INFLUENCE OF HUMIC ACIDS AS A FEED SUPPLEMENT ON THE REPRODUCTIVE PERFORMANCE OF SOWS

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ABSTRACT

A study was conducted to determine the effect of dietary natural humic acids as feed supplements in the diet on a sow's reproductive performance. During the survey, there were followed 26 pregnant and later farrowed sows together with their litters, divided into two groups, 12 of them belonged to the control group and 14 to the test group. In the test group, one month before the expected farrowing of sows (late gestation) to weaning, a commercial feed supplement from dietary humic acids was given. The prevalence of TPWL in the CG was 22.62%, while in the TG it was 17.19%. The prevalence of PWM was 8.45% in the CG, while in the TG it was 3.65%, but without a statistically significant difference. Depending on the sow's dietary treatment, there did not find a statistically significant influence on reproductive performances between the groups. A balanced sow's diet in the most sensitive period from farrowing to weaning is of great importance for obtaining improved reproductive performances in sows.

Key words: sows, pregnancy, lactation, nutrition, litter.

INTRODUCTION

Humic acids are a group of organic compounds that are naturally present in humus. They are formed in the soil by the decomposition of organic matter, especially plants (Islam et al., 2005; Vetvicka et al., 2010; Kaevska et al., 2016). Humic acids are insoluble in water in acidic conditions (pH<2), and soluble in water at a higher pH reaction. They contain up to 4% nitrogen and up to 33-36% oxygen. Soluble humic acids are in the form of potassium or sodium humates. Potassium humates are used in soils, while sodium humates are recommended for animals because sodium is an important inorganic electrolyte for the animal body.

Both, humic acids and fulvic acids are fractions of a group of organic compounds that are called humic substances. These organic compounds are found in well-decomposed peat (Vetvicka et al., 2010).

Current knowledge about the biological effects of humic acids on animals is limited and incomplete. Most of the research in this field refers to poultry production (Yang et al., 2019), especially broiler production, and lately also to pig production. However, there is almost no doubt among researchers that humic acids have very positive effects on the animal body (Wang et al., 2020). Thus, according to some authors, humic acids have a positive effect on the cardiovascular, endocrine, immune, and digestive systems (Thiel et al.,1981; Kühnart et al., 1991; Islam et al. 2005; Kunavue and Lien, 2012; Zhu et al., 2012; Kaevska et al., 2016; Trckova et al., 2017; Ferronato & Prandini, 2020). In addition, it has been determined that humic acids have an antioxidant effect and can help in the body's detoxification processes.

According to Thiel et al. (1981), humic acids have no adverse effects on animal health. They are non-toxic when used as a feed supplement for animal nutrition. Therefore, humic

acids can be freely used in domestic animal breeding technologies, especially in the so-called "antibiotic-free animal farming", due to their antibacterial effect. Substitution of antibiotics with humic acids as growth promoters in domestic animals does not cause loss of genetic performance of animals. Their use excludes the possibility of residues and resistance as with the use of antibiotics (Humin Tech, 2004).

Humic acids stimulate the absorption of macro- and microelements from food, which contributes to strengthening the body's immune response. Based on all this, it can be concluded that the use of natural humic acids and their derivatives like a feed supplement in the nutrition of domestic animals can fully satisfy the needs of organic farming.

No data were found in the available literature on the effect of humic acids on the reproductive performance of sows. However, according to the manufacturers, preparations with humic acids used as a feed supplement for sows, have a positive effect on the reproductive performance of sows: reduction in the number of aborted fetuses, lower differences in the birth weight of piglets (equalized litters), as well as the greater mass of the litter, and through the quality of the milk and the performance of the piglets in the litter (Organit Ltd).

The aim of this study was conducted to determine the effect of dietary natural humic acids as a feed supplement in the diet on a sow’s reproductive performance.

MATERIAL AND METHODS

The research was done on 26 pregnant and then farrowed sows with their litter. The sows were divided into two groups: a control group (CG) with 12 pregnant and then farrowed sows with their litters and a test group (TG) with 14 pregnant and then farrowed sows with their litters. The pregnant sows were kept in a gestation stall in individual crates until one week before farrowing, and then they were moved to a farrowing area where the sows were placed in farrowing crates with fixation. The housing and feeding conditions of the sows in both groups were identical and were following the stipulated norms.

To include the sows in the research that will farrow at approximately the same time, as well as to exclude other factors that could affect the results of the research, sows from both groups were inseminated in 4 cycles, three sows in a group of every 2 weeks. In the third and fourth cycles, 4 sows were included in the TG.

In the feed mixture for feeding the pregnant sows in the TG, one month before the expected term for farrowing and then after farrowing until the piglets weaning, a commercial preparation with 80% natural humic acids from the organic matter in powder form was added in the amount of 100 g/sow.

