Analysis
Crude protein, % [1]	19.6	19.7	19.6	19.8	19.6	19.6	19.6	19.4	19.6	19.8	19.6	19.7
Crude fat, % [1]	4.2	4.2	4.7	4.6	5.2	5.0	5.5	5.4	4.0	4.1	4.9	5.1
Ashes, % [1]	5.7	4.9	5.8	5.1	6.0	5.3	6.1	5.4	5.7	4.8	6.3	5.3
Water, % [1]	11.9	11.0	11.8	10.9	11.7	11.0	11.6	11.0	11.8	10.8	11.5	10.8
FUgp per 100 kg [1]	117	117	117	116	117	116	117	115	117	117	117	117
Calcium, g/kg [1]	9.2	8.7	9.2	8.5	9.2	8.6	9.1	8.4	9.1	8.5	9.1	8.5
Phosphorus, g/kg [1]	6.1	6.1	6.2	6.1	6.3	6.3	6.4	6.3	6.1	6.2	6.4	6.5
Lysine, g/kg [2]	12.6	12.9	12.6	13.1	12.6	12.9	12.5	12.7	12.6	12.9	12.5	12.8
Methionine, g/kg [2]	4.0	4.1	3.9	4.0	3.9	3.9	3.9	3.9	4.0	4.1	3.9	3.9
Cystine, g/kg [2]	3.3	3.5	3.3	3.5	3.3	3.5	3.3	3.5	3.3	3.5	3.3	3.6
Met+cyst, g/kg [2]	7.3	7.6	7.2	7.5	7.2	7.4	7.2	7.4	7.3	7.5	7.2	7.5
Threonine, g/kg [2]	8.0	8.4	8.0	8.3	8.0	8.2	7.9	8.1	7.9	8.3	7.7	8.0
Tryptophan, g/kg [2]	2.9	3.1	2.9	3.1	2.8	2.9	2.8	3.3	2.9	3.1	2.8	3.3
Isoleucine, g/kg [2]	8.2	8.8	8.0	8.7	7.9	8.5	7.7	8.8	8.2	8.6	7.8	8.9
Leucine, g/kg [2]	14.7	15.1	14.4	14.6	14.0	14.1	13.7	15.3	14.7	14.4	13.8	15.5
Histidine, g/kg [2]	4.7	5.3	4.7	5.1	4.7	5.1	4.7	5.3	4.7	5.1	7.8	5.3
Fenylalanine, g/ [2]kg	9.3	9.4	9.2	9.3	9.1	9.1	9.0	9.4	9.3	9.3	9.1	9.6
Tyrosine, g/kg [2]	7.1	6.8	6.9	6.5	6.7	6.4	6.6	6.9	7.1	6.4	6.5	6.9
Fenyl.+tyrosin, g/kg [2]	16.4	16.2	16.1	15.8	15.8	15.5	15.6	16.3	16.4	15.8	15.6	16.4
Valine, g/kg [2]	9.7	10.6	9.4	10.4	9.1	10.4	8.8	10.4	9.7	10.2	8.8	10.4
Zinc, mg/kg [2]	133	132	133	129	133	146	133	132	133	144	133	138

[1] Average of 8 analyses.

[2] Average of 4 analyses.