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Effect of Dietary L-Tryptophan Supplementation on Growth Performance and Serum Metabolites of Weaner Pigs

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Target Audience: *Academic researchers, Pig farmers, Animal Scientist*

Abstract

The effect of dietary L-tryptophan supplementation on growth performance and serum metabolites of weaner pigs was studied using a total of 12 male pigs weaned at 28 days of age. Four different diets with graded inclusion levels of 0.0, 0.1, 0.2 and 0.3% L-tryptophan/kg to corn-soyabean meal based diets were fed to a group of 3 piglets each. Pigs were allotted in a completely randomized design Experimental diets and water were supplied ad libitum for the period of six weeks. After the feeding trial, weekly growth performance (body weight gain, feed intake, and feed conversion ratio), haematological parameters and serum indices were determined. Increased dietary tryptophan supplementation significantly (P<0.05) affected only the lymphocytes and eosinophils among all haematological indices examined and there was no significant (P>0.05) difference in all serum indices measured. Total feed intake was significantly (P<0.05) affected by all the parameters measured for growth indices. This experiment showed that dietary tryptophan improved the growth performance and health status of weaner pigs.

Key words: *Tryptophan, Growth performance, Blood parameters, Weaner pigs.*

Description of Problem

Early weaning (10-28 days of age) is a common practice in pig farms which allows a greater number of piglets per sow per year, considered as an advantage in the productivity of the farm, as well as to decrease the transmission of diseases from the sow to the litter (1). At the time of weaning, the pig is exposed to a series of stressors that, if left unchecked, can lead to poor performance and increased mortality due to weaning, the piglet is forced to change from an almost ideal liquid diet, based on lactose, fat and milk protein, to a dry diet based on different proteins, fats and carbohydrates.

Dietary supplementation with appreciable amount of tryptophan can serve as therapeutic effect on the animal body. The reason for this is that tryptophan can influence the synthesis of serotonin, an inhibitory neurotransmitter of the central nervous system which has a sedative effect such as the suppression of sleep-wake mechanisms, temperature regulation, sensitivity to pain and aggressive behavior (1). Given a full understanding of the various effects of light upon the sow or boar, then specifications can be devised for artificial lighting to promote healthy, profitable pig production. Management of light is no different from other aspects of environmental control in pig production. Light has both direct and indirect effects on productivity, e.g. weight gain, feed uptake and feed conversion rate; pigs also show seasonal fluctuation in reproduction (rather than strict seasonality). Different degrees of seasonality are reported from different countries, ranging from distinct short day breeders (2), conventionally in countries from 50-60^o North and 30-40^o South (3) to no seasonal changes (4). The experiment reported here was conducted to evaluate the effects of diets supplemented with graded levels of tryptophan and exposure to light on performance of weaned pigs and serum indices of weaned pigs.

Materials and Methods

Twelve (12) male pigs weaned at 28 days of age were randomly assigned to 4 experimental diets containing 4 treatments supplemented with tryptophan (0.00, 0.1, 0.2 and 0.3% L-Trp/kg) with 3 pigs per treatment (n = 3). Pigs and their environment were monitored twice daily. Feed and water were provided *ad libitum* throughout the experimental period. Pigs in each experiment were allotted to treatments on the basis of body weight and the Body weight gain (BWG) and Feed intake (FI) were recorded weekly. Blood samples were collected at the end of the feeding trial. The animals were bled in the morning before feeding from the anterior vena cava. The blood samples were collected intravenously into the sample bottles containing EDTA for haematological studies Packed cell volume (PCV), Heamoglobin (Hb), Red blood cell (RBC), White blood cell (WBC), monocytes, eosinophils and platelets.

