

# The Influence of Graded Levels of Protein on the Utilization of Nitrogen and Amino Acids in Canola Meal by Starter Pigs

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Previous studies for determining the protein quality and amino acid (AA) digestibility of canola meal (CM) and/or soybean meal (SBM) for swine have been primarily performed with growing and finishing pigs. Available information on the biological value (BV), net protein utilization (NPU) and AA digestibility of CM protein in starter pig diets is few and inconsistent. The objectives of this experiment were: 1) to determine the digestibility and retention of CM protein (N x 6.25) and 2) to determine the digestibilities among AA in CM when included in isoenergetic starter pig diets at graded levels.

## MATERIALS AND METHODS

Eight crossbred barrows, four from each of two litters, with an average initial weight of 9.0 kg were assigned to a 36 day nitrogen balance study. Animals were allotted to one of four dietary treatments on the basis of initial weight in a replicated 4x4 Latin square design. Protein in the diet was supplied by CM replacing cornstarch at levels of 7.8, 13.2, 17.0 and 23.8% (Table 1). The diets were balanced for digestible energy by the addition of corn oil.

Pigs were fed the diets in the form of a mash at a level of approximately 4% of body weight in three equal amounts at 0800, 1300 and 1800 h. Water was supplied ad libitum. The barrows were individually confined in 0.5 x 1.0 m metabolic crates which permitted separation and quantitative collection of feces and urine. Each of the four test periods lasted nine days. Pigs were allowed to adapt to each diet for the first five days of each period and feces and urine were collected for the next four days. Estimates of metabolic fecal nitrogen (N) and AA were determined according to the regression method (Mitchell 1924).

Data were analyzed by the least squares analysis of variance and differences between means were assessed using Student-Newman-Keuls (SNK) procedure (Steele and Torrie 1980). An additional analysis was computed in which treatment sum of squares was sub-divided into linear (L), quadratic (Q) and cubic (C) response curves (RC) and tested for significance ( $P < 0.05$ ).

## RESULTS

The composition and chemical analyses of the diets are presented in Table 1. The pigs gained an average of 168 g/day in liveweight during the 36 day trial. The apparent digestibility co-efficients (ADC) for dry matter (DM) and energy

linearly ( $P < 0.05$ ) decreased as the level of protein in the diet increased (Table 2). The ADC for N, apparent N balance and apparent NPU linearly ( $P < 0.05$ ) increased as the protein level in the diet increased. There was also a linear ( $P < 0.055$ ) increase in the apparent BV with increased levels of protein (Table 2).

The true N balance increased linearly ( $P < 0.05$ ) with increased protein level. The level of protein intake had no significant effect on true N digestion, true BV or true NPU. The co-efficients for true BV and NPU were 70.5 and 57.7%, respectively. The apparent digestibilities among all the indispensable AA linearly ( $P < 0.05$ ) and/or quadratically ( $P < 0.05$ ) increased as the dietary protein level increased (Table 3). The indispensable AA which had the lowest average apparent digestibility among the four levels of protein tested were isoleucine (73.7%), phenylalanine (74.3%), threonine (74.4%) and methionine (74.8%). No differences in the true digestibilities among the AA measured were detected (Table 3) as the level of CM protein in the diet increased.

## DISCUSSION

The observed differences among the ADC for DM and energy were most probably due to the increase in CM (high in fibre) at the expense of cornstarch which is low in fibre and high in digestible energy.

It is generally accepted that under standardized conditions, as the level of protein in the diet increases, apparent N and AA digestibility, BV and NPU increase, true BV and NPU decrease and the true N and AA digestibility remain constant (Eggum 1973). The only unexpected results in this study, therefore, were that true BV and NPU remained constant rather than decreased with increased protein levels. Partial explanation for this may be the affect of dietary fibre on microbial fermentation in the hindgut and fecal N excretion (Sauer et al. 1982). The calculated values for the true BV and NPU of CM for starter pigs were 70.5 and 57.7%, respectively.

