

## THE EFFECT OF SUPPLEMENTAL THREONINE ON THE ILEAL DIGESTIBILITY OF AMINO ACIDS AND THE PERFORMANCE OF GROWING AND FATTENING PIGS<sup>1</sup>

### DJELOVANJE DODATKA TREONINA NA PROBAVLJIVOST AMINO KISELINA U ILEUSU I NA PROIZVODNA SVOJSTVA SVINJA U RASTU I TOVLJENIKA

**L. Babinszky, J. Tossenberger and J. Szabó**

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#### SUMMARY

The objective of present investigations was to determine the effect of various levels of threonine in diets on the ileal digestibility of amino acids in pigs in the first (30-60 kg) and the second (60-103 kg) fattening period. The effect of the threonine content of diets on the performance of growing (20-60 kg) and fattening (60-103 kg) pigs was also investigated. A total of 12 castrated males ( $32 \pm 2$  kg), fitted with an ileum-caecum type re-entrant cannula, were used in the digestibility trials. In the first period of trial (30-60 kg) the threonine content of the feed for the first treatment (treatment A) was 5.2 g/kg and for the second treatment (treatment B) 6.6 g/kg diet.

In the second period, the threonine levels in the diets were 3.6 g/kg for treatment A and 5.2 g/kg for treatment B respectively.

Ten pigs (50 % barren, 50 % female) per treatment were used in the performance trials. Their individual live weight at the beginning of the trial was  $20 \pm 1.8$  kg. Five treatments were applied in the trials. The experimental diet corresponded to treatment A in the digestibility trials, and contained 4.8 g (for the 20-60 kg phase) or 3.6 g (for the 60-103 kg phase) threonine per kg feed. For the second, third, fourth and fifth treatments, the threonine content was set in stages, by means of the addition of synthetic threonine, at 5.2, 5.6, 5.9, 6.3 g/kg for the growing period (20-60 kg) and 4.0, 4.4, 4.8, 5.2 g/kg (analysed values) for the fattening period (60-103 kg).

From the results it can be concluded that supplementation of the diet of growing and fattening pigs with synthetic threonine results in a significant increase in the ileal digestibility of threonine.

The results obtained from the model fattening trial show that an increase in average daily weight gain and feed conversion can be anticipated if the threonine content of the diet is set at 6.3 g/kg in the first fattening period and 4.8 g/kg in the second fattening period will result from the improved fattening parameters.

**Key Words:** Threonine, Digestibility, Performance, Fattening Pig.

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Prof. dr. Laszlo Babinszky, dr. Janos Tossenberger, dipl. ing. Janos Szabó, PANNON Agricultural University, Faculty of Animal Science, H-7401 Kaposvár, P.O. Box 16., Hungary

## INTRODUCTION

Experimental data published previously indicate that, among the range of amino acids which exert a limiting effect on the performance of pigs, besides lysine and methionine, principally threonine and tryptophan show such a limiting effect. Hence the scientific significance of the performance of trials which provide data on these two amino acids with respect to the requirements of growing and fattening pigs.

In general the requirement of pigs for limiting amino acids can scarcely be covered by synthetic amino acids without a considerable excess of the remaining amino acid accumulation.

Data published by Sauer and Ozimek (1986) indicate that supplementation of limiting amino acids by means of synthetic amino acids allows the protein level in the diet to decrease. In accordance with investigations carried out by Lenis and Diepen (1990), if precise amino acid requirement is known, the protein level can be reduced by 12 %.

The objective of the trials outlined in this paper was to determine how various levels of threonine in the diet (given that the levels of energy ( $ME_s$ ), crude protein, methionine, cystine and tryptophan remain constant) influence the ileal digestibility of essential amino acids and fattening performance in pigs.

In order to provide answers to these questions, investigations were carried out on the ileal digestibility and fattening performance of growing and fattening pigs.

## MATERIALS AND METHODS

### Digestibility trial

The digestibility trials were carried out in the first fattening period, using animals of live weight between 30 and 60 kg, and in the second fattening period, using animals of live weight between 60 and 103 kg. In the course of the trials two treatments were applied for each of these two live weight phases. The first treatment (A) involved a diet providing 13.2 MJ/kg metabolizable energy, the crude protein and lysine concentration being set in accordance with the recommendations of the ARC (1981). Methionine and cystine content and tryptophan content were set at 6.5 % and 19 % of the lysine content respectively. The threonine

content of the diet amounted to 5.2 g/kg in the first fattening period and 3.6 g/kg in the second fattening period.