A commercial preparation with 80% natural humic acids from the organic matter in the form of a suspension was added in drinking bowls in the amount of 150 mL suspension/day/litter in the TG, in the period from one week after birth to weaning.

In all litters of farrowing sows, regardless of the experimental group, the following reproductive results of the litter were recorded for the research:

- total born (TB),
- live born (LB),
- stillborn (SB),
- non-vital (NV),
- preweaning mortality (PWM),
- total preweaning loss (TPWL)
- total weaned (TW).

RESULTS AND DISCUSSION

The reproduction data of the sow population that was included in the research are shown in table 1. Most of the sows had their fourth farrowing in a row, a total of 8, of which 2 were

in the CG and 6 were in the TG. Three sows in each group were having their first farrowing and 3 sows in each group were having their fifth or more than fifth farrowing in a row.

Only two sows that were included in the CG were conceived after the second insemination, while all other sows in the experiment were conceived after the first insemination, with a conception rate of 92.31%.

Table 1. Reproduction data of the studied sow population

Experimental group	n	Farrowing in a row					Number of inseminations	
		1	2	3	4	≥ 5	1	2
CG	12	3	3	1	2	3	10	2
TG	14	3	1	1	6	3	14	0
CG + TG	26	6	4	2	8	6	24	2
Conception rate							92.31%	

CG control group, TG test group

The conception rate in our research is higher than the conception rate obtained by de Andres et al. (2019). These authors, in their research, carried out in the last 10 years in pig farms in Spain, found an increase in conception rate (from 86.2% to 89.0%), and a decrease in the repetition of the service (from 11.3% to 8.6%). The determined high conception rate in our research indicates a good reproductive health status of the investigated sow population, but also of the whole herd if the random selection of the individuals is taken into account.

The duration of the pregnancy of sows for both experimental groups was almost identical, i.e. in the CG it was 113.42 ± 0.484 days, and in the TG, it was 113.64 ± 0.570 days (table 2). This data was the same as the generally known data for the duration of the pregnancy period in sow 3-3-3, ie 3 months, 3 weeks, and 3 days, or 114 days.

Table 2. Duration of pregnancy and examination period of sows

Experimental group	n	Duration of	
		pregnancy	examination period
		$\bar{x} \pm S_{\bar{x}}$	$\bar{x} \pm S_{\bar{x}}$
CG	12	113.42±0.484	60.58±0.733
TG	14	113.64±0.570	61.77±0.856
CG + TG	26	113.54±0.373	61.20±0.568

Table 3. Reproductive performance of the studied sow population from farrowing to weaning

	CG		TG		CG + TG	
	n	$\bar{x} \pm S_{\bar{x}}$	n	$\bar{x} \pm S_{\bar{x}}$	n	$\bar{x} \pm S_{\bar{x}}$
TB	168	14.00±0.564	192	13.71±0.507	360	13.85±0.371
LB	142	11.83 ± 0.458	165	11.79 ± 0.422	307	11.81 ± 0.304
SB	23	1.92 ± 0.358	27	1.93 ± 0.412	50	1.92 ± 0.271
NV	3	0.25 ± 0.179	0	0.00	3	0.12 ± 0.085
PWM	12	1.00 ± 0.275	6	0.43 ± 0.228	18	0.69 ± 0.182
TW	130	10.83 ± 0.474	159	11.36 ± 0.398	289	11.12 ± 0.303

Sows from the CG were included in the experiment for an average of 60.58 ± 0.733 days, while sows from the TG were included in the experiment one day longer, that is, 61.77 ± 0.856 days.

Table 3 shows the reproductive performance of the studied sow population from farrowing to weaning.

The difference in the TB in the litter between the two groups did not show statistical significance. On average, 14.00±0.564 piglets/litter were born in the CG, and 13.71±0.507 piglets/litter in the TG. There was no difference in the LB between the litters of both groups (11.83±0.458 piglets/litter in the CG and 11.79±0.422 piglets/litter in the TG). These results are within the results determined by de Andres et al. (2019), according to which the TB per litter for the period 2009-2018 in Spain increased from 12.4 to 15.3 piglets, and the LB increased from 11.4 to 13.7 piglets.

No difference was determined in the SB between the experimental groups. In the CG, SB was on average 1.92±0.358 piglets/litter, and in the TG, the SB was 1.93±0.412 piglets/litter. The data of SB in our research are slightly higher than the SB (0.9 - 1.2 piglets/litter) determined by de Andres et al. (2019).

NV was recorded only in litters in the CG (0.25±0.179 piglets/litter). No NV were registered in the litters included in the TG. The PWM in the litters of the CG, expressed in absolute value, was 1.00±0.275 piglets/litter, while the PWM in the litters of the TG was 0.43±0.228 piglets/litter.

The average TW in the CG was 10.83±0.474 piglets/litter, and in the TG it was 11.36±0.398 piglets/litter.

The average age of the piglets dying in the CG was 6.82±2.088 days, while in the TG piglets daying one day earlier, that is, at the age of 5.80±4.055 days (table 4).

Table 4. The average age of piglets at dying and weaning

Experimental group	The average age of piglets (days) at	
	dying	weaning
	$\bar{x} \pm S_{\bar{x}}$	$\bar{x} \pm S_{\bar{x}}$
CG	6.82±2.088	29.00±0.564
TG	5.80±4.055	29.31±0.347
CG + TG	6.50±1.839	29.16±0.320

The average age of piglets at weaning was almost identical for both groups, 29.00±0.564 days in the CG and 29.31±0.347 days in the TG.

Table 5 shows the loss of piglets in litters of the studied sow population depending on the experimental group.

Table 5. Loss of piglets in litters of the studied sow population

	CG		TG		CG + TG	
	n	%	n	%	n	%
SB	23	13.69	27	14.06	50	13.89
TB	168		168		360	
PWM	12	8.45	6	3.64	18	5.86
LB	142		165		307	
PWM + NV	15	10.56	6	3.64	21	6.84
LB	142		165		307	
TPWL	38	22.62	33	17.19	71	19.72
TB	168		192		360	

The prevalence of SB in the litters of the CG was 13.69%, and 14.06% in the litters of the TG. The prevalence of PWM in the litters of the CG was 8.45%, and 3.64% in the litters of the TG. However, the differences in PWM between CG and TG did not show statistical significance. Otherwise, the PWM in both groups was significantly lower than those determined by de Andres et al. (2019) where PWM was up to 11.5% - 13.2%.

The prevalence of TPWL which includes SB, PWM, and NV was 22.62% in the CG, and 17.19% in the TG. From the results presented in table 3 and table 5, it can be concluded that there is a difference of 0.82 piglets/litter between the TPWL in the CG and the TG (3.17 piglets/litter in CG compared to the 2.35 piglets/litter in the TG). Although this difference did not show statistical significance, it still means extra piglets were weaned per litter.

The statistical analysis of the obtained results showed a significant positive correlation ($P<0.01$) between TB and LB; TB and SB; and TB and PWM (table 6). Also, a high statistically significant correlation was determined between LB and TW ($p<0.01$). A negative statistically significant correlation exists between SB and TW ($p<0.05$).

Table 6. Pearson's correlation coefficient between the reproductive performance of the studied sow population

Reproductive performance	LB	SB	NV	PWM	TW
TB	0.631^{**}	0.561^{**}	-0.124	0.542^{**}	0.305
LB	1	-0.268	-0.025	0.263	0.824^{**}
SB		1	-0.119	0.323	-0.446^{*}
NV			1	0.292	-0.194
PWM				1	-0.317

** p<0,01; * p<0,05

The influence of the variable feeding regime of sows with humic acids as a feed supplement on the values of the variables for the reproductive performance of the studied population of sows was determined by regression analysis General linear model, a univariate procedure in the statistical program SPSS (Table 7).

Table 7. Influence of the addition of humic acids to the diet of sows on reproductive performance

Factor variable: Diet of sows with humic acids			
Source of variation	Degrees of freedom	Variance	F-value
Model	5	10.465	40.190***
TB	1	0.647	2.485^{ns}
LB	1	0.600	2.304^{ns}
SB	1	0.858	3.296^{ns}
NV	1	0.227	0.873^{ns}
PWM	1	0.135	0.519^{ns}
TW	1	0.067	0.258^{ns}
Error	20	0.260	
Total	26		
$R^2 = 0.923$			

*** p<0,001
^{ns} not significant

At the same time, through the analysis of the variance for the fixed variables of the reproductive performance for the different groupings depending on the factor variable, it was determined that there is no statistically significant difference between the reproductive performance in the experimental groups depending on the diet of the sows as a factor variable. The value for R^2 in the model was very high (R^2=0.923), which means that most of the variance in terms of diet can be explained by the fixed variables.

However, given the small population of sows involved in the experiment, one might expect this difference in a larger population to be statistically significant. Because the biggest losses in pig farming are in the period before piglets weaning, it is necessary for further research on the influence of humic acids on the reproductive performance of sows and obtaining a higher number of weaned piglets per litter.

In addition to this consideration can be added the research of Langendijk et al. (2019) was aimed at reducing the number of SB in sow litters. The authors tried adding supplements (patent protected) to the drinking water of the sows 5 days before the expected date of farrowing until the end of farrowing, to increase the oxygen level of the piglets at the time of birth, thus reducing the risk of asphyxia. At the same time, the TB was 15.7±0.6 piglets/litter. The number of LB increased to 14.7±0.3 piglets/litter compared to the CG (14.1±0.3 piglets/litter; $P<0.05$), which is almost 0.6 piglets/litter more. Although the number of weaned piglets in the litