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Aggressiveness and Productive Performance of Piglets Supplemented with Tryptophan

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Abstract: Early weaning is a common practice in pig farms, this might cause distress and fighting among piglets. The amino acid tryptophan is the precursor of the neurotransmitter serotonin, which has sedative effects that reduce aggression, however, it also has anorexigenic effects that could reduce feed intake and weight gain. In this study, it was evaluated tryptophan supplementation above requirement levels in social behaviour and productive performance of piglets weaned at 21 days of age. Four levels of dietary tryptophan were used (T_1, 0.23%, Control; T_2, 0.27%; T_3, 0.31% and T_4, 0.35%). Tryptophan was orally supplemented to each piglet every day. Treatments were randomly assigned to 544 piglets (5.69±1.14 kg) with 8 replicates per treatment. Behavioural observations of piglet activity were done for 6 h daily during four consecutive months, in periods of 8 days, from 14-2 h. Data were analyzed with PROC MIXED according to a completely randomized design with repeated measurements. Aggressiveness measured as biting appendixes (ears and tail) and fighting, were different among treatments ($p<0.05$) with less activity for T_3 (15.10±0.09, 42.19±0.13) and T_4 (12.25±0.09, 33.33±0.13%). However, no differences ($p>0.05$) were found for feed intake, daily weight gain and feed conversion between treatments. Results showed that tryptophan supplementation reduced aggression in weaned piglets, however, there was no change in productive performance.

Key words: Weaned piglets, tryptophan, aggression, productive performance

INTRODUCTION

Early weaning (10-28 days of age) is a common practice in farms dedicated to pig production, which on one hand allows to obtain 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 (Worobec *et al.*, 1999). However, there can be disadvantages to early weaning that have not been considered; since, in the case of piglets, it causes behavioral problems (Weary *et al.*, 1999; Worobec *et al.*, 1999).

In commercial swine production, weaning is probably one of the most stressful events in the life of a pig. Piglets experience abrupt environmental, social and dietary changes at a time when usually they should not face them. These include separation from the sow, change of environment, mixing with piglets from different litters and change from a liquid diet based on milk to a solid one mainly based on cereal grain. Weaning exposes piglets to different conditions that affect their well-being, which in turn causes stress. When tryptophan is supplemented in higher amounts than the requirements, it can be used as a therapeutic supplement. The reason of this is that tryptophan can influence the synthesis of serotonin, an inhibitory neurotransmitter of the central nervous system (Li *et al.*, 2006; Hartmann, 1986), which has a sedative effect such as the suppression of sleep-wake mechanisms, temperature regulation, sensitivity to pain and aggressive behavior (Li *et al.*, 2006).

There are evidences that implicate the serotonergic transmission in the feeding behaviour (Molfino *et al.*, 2008), which might decrease feed intake. Basomedial nuclei of hypothalamus and lateral hypothalamic area involved with control of the feeding behaviour, are innervated by serotonin neurons from the midbrain raphe (Madeiros *et al.*, 2005). Studies with administration of serotonin precursors, inhibitors of serotonin presynaptic uptake serotonin releasers, inhibitor of tryptophan hydroxylase and receptor serotonin are concordant with the serotonergic hypothesis of appetite modulation.

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Postsynaptic receptors 5HT1B and 5HT2C are the more relevant for the anorexigenic response in mammals and birds. Chou-Green *et al.* (2003) showed that 5HTC2C knockout mice developed hyperphagia and adiposity. In addition, hyperphagia and obesity after brain serotonin depletion induced by inhibition of tryptophan hydroxylase, or after neurotoxic lesion of serotonin neurons, have reinforced serotonergic hypothesis (Breisch *et al.*, 1976; Saller and Stricker, 1976).

The objective of this study was to investigate if supplementation of tryptophan above requirement levels affects aggressive behaviour and reduces feed intake in weaned piglets.

MATERIALS AND METHODS

Animals: Five hundred forty four hybrid (Yorkshire × Duroc × Pietrain) piglets (barrows and gilts) weaned at 21 of age, with an average body weight of 5.69±1.14 kg were used. Piglets were provided with feed (Table 1) and water *ad libitum*. The feed that animals received was a milk substitute for piglets diluted in water mixed with the pre-starter feed on the day of weaning; later they were only fed with the pre-starter feed. The pre-starter diets were offered as follows: pre-starter 1 was given on the 1st day after weaning. From the 2nd and 4th day, pre-starter 1 was mixed with pre-starter 2; on the 5th and 6th days after weaning pre-starter 2 was mixed with pre-starter 3 and finally, after the 6th day of age only the pre-starter 3 was provided. These mixtures were made in order to avoid digestive problems due to abrupt changes in the feed.