For the second treatment (B), the metabolizable energy, crude protein, lysine, methionine, cystine and tryptophan content of the diet were set in accordance with those applied in the first treatment, while the threonine content was set at 60 % of the lysine content (6.6 and 5.2 g/kg respectively).

The experimental diets were constituted on the basis of grain meal and meat and bone meal. The nutrient and amino acid content of the diets are shown in Table 1.

The experimental animals consisted of semi-sibling castrated males of a male line of the KAHYB hybrid, which were fitted with re-entrant cannulas prior to the beginning of the trials. The average live weight of the animals before the start of the trials was 32 kg. Twelve animals per treatment (4 animals, 3 replicates) were used in the digestibility trials. The animals received their feed in liquid form (1 part feed to 2 parts water). The daily ration was set at 3.5% of the live weight, and was given in two equal portions. The digestibility trials consisted of a pre-period of 9 days and three 24-hour collection periods. 24-hour rest periods were programmed between the days scheduled for the collection of digesta. During the collection period, the total digesta for 24 hours was collected and kept refrigerated prior to processing.

### Fattening trial

Five treatments were applied in the model fattening trials. The first treatment in the first and second fattening period corresponded to the first treatment in the digestibility trials. The fifth treatment in the fattening trial was identical to that applied in the second treatment of the digestibility trial. Treatments 2, 3 and 4 applied in the first and the second fattening period differed from each other only in threonine content (Table 2).

Animals of the KAHYB genetic construction, with an average live weight of 20 kg, at the beginning of the trial, were used in this investigation. Ten animals (5 barrows and 5 gilts) were used for each treatment. These were kept in individual crates, and were provided with dry feed ad libitum. Feed intake and live weight were recorded continuously throughout the trial.

**Table 1. Nutrient and amino acid content of the diets (g/kg)**

**Tablica 1. Sadržaj hranjivih tvari i aminokiselina u hrani**

*Digestibility trial - Pokus probavljivosti*

	Treatments - Postupak			
	A		B	
	30 - 60 kg	60 - 103 kg	30 - 60 kg	60 - 103 kg
ME <sub>5</sub> (MJ/kg) <sup>a</sup>	13.2	13.2	13.2	13.2
Crude Protein - SB	165.0	120.0	165.0	120.0
Lysine	11.0	8.3	10.9	8.4
Met+Cys	7.1	5.5	7.0	5.5
Tryptophan	2.0	1.6	2.0	1.6
Threonine	5.2	3.6	6.6	5.2

<sup>a</sup> Calculated values - kalkulativne vrijednosti

**Table 2. Nutrient and amino acid content of the diets (g/kg)<sup>a</sup>**

**Tablica 2. Sadržaj hranjivih tvari i aminokiselina u hrani**

*Fattening trial - Pokus tovljenja*

	Treatments - Postupci				
	I.	II.	III.	IV.	V.
<b>20-60 kg:</b>					
ME <sub>5</sub> (MJ/kg) <sup>a</sup>	13.2	13.2	13.2	13.2	13.2
Crude Protein - SB	162.0	162.0	162.0	162.0	162.0
Lysine	10.5	10.5	10.5	10.5	10.5
Met+Cys	6.8	6.8	6.8	6.8	6.8
Tryptophan	2.0	2.0	2.0	2.0	2.0
Threonine	4.8	5.2	5.6	5.9	6.3
<b>60-103 kg:</b>					
ME <sub>5</sub> (MJ/kg) <sup>a</sup>	13.2	13.2	13.2	13.2	13.2
Crude Protein - SB	116.0	116.0	116.0	116.0	116.0
Lysine	8.4	8.4	8.4	8.4	8.4
Met+Cys	5.5	5.5	5.5	5.5	5.5
Tryptophan	1.6	1.6	1.6	1.6	1.6
Threonine	3.6	4.0	4.4	4.8	5.2

<sup>a</sup> Calculated values - Kalkulativne vrijednosti

### Laboratory analysis

The amino acid content of the feed mixes and of the freeze-dried digesta samples were determined in accordance with Bech-Andersen et al. (1990).

### Statistical analysis

Statistical analysis of the experimental data was carried out by means of variance analysis with the aid of SAS software (1990).

The statistical accuracy of significant differences observed between the treatments was checked by means of the TUKEY test (SAS, 1990).