## SUMMARY

The increased levels of CM protein in the diet of starter pigs resulted in a linear ( $P < 0.05$ ) decrease in the apparent digestibility of DM and energy and a linear increase in the apparent digestibility of N, nitrogen balance, BV and NPU. The level of crude protein had no significant effect on true N digestion (81.6%), true BV (70.5%) or true NPU (57.7%). The apparent digestibilities among the indispensable AA linearly ( $P < 0.05$ ) and/or quadratically ( $P < 0.05$ ) increased as the level of dietary protein increased. The level of protein in the diet had no significant effect on the true digestibility among the dispensable AA, with isoleucine (80.3%), threonine (80.3%), phenylalanine (81.8%) and leucine (82.0%) having the lowest average true digestibilities.

## ACKNOWLEDGEMENTS

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## REFERENCES

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TABLE 1. FORMULATION AND CHEMICAL COMPOSITION OF CANOLA MEAL (CM) SUPPLEMENTED DIETS CONTAINING FOUR GRADED LEVELS OF PROTEIN

LEVEL OF CRUDE PROTEIN (%):	7.8	13.2	17.0	23.8
<u>INGREDIENTS (%)</u> :				
Canola Meal (36.5% CP)	16.4	32.9	49.3	65.8
Corn Starch	69.6	51.1	32.7	14.2
Dextrose	10.0	10.0	10.0	10.0
Corn Oil	--	2.0	4.0	6.0
Premix <sup>1</sup>	4.0	4.0	4.0	4.0
<u>CHEMICAL ANALYSIS<sup>2</sup></u>				
Dry Matter (%)	89.40	89.60	90.10	90.90
Digestible Energy (MJ/kg)	13.42	13.49	13.84	13.94
Ether Extract (%)	0.76	2.12	4.61	7.08
Acid Detergent Fibre (%)	4.84	7.65	10.34	14.19
Neutral Detergent Fibre (%)	7.35	12.50	15.42	18.96
<u>INDISPENSABLE AA'S (%)</u>				
Arginine	0.46	0.80	1.04	1.45
Histidine	0.22	0.38	0.49	0.68
Isoleucine	0.32	0.55	0.70	0.97
Leucine	0.60	1.03	1.30	1.79
Lysine	0.44	0.75	0.98	1.34
Methionine	0.12	0.23	0.30	0.44
Phenylalanine	0.32	0.54	0.68	0.93
Threonine	0.35	0.62	0.80	1.08
Valine	0.41	0.70	0.91	1.24

<sup>1</sup> Starter premix provided the following per kg of diet: 5g iodized salt, 15g calcium phosphate, 10g ground limestone, 120.0 mg zinc, 12.0 mg manganese, 150.0 mg iron, 12.0 mg copper, 0.1 mg sodium, 0.12 mg cobalt, 0.04 mg magnesium, 0.1 mg selenium, 193.0 mg calcium, 5000 IU vitamin A, 500 IU vitamin D, 23 IU vitamin E, 4.0 mg vitamin K, 12 mg riboflavin, 45 mg niacin, 25 mg calcium pantothenate, 30 ug vitamin B, 500 mg choline chloride, 0.2 mg biotin, 1.5 mg pyridoxine, 1.0 mg folic acid, 0.15 g ethoxyquin, 275 mg ASP 250.

<sup>2</sup> Determined values reported on an as-fed basis.

TABLE 2. DAILY UTILIZATION OF DRY MATTER, ENERGY AND NITROGEN (N) IN CANOLA MEAL (CM) BY STARTER PIGS FED DIETS CONTAINING FOUR GRADED LEVELS OF PROTEIN<sup>a</sup>.