The navel was disinfected at birth; animals were also weighed and injected with iron. At 3 days of age they were tagged. On days 2, 9 and 16th after birth, a preventive treatment against joint problems was applied (0.3 mL of Minoxel Plus®, trademark by LAPISA®).

Animals were distributed in 4 pens (2.5×3.0 m) in groups of 17 pigs pen^{-1} with slatted floor and steel lined walls. The room had enough light and ventilation. Piglets were randomly assigned to 4 levels of tryptophan (T_1, 0.23%, control; T_2, 0.27%, T_3, 0.31% and T_4, 0.35%). Tryptophan was orally supplemented to each piglet every day, 3 days before and three days after weaning. Each pen was considered an experimental unit. Each treatment had 8 replicates.

All observations were made by the same observer. Behavioral observations of piglet activity were done for 6 h daily during 4 consecutive months, in periods of 8 days, from 14.00-2.00 h (Martin and Bateson, 1993). The proportion of time spent chewing ears and tail and fighting was registered and calculated as follows:

$$\text{Relative frequency} = \frac{\text{No. events of the behaviour}}{\text{Total hours of observation}}$$

Table 1: Composition of the pre-starter diets offered to the piglets during the experiment

Component (%)	Pre-starter 1	Pre-starter 2	Pre-starter 3
Dry matter	89.88	91.43	93.02
Organic matter	83.95	86.45	87.70
Ash	05.43	04.98	05.32
Ether extract	08.64	08.17	07.18
NDF[1]	22.74	26.05	24.19
ADF[2]	03.65	02.64	05.84
Crude Protein	21.21	20.88	18.38

[1]Neutral detergent fiber; [2]Acid detergent fiber

Daily Weight Gain (DWG) was determined. Piglets were weighed at the beginning and at the end of the experiment and the DWG was calculated with the following equation:

$$\text{DWG} = \frac{\text{Final weight -Initial weight}}{\text{Duration of the experiment (days)}}$$

Feed conversion was also calculated:

$$\text{Feed conversion} = \frac{\text{Daily feed intake}}{\text{Daily weight gain}}$$

Statistical analysis: The Kolmogorov and Smirnov normality test was applied to the data obtained in the behavioral study (Lehner, 1996), as well as the Bartlett variance homogeneity test (Herrera and Barreras, 2005). Data were then analyzed with PROC MIXED (Littell *et al.*, 1998) accordingly to a completely randomized design with repeated measurements. The statistical model was:

$$Y_{ijk} = \mu + T_i + R_{j(i)} + D_k + (TD)_{ik} + \varepsilon_{ijk}$$

where:

Y_{ijk} = Observed values
μ = General mean
T_i = Effect of the ith treatment
$R_{j(i)}$ = Effect of the jth replicate with the lth treatment
D_k = Effect of the kth day
$(TD)_{ik}$ = Treatment/day interaction
ε_{ijk} = Random error

Data obtained from the productive variables were analyzed with the GLM procedure, accordingly to a completely randomized design (Steel and Torrie, 1988), with the following model:

$$Y_{ij} = \mu + T_i + R_j + \varepsilon_{ij}$$

where:

Y_{ij} = Observed values of the ith treatment and jth replicate
μ = General mean
T_i = Effect of the ith treatment
R_j = Effect of the jth replicate
ε_{ij} = Random error

RESULTS AND DISCUSSION

Animals supplemented with the highest levels of tryptophan (T_3, T_4), showed a lower frequency ($p<0.05$) of biting appendixes (ears and tail) and aggression (fighting) with regard to T_1 and T_2 (Table 2).

No differences were observed ($p>0.05$) among treatments in daily weight gain, feed intake and feed conversion (Table 3).

At weaning time piglets from different litters are mixed. The variability of the animals, because of their different origin, tends to make them prone to show aggressive behavior (Erhard *et al.*, 1997). In this study, the behavior of biting appendixes (ears and tail) and aggression (fighting) in the piglets assigned to T_3 and T_4 had a lower frequency compared to T_1 (control treatment) and T_2. This agrees with what is mentioned in the literature that when administering tryptophan in quantities above the requirements, it can influence serotonin production at brain level (Fernstrom and Wurtman, 1971, 1972), diminishing aggressive behavior in animals (Fernstrom, 1983; Leathwood, 1987). Janczak *et al.* (2001), observed a tendency to decrease aggressiveness among animals when supplementing tryptophan in the drinking water of mice (2.08 g L^{-1}, approximately 0.4% of the daily feed intake). Tail biting is an abnormal behavior in pigs, which is thought to have a multifactor origin and it is considered an unpredictable event in farms, but it is associated with post-weaning mortality above 20.5% and the presence of breathing illnesses (Moinard *et al.*, 2003). This is of great importance because in Europe it is illegal to cut the tails and almost always, even if they are cut, the pigs tend to present this behavior, causing great losses due to the lesions caused to the skin of the animals.