## RESULTS

### Digestibility trial

The most significant experimental data obtained from these trials can be summarised as follows.

The ileal digestibility coefficients for crude protein and amino acids determined for the first and second fattening period can be seen in Table 3. In treatment A the animals were fed a diet containing a minimal level of threonine (4.8 g/kg); in treatment B the animals were given a diet with a high level of threonine (6.3 g/kg). As can be seen from the data presented in this table, various levels of threonine content did not influence the digestibility of lysine, methionine, cystine or tryptophan. Supplementation with synthetic threonine resulted, as anticipated, in

a significant increase in the ileal digestibility of threonine ( $P \leq 0.05$ ).

The ileal digestibility coefficients determined for the second fattening period are also shown in Table 3.

The tendency shown by the values obtained corresponds fully to that of the values originating from the first fattening trial.

### Fattening trial

The results obtained from the first fattening period (20-60 kg) can be seen in Table 4.

It is clear that, given the same feed intake but with a lower level of threonine (treatments I and II), the trial groups showed a significantly lower increase in live weight than the animals in the group provided with a diet of higher threonine content (treatments III, IV and V). Feed conversion increased by 14% in parallel with increase in live weight. In the second fattening period (60-103 kg) in groups IV and V, daily average feed intake increased with a higher level of threonine intake.

An increased feed intake of approximately 400 g resulted in a daily increase in live weight of over 300 g in groups IV and V. Although this rise in increase in live weight can be traced back to increased feed intake in every case, it cannot be ruled out that threonine has a favourable effect of increase in live weight. Threonine intake showed an insignificant effect on feed conversion.

**Table 3. Ileal digestibility of crude protein and amino acids (%)**  
**Tablica 3. Probavljivost sirovih bjelančevina i aminokiselina u ileusu, %**

	Live weight - Živa vaga					
	30 - 60 kg			60 - 103 kg		
	Treatments		RMSE*	Treatments		RMSE*
	A	B		A	B	
Crude protein - SB	72.6	71.9	2.9	78.0	76.4	2.8
Lysine	84.1	83.7	2.3	88.4	87.1	2.2
Methionine	87.5	87.0	1.5	88.9	88.2	1.7
Cystine	69.2	68.2	3.3	76.7	75.7	3.7
Tryptophan	73.7	73.8	3.5	76.8	75.7	3.1
Threonine	64.7 <sup>a</sup>	72.4 <sup>b</sup>	3.0	70.1 <sup>c</sup>	78.1 <sup>d</sup>	4.0

\* Root mean square error.

<sup>a,b</sup> Different letters denote significant difference between 30 and 60 kg  $P \leq 0.05$

<sup>c,d</sup> Different letters denote significant difference between 60 and 103 kg  $P \leq 0.05$ .

**Table 4. Results of the fattening trials**

**Tablica 4. Rezultati pokusa tovljenja**

	Treatments					
	I.	II.	III.	IV.	V.	RMSE*
<b>20-60 kg</b>						
Feed intake (g/day) - Uzimanje hrane (g/dan)	1609	1620	1636	1685	1688	117
Daily weight gain (g) - Dnevni prirasti, g	596 <sup>a</sup>	610 <sup>a,b</sup>	679 <sup>b,c</sup>	703 <sup>c</sup>	723 <sup>c</sup>	70
Feed conversion (kg/kg) - Konverzija hrane (kg/kg)	2.72 <sup>a</sup>	2.67 <sup>a</sup>	2.41 <sup>b</sup>	2.40 <sup>b</sup>	2.34 <sup>b</sup>	0.2
<b>60-103 kg</b>						
Feed intake (g/day) - Uzimanje hrane (g/dan)	2177 <sup>a</sup>	2364 <sup>a,b</sup>	2444 <sup>a,b</sup>	2590 <sup>b</sup>	2578 <sup>b</sup>	240
Daily weight gain (g) - Dnevni prirasti, g	573 <sup>a</sup>	671 <sup>a</sup>	799 <sup>b</sup>	869 <sup>b,a</sup>	851 <sup>b,a</sup>	119
Feed conversion (kg/kg) - Konverzija hrane (kg/kg)	3.84 <sup>a</sup>	3.42 <sup>b,c</sup>	3.09 <sup>b,c</sup>	3.04 <sup>d</sup>	3.04 <sup>b,d</sup>	0.3
<b>20-103 kg</b>						
Feed intake (g/day) - Uzimanje hrane (g/dan)	1906 <sup>a</sup>	1944 <sup>a,c</sup>	1982 <sup>a,b</sup>	2111 <sup>b,c</sup>	2098 <sup>b,c</sup>	139
Daily weight gain (g) - Dnevni prirasti, g	578 <sup>a</sup>	638 <sup>a,a</sup>	717 <sup>b,c</sup>	780 <sup>b</sup>	781 <sup>b</sup>	77
Feed conversion (kg/kg) - Konverzija hrane (kg/kg)	3.32 <sup>a</sup>	3.06 <sup>b</sup>	2.76 <sup>c</sup>	2.70 <sup>c</sup>	2.69 <sup>c</sup>	0.2