LEVEL OF CRUDE PROTEIN (%)	7.8	13.2	17.0	23.8	RC <sup>1</sup>
<b>CRITERIA</b>					
<b>DIGESTIBILITIES (%):</b>					
Dry Matter	88.9 a	85.1 b	81.9 c	77.5 d	L
Ether Extract	72.1 a	82.1 b	87.4 c	90.3 c	L, Q
Acid Detergent Fibre	39.1	39.0	40.4	45.3	NS
Neutral Detergent Fibre	58.8	64.9	63.1	61.1	Q
Digestible Energy	88.4 a	84.3 b	81.6 c	78.0 d	L
<b>DETERMINATIONS:</b>					
Apparent N digestion (%)	69.8 a	75.6 b	75.2 b	77.7 b	L
Apparent N Absorption (g/day)	4.1 a	7.4 b	9.4 c	13.7 d	L
Apparent N Retention (g/day)	2.5 a	4.8 b	6.2 c	9.1 d	L
Apparent BV (%) <sup>2</sup>	61.0	65.5	65.7	66.3	NS
Apparent NPU (%) <sup>3</sup>	42.7 a	49.5 b	49.5 b	51.6 b	L
True N Digestion (%)	81.6	82.5	80.7	81.6	NS
True N Absorption (g/day)	4.7 a	8.1 b	10.1 c	14.3 d	L
True N Retention (g/day)	3.3 a	5.7 b	7.1 c	9.9 d	L
True BV (%)	70.2	70.5	69.7	69.1	NS
True NPU (%)	57.3	58.2	56.3	56.5	NS

<sup>1</sup>RC, significance (P<0.05) of the linear (L) or quadratic (Q) response curves (RC) to the dietary level of protein (NS being not significant).

<sup>2</sup>Biological value, N retained expressed as a percentage of the N absorbed.

<sup>3</sup>Net Protein Utilization, N retention expressed as a percentage of the gross N intake.

<sup>a</sup>a-d, means within the same row with the same or no letter are significantly different (P<0.05).

TABLE 3. APPARENT AND TRUE FECAL AVAILABILITIES OF AMINO ACIDS (AA) IN CANOLA MEAL (CM) SUPPLEMENTED DIETS FED AT GRADED LEVELS OF PROTEIN TO STARTER PIGS<sup>2</sup>

LEVEL OF CRUDE PROTEIN (%)	7.8	13.2	17.0	23.8	RC <sup>1</sup>
CRITERIA					
<u>APPARENT AA (%)</u>					
Arginine	81.7 a	86.3 b	86.4 b	87.5 b	L, Q
Histidine	82.3 a	86.0 b	85.6 b	86.7 b	L, Q
Isoleucine	68.9 a	75.2 b	74.4 b	76.3 b	L, Q
Leucine	70.1 a	76.6 b	76.0 b	77.7 b	L, Q
Lysine	74.4 a	79.6 b	79.6 b	80.4 b	L, Q
Methionine	65.5 a	76.3 b	77.1 b	80.1 b	L, Q
Phenylalanine	69.5 a	75.8 b	75.1 b	76.8 b	L, Q
Threonine	69.1 a	76.4 b	75.4 b	76.7 b	L, Q
Valine	71.5 a	74.5 ab	77.4 b	79.0 b	L
<u>TRUE AA (%)</u>					
Arginine	88.7	90.4	89.4	89.6	NS
Histidine	87.9	89.3	88.1	88.5	NS
Isoleucine	79.6	81.6	79.5	80.1	NS
Leucine	81.5	83.3	81.4	81.7	NS
Lysine	82.0	84.2	82.8	82.8	NS
Methionine	81.0	84.0	83.3	84.4	NS
Phenylalanine	81.6	83.2	81.1	81.3	NS
Threonine	79.0	82.2	79.9	80.1	NS
Valine	84.3	82.0	83.0	83.1	NS

<sup>1</sup>RC, significance ( $P < 0.05$ ) of the linear (L) or quadratic (Q) response curves (RC) to dietary level of protein (NS being not significant).

<sup>2</sup>a-b, means within the same row with the same or no letter are not significantly different ( $P < 0.05$ ).