Tryptophan supplementation of piglets positively affected some categories related with their behavior, however, it had no effect on their productive behavior (feed intake, daily weight gain and feed conversion). This suggests that when giving tryptophan above the requirements, feed intake does not decrease, result that agrees with that reported by Li *et al.* (2006). However, it is important to consider when tryptophan is supplemented that several nutritional factors can influence the passage of tryptophan across the blood-brain barrier to convert it into serotonin, such as the level in the diet of Large Neutral Amino Acids (LNAA; leucine, isoleucine, methionine, valine, phenylalanine and tyrosine), which compete with tryptophan for carrier proteins across the cell membrane; as well as the level of carbohydrates in the diet because high glycaemic diets increase insulin which in turn appears to remove selectively the LNAA from plasma with less effect on tryptophan (Clark and Mills, 1997) and the concentration of fatty acids, which compete with trypto-phan for binding to albumin (Grimmett and Sillence, 2005).

Table 2: Frequencies of biting appendixes (tail and ears) and aggression (fighting)

Treatments	Biting appendixes[2]	Fights
1 (0.23% de Tryptophan)[1]	53.650[a]	105.210[a]
2 (0.27% de Tryptophan)	25.270[a]	58.340[a]
3 (0.31% de Tryptophan)	15.100[b]	42.190[b]
4 (0.35% de Tryptophan)	12.250[b]	33.330[b]
SEM[3]	0.092	0.1282

Different superscript indicates differences among treatments ($p<0.05$); [1]Control treatmen; [2]Bites on ears or tail; [3]Standard error of the mean

Table 3: Productive variables evaluated in pigs weaned at 21 days of age

Treatments	DWG[1]	Feed intake	Feed conversion
1 (0.23% de Tryptophan)	140.08±50.13	170.36±28.67	1.21±0.73
2 (0.27% de Tryptophan)	145.45±38.45	169.21±30.55	1.16±0.42
3 (0.31% de Tryptophan)	139.07±35.85	167.38±46.35	1.20±0.31
4 (0.35% de Tryptophan)	145.12±33.61	160.80±36.29	1.10±0.27
P>F[2]	0.9825000	0.9524000	0.701700

Different superscript indicates differences among treatments ($p<0.05$); [1]Daily weight gain; [2]Probability

Daily weight gain in the present study was not different among treatments, which indicates that it did not increase with tryptophan supplementation. Similar results are reported by Séve *et al.* (1991), who provided tryptophan to young pigs and did not observe any change in feed intake, daily weight gain, or in feed conversion ratio.

CONCLUSION

The results obtained in this study showed that supplementation with tryptophan to pigs weaned at 21 days of age decreased the frequency of biting appendixes (ears and tail) and aggressiveness (fighting). However, it did not affect the productive behavior of the piglets.

REFERENCES

Breisch, S.T., F.P. Zemlamn and B.G. Hoebel, 1976. Hyperphagia and obesity following serotonin depletion by intraventricular p-chorophenylalanine. Science, 192: 382-385. PMID: 130678.

Clark, J. and D.S. Mills, 1997. Design Considerations for the Evaluation of Tryptophan Supplementation in the Modification of Equine Behavior. In: Mills, D.S., S.E. Heath and L.J. Harrington (Eds.). Proceedings of the 1st International Conference on Veterinary Behavioural Medicine. Universities Federation for Animal Welfare, Potters Bar, April 1-2, Birmingham, UK, pp: 164-173.

Chou-Green, J.M., T.D. Holscher, M.F. Dallman and S.F. Akana, 2003. Repeated stress in young and old 5HT2C knockout mice. Physiol. Behav., 70: 217-226. PMID: 12834793.

Erhard, H.W., M. Mendl and D.D. Ashley, 1997. Individual aggressiveness of pigs can be measured and used to reduce aggression after mixing. Applied Anim. Behav. Sci., 54: 137-151. DOI: 10,1016/SO168-159(97)00068-3. http://www.science_direct.com/science?=ob=ArticleURL&_udi=B6T48-3RXXXRP-6&_user=6180058&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000069457&version=1&_urlVersion=o&_userid=6180058&md5=3cb3e2750baa427f9f705ef69e7a844e.

Fernstrom, J.D. and R.J. Wurtman, 1971. Brain serotonin content: Physiological dependence on plasma tryptophan levels. Science, 173: 149-152. PMID: 5581909.

Fernstrom, J.D. and R.J. Wurtman, 1972. Brain serotonin content: Physiological regulation by plasma neutral amino acids. Science, 178: 414-416. PMID: 5077329.

Fernstrom, J.D., 1983. Role of precursor availability in control of monoamine biosynthesis in brain. Physiol. Rev., 63: 484-546. PMID: 6132421.