\* Root mean square error,

<sup>a,b,c,d</sup>: Different letter denote significant difference  $P \leq 0.05$ .

The Table 4. summarises also the total fattening period lengths (20-103 kg). It can be established that, with respect to fattening performance, average, daily feed intake in the groups with higher threonine content in the diet indicated an insignificant increase. Average daily gain increase showed a rising tendency up to treatment IV, but in group V, where the threonine content of the diet was 6.3 g/kg in the first fattening period and 5.2 g/kg in the second fattening period, no further increase was observed.

Feed conversion was also at an optimal level in group IV. The threonine content of the feed given in the first fattening period was 6.3 g/kg, that in the second fattening period being 4.8 g/kg.

#### CONCLUSIONS

The following are the major conclusions which can be drawn from the results presented in this study.

1. Supplementation of the diet of growing and fattening pigs with synthetic threonine results in a significant increase in the ileal digestibility of threonine.

2. The results obtained from the model fattening period and 4.8 g/kg in the second fattening

period. The amount of threonine is 56-57 % of that of lysine.

In this case, it can be anticipated that a reduction in the duration of the fattening period will result from the improved fattening parameters.

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## SAŽETAK

Cilj ovih istraživanja bio je odrediti djelovanje raznih količina treonina u hrani na probavljivost amino kiselina u ileusu u svinja u prvom (30-60 kg) i drugom razdoblju tova (60-103 kg). Isto tako je istraživano djelovanje sadržaja treonina u hrani na proizvodna svojstva svinja u porastu (20-60 kg) i u tovu (60-103 kg). U pokusima probavljivosti sudjelovalo je ukupno 12 kastriranih mužjaka ( $32 \pm 2$  kg) kojima je ugrađena povratna kanila tipa ileus-caecum. U prvom razdoblju pokusa (30-60 kg) sadržaj treonina u hrani u prvom postupku (postupak A) iznosio je 5.2 g/kg a u drugom postupku (postupak B) 6.6 g/kg.

U drugom razdoblju količina treonina u hrani bila je 3.6 g/kg u postupku A i 5.2 g/kg u postupku B.

Deset svinja (50% kastrata, 50% ženki) po postupku sudjelovalo je u pokusima proizvodnih svojstava. Njihova pojedinačna živa vaga iznosila je na početku pokusa  $20 \pm 1.8$  kg. U pokusima je primijenjeno 5 postupaka. Pokusna hranidba odgovarala je postupku A u pokusima probavljivosti a sadržavala je 4.8 g (za fazu 20-60 kg) ili 3.6 g (za fazu 60-103 kg) treonina na kg hrane. U drugom, trećem, četvrtom i petom postupku sadržaj treonina određen je u fazama dodatkom sintetičkog treonina po 5.2, 5.6, 5.9, 6.3 g/kg za razdoblje rasta (20-60 kg) i 4.0, 4.4, 4.8, 5.2 g/kg (analizirane vrijednosti) za razdoblje tova (60-103 kg).

Iz rezultata može se zaključiti da dodatak sintetičkog treonina u hrani svinja značajno povećava probavljivost treonina u ileusu.

Rezultati dobiveni iz pokusa tova pokazuju da se prosječno dnevno povećanje težine i konverzija hrane mogu predvidjeti ako je sadržaj treonina u hrani 6.3 g/kg u prvom razdoblju tova i 4.8 g/kg u drugom razdoblju tova. U tom slučaju može se očekivati da će smanjenje u trajanju razdoblja tova biti rezultat poboljšanih parametara tova.

Ključne riječi: Treonin, probavljivost, proizvodna svojstva, tovljenici