Table 1: Composition of the experimental diet fed to pigs

Ingredients	Control	Dietary L-Tryptophan Supplementation, g/kg		
		0.10%	0.20%	0.30%
Maize	40.00	39.90	39.80	39.70
Soybean meal	28.00	28.00	28.00	28.00
Fish meal	4.00	4.00	4.00	4.00
Corn Bran	20.00	20.00	20.00	20.00
Palm Oil	4.00	4.00	4.00	4.00
Di-calcium phosphate	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00
L-Tryptophan	0.00	0.10	0.20	0.30
Salt	0.30	0.30	0.30	0.30
Vitamin - Mineral premix	0.30	0.30	0.30	0.30
L- lysine	0.20	0.20	0.20	0.20
DL- Methionine	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00
Calculated Nutrients				
ME Kcal/Kg	3071.36	3067.93	3064.49	3061.06
Crude Protein %	20.96	20.95	20.94	20.93
Calcium %	0.40	0.40	0.40	0.40
Total Phosphorus %	0.41	0.41	0.41	0.41

-Ala was provided as an isonitrogenous control for L-Trp.[2]The vitamin premix provided per kilogram of complete diet: 6,613.8 IU of vitamin A as vitamin A acetate; 992.0 IU of vitamin D3; 19.8 IU of vitamin E;2.64 mg of vitamin K as menadione sodium bisulfate; 0.03 mg of vitamin B12; 4.63 mg of ribofl avin; 18.52 mg of D-pantothenic acid as calcium panthonate;24.96 mg of niacin; 0.07 mg of biotin.

[3]The trace mineral premix provided per kilogram of complete diet: 4.0 mg of Mn as manganous oxide; 165 mg of Fe as ferrous sulfate; 165 mg of Zn as zinc sulfate; 16.5 mg of Cu as copper sulfate; 0.30 mg of I as ethylenediamine dihydroiodide; and 0.30 mg of Se as sodium selenite.[4]SID = standardized ileal digestible.

The blood samples for serum analysis were allowed to clot, centrifuged and the serum was separated and stored in refrigerator at -20^{0}C until analyzed for serum parameters {albumin, globulin, total protein, glucose, cholesterol, triglycerides, high density lipoprotein (HDL), low density lipoprotein (LDL), very low density lipoprotein (VLDL), Serum enzymes (Aspartate aminotransferase (AST), Alanine aminotransferase (ALT) and Alkaline phosphate (ALP)}. The design used was a completely randomized design. Data were analyzed using ANOVA procedure of SAS (5). Duncan Multiple range (6) test was used to determine differences among treatment means. Means were considered different at p<0.05. The supplemental quantities of L-tryptophan levels in the diet that gave the best performance were determined by linear regression analysis

Results

Table 2 shows the growth performance of weaner pigs fed graded levels of L-tryptophan. The average initial body weight of pigs fed 0.0, 0.1, 0.2, and 0.3% dietary supplement of tryptophan and exposure to light were 9.43, 8.73, 9.10 and 9.07Kg respectively. There was no significant (P>0.05) difference among the treatment groups for initial body weight, final body weight, weight gain and feed conversion ratio (FCR). The final body weight for pigs on 0.1% and 0.2% tryptophan inclusion in the diet were the same (16.67Kg). Pigs fed with 0.3% tryptophan inclusion in their diets with light exposure had the highest total weight gain of 8.27Kg/ Week while Pigs without dietary tryptophan supplementation with light exposure had the lowest total weight gain of 6.23Kg/ week.

There was a significant (P<0.05) difference among the treatment groups for the total feed intake. The feed intake values as shown in Table 2 were 20.04, 19.12, 19.12 and 19.12Kg/week for the pigs fed with 0.0, 0.1, 0.2, and 0.3% dietary tryptophan respectively. The feed conversion ratio was highest and poor for pigs fed without dietary tryptophan (3.47per week) while pigs with 0.3% tryptophan inclusion had the lowest and best feed conversion ratio with 2.48 per week.

Table 2: Growth performance of weaner pigs fed graded levels of L- tryptophan

Parameters	0.0%	0.1%	0.2%	0.3%	SEM	$\alpha_{0.05}$
Initial Body Weight (Kg)	9.43	8.73	9.10	9.07	1.89	NS
Final Body Weight (Kg)	15.67	16.67	16.67	17.33	3.86	NS
Total Feed intake (Kg/week)	20.04^a	19.12^b	19.12^b	19.12^b	0.00	*
Total Weight Gain (Kg/week)	6.23	7.93	7.57	8.27	2.03	NS
Feed Conversion Ratio	3.47	2.80	2.61	2.48	0.85	NS

a,b, c : Means with different superscripts on the same row are significantly different(P<0.05)
$\alpha_{0.05}$: Level of significance; **NS**: No significant difference (p>0.05); ***:** Significant difference (P<0.05); **SEM**: Standard error of mean

Table 3: Haematological indices of weaners pig fed diets supplemented with graded levels of L-tryptophan

Parameter	0.0%	0.1%	0.2%	0.3%	SEM	$\alpha_{0.05}$
PCV (%)	23.33	28.33	24.67	27.33	4.68	NS
Haemoglobin (g/L)	7.78	9.44	8.22	9.31	1.62	NS
Erythrocytes(10^{12}/L)	7.53	8.37	7.78	8.03	0.55	NS
Leukocytes (10^9/L)	13350	14233	17267	18100	3168.38	NS
Lymphocytes(10^9/L)	41.00^b	55.33^a	46.47^{ab}	48.00^{ab}	3.62	*
Heterophils (10^9/L)	45.33	37.33	46.67	40.67	5.22	NS
Monocytes (10^9/L)	3.67	3.67	4.00	4.67	0.71	NS
Eosinophils (10^9/L)	3.33^{ab}	3.67^a	2.00^b	3.33^{ab}	0.58	*
Platelets (10^9/L)	157333	217333	210667	180333	76473.52	NS
MCV(fl)	31.60	33.82	32.05	34.56	7.07	NS
MCH (µµ/g)	10.53	11.27	10.68	11.78	2.44	NS
MCHC (%)	33.33	33.33	33.34	33.94	0.43	NS

a,b: Means with different superscripts on the same row are significantly different ($P<0.05$)
PCV: Packed cell volume**;** **MCV**: Mean corpuscular volume; **MCH**: Mean corpuscular Haemoglobin; **MCHC**: Mean corpuscular Haemoglobin
$\boldsymbol{\alpha_{0.05}}$: Level of significance; **NS**: No significant difference ($p>0.05$);*****: Significant difference ($P<0.05$); **SEM**: Standard error of mean

Table 4: Serum biochemical indices of weaners pig fed diets supplemented with graded level of L-tryptophan

Parameter	0.0%	0.1%	0.2%	0.3%	SEM	$\alpha_{0.05}$
Total Protein (g/dl)	5.42	5.42	4.81	5.01	1.02	NS
Albumin (g/dl)	4.15	4.31	4.03	4.04	0.22	NS
Globulin (g/dl)	1.27	1.11	0.78	0.97	0.43	NS
AST (µ/L)	110.91	53.52	54.92	78.61	40.06	NS
ALT (µ/L)	27.48	24.83	26.58	26.44	6.30	NS
ALP (µ/L)	32.34	26.60	30.74	32.18	4.47	NS
Cholesterol (mg/dl)	74.92	81.30	81.00	68.19	14.64	NS
Triglyceride (mg/dl)	48.24	57.97	32.30	33.12	13.47	NS
Glucose (mg/dl)	78.46	77.20	80.66	71.85	9.80	NS
HDL (mg/dl)	127.87	148.09	103.28	104.37	43.82	NS
VLDL (mg/dl)	9.65	11.59	6.46	6.63	2.69	NS

a,b : Means with different superscripts on the same row are significantly different ($P<0.05$)
ALT: alanine amino-transferase; **AST**: aspartate amino-transferase; **ALP:** alkaline phosphate**;** **HDL**: High density lipo-protein; **VLDL:** Very low density lipo-protein
$\boldsymbol{\alpha_{0.05}}$: Level of significance; **NS**: No significant difference ($p>0.05$); ***:** Significant difference ($P<0.05$); **SEM**: Standard error of mean.

Haematological indices of weaners pig fed diets supplemented with graded levels of L-tryptophan is shown in Table 3. There was no significant (P>0.05) difference in the PCV, Haemoglobin, RBC, WBC, Heterophils, Monocytes, paletelets, MCV, MCH and MCHC among the treatments groups. The highest PCV value was obtained in 0.1% tryptophan supplementation (28.33%) and lowest at 0.0% tryptophan supplementation of 23.33%. For WBC count, treatment group with 0.3% inclusion level had the highest values of 18100×10^9/L and treatment without tryptophan supplementation had the lowest values of 13350×10^9/L. The higher the tryptophan supplementation with light exposure, the higher the leukocytes count. There was a significant (p<0.05) difference in both lymphocytes and eosinophils values among the treatment groups. The tryptophan supplementation of 0.0, 0.1, 0.2 and 0.3% were 41.00, 55.33, 46.47, 48.00×10^9/L of lymphocytes respectively. 0.1% tryptophan supplementation had the highest value of lymphocytes of 55.33×10^9/L while lowest at 0.0% supplementation (41.00×10^9/L) while the eosinophils values of 0.0 and 0.3% tryptophan inclusion were the same (3.33×10^9/L), had the highest and lowest value at 0.1% and 0.2% tryptophan inclusion respectively.

Table 4 shows the serum biochemical indices of weaners pigs fed diets supplemented with graded levels of L-tryptophan with light exposure. There was no significant (P>0.05) difference among the serum biochemical parameters determined in all the treatments groups. Both 0.0% and 0.1% tryptophan inclusion had the highest value of 5.42g/dl. The highest value of serum globulin was obtained for pigs on 0.0% diet (1.27g/dl) and lowest at 0.2% (0.78g/dl). 0.2% supplemental tryptophan had the highest serum glucose value of 80.66 mg/dl. It was obtained that cholesterol fraction, high density lipo-protein (HDL) and very low density lipo-protein (VLDL), the lowest values was observed in treatment 0.2% supplemental tryptophan.

Discussion

Piglets benefit from increasing or long day lengths (of about 15-18 hours) (increasing suckling - improved milk composition - heavier and larger litters at weaning). Long or lengthening day length increase food intake in grower/finishers (7).

Feed intake is an important determinant of performance and may also reflect the health status of weanling pigs (8, 9). Recently it was demonstrated that the majority of weanling pigs did not start eating during the dark periods of the day (10). A minimal period without feed intake postweaning is considered essential to maintain the structure and function of the small intestine (11). There was an improvement in feed intake of pigs among all treatments, the improvement in feed intake and reduction in loss of BW observed for pigs weaned might be explained by a reduction in aggressiveness (12).

It is difficult to compare the results as total serum protein may vary greatly due to different feeding practices and genotype (13). Values obtained in this study ranges between 4.81and 5.42 g/dl for the treatment groups and these values are found within the normal range of 4.8 to 10.3g/dl reported by Mitruka and Rawnsley (14) as the normal total serum protein values for domestic swine. The non significant difference of serum albumin could be due to the isonitrogenous nature of the diets. These results are in agreement with Miller *et al*., (15) that reported that albumin levels tend to remain constant throughout life after reaching a maximum at 3 weeks of age. The higher the tryptophan supplementation, the higher the leukocytes values obtained.

There was a significant difference in the eosinophils values among the treatment groups. According to Jain (16), he reported that the normal range for swine eosinophils is 1.0 to 11. The range obtained was between 2.00 to 3.67. The result obtained suggests a positive immunity status of the pigs used at graded inclusion of tryptophan. Schalms *et al*., (17) gave the range of differential percentages of lymphocytes as 40 to 60% and Jain (16) gave the range as 39 to 62% while Mitruka and Rawnsley (14) reported a range of 49.1 to 68.9% for female pigs. The range obtained was 41.00 to 48.00% and this suggests that all weaner pigs in all treatments had values within the normal limit and this imply that the animals were free of any infections.

Conclusion and Applications

In this study,

1. Tryptophan supplementation improved the growth performance and health status of weaner pigs without any toxicity as most blood parameters were within the normal range.
2. No adverse effects were observed on biochemical and physiological homeostasis of animals fed graded levels of tryptophan.

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