Grimmett, A. and M.N. Sillence, 2005. Calmatives for the excitable horse: A review of L-tryptophan. Vet. J., 170: 24-32. PMID: 15993787.

Hartmann, E.L., 1986. Effect of L-tryptophan and other amino acids on sleep. In diet and behaviour: A multidisciplinary evaluation. Proceedings of a Symposium. Arlington, Virginia. November 27-29, 1984. Nutrition Reviews. Supplement, pp: 70-73. PMID: 2980859.

Herrera, H.J.G. and S.A. Barreras, 2005. Statistical Analysis of Animal Experiments. 2nd Edn. Colegio de Postgraduados. México, pp: 216. ISBN: 968-839-300-2.

Janczak, A.M., M. Bakken and B.O. Braastad, 2001. A cautionary note regarding the use of nutritional L-tryptophan to alter aversion-related behaviour in mice. Applied Anim. Behav. Sci., 72: 365-373. PMID: 17426812.

Leathwood, P.D., 1987. Tryptophan availability and serotonin synthesis. Proc. Nutr. Soc., 46: 143-156. PMID: 2437591.

Lehner, P.N., 1996. Handbook of Ethological Methods. 2nd Edn. Cambridge University Press, UK, pp: 672. ISBN: 052-155-405-5.

Li, Y.Z., B.J. Kerr, M.T. Kidd and H.W. Gonyou, 2006. Use of supplementary tryptophan to modify the behavior of pigs. J. Anim. Sci., 84: 212-220. PMID: 16361509.

Littell, R.C., P.R. Henry and C.B. Ammerman, 1998. Statistical analysis of repeated measures data using SAS procedures. J. Anim. Sci., 76: 1216-1231. PMID: 9581947.

Madeiros, M.A., R.H. Costa-E-Sousa, L.M. Olivares, W.S. Cortés and L.C. Reis, 2005. A reassessment of the role of serotonergic system in the control of feeding behavior. Ann. Brazilian Acad. Sci., 77: 103-111. DOI: 10.1590/S0001-37652005000100008.

Martin, P. and P. Bateson, 1993. Measuring Behaviour. An Introductory Guide. 2nd Edn. Cambridge University Press, UK, pp: 222. ISBN: 0-521-44614-7.

Moinard, C., M. Mendl, C.J. Nicol and L.E. Green, 2003. A case control study of on-farm risk factors for tail biting in pigs. Applied Anim. Behav. Sci., 81: 333-355. DOI: 10.1016/SO168-1591(02)00276-9. http://www.sciencedirect.com/science?_ob=ArticleURL&-udi=B6T48-47P155J-4&_user=6180058&_rdoc=1&_fmt=&_orig=search&_sort=&view=c&_acct=C000069457&_version=1&_urlVersion=o&_userid=6180058&md5=15b9f212244f12bc953ad292a26ec277.

Molfino, A., M. Muscaritoli, A. Cascino, F. Fanfarillo, A. Fava, G. Bertini, G. Citro, F.R. Fanrlli and A. Laviano, 2008. Free tryptophan/large neutral amino acids ratios in blood plasma do not predict cerebral spinal fluid tryptophan concentrations in interleukin-1-induced anorexia. Pharmacol. Biochem. Behav., 89: 31-35. PMID: 18045669.

Saller, C.F. and E.M. Stricker, 1976. Hyperphagia and increased growth in rats after intraventricular injection of 5, 7-dihydroxytryptamine. Science, 192: 385-387. PMID: 841345.

Séve, B., M.C. Meunier-Salaun, M. Monnier, Y. Colleaux and Y. Henry, 1991. Impact of dietary tryptophan and behavioral type on growth performance and plasma amino acids of young pigs. J. Anim. Sci., 69: 3679-3688. PMID: 1718934.

Steel, R.G. and J.H. Torrie, 1988. Bioestadística: Principios and Procedimientos. 2nd Edn. McGraw Hill. México, D.F., pp: 622 . ISBN: 0-07-060926-8.

Weary, M.D., C.M. Appleby and D. Fraser, 1999. Responses of piglets to early separation from the sow. Applied Anim. Behav. Sci., 63: 289-300. DOI: 10.1016/SO168-1591(99)00021-0. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T48-3WD5B3H-3&_user6180058&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000069457&version=i&_userid=6180058&md5=54b5cc6d72f110aa30e6df5c.

Worobec, E.K., I.J.L. Duncan and T.M. Widowski, 1999. The effects of weaning at 7, 14 and 28 days on piglet behavior. Applied Anim. Behav. Sci., 62: 173-182. DOI: 10.1016/SO168-1591(98)00225-1. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T48-3VFFBM8-7&_user=6180058&-rdoc=1&_fmt=&_orig=search&sort=d&view=c&_acct=C000069457&version=1&_userid=6180058&md5=f607ea82fb45498506dc70629a1f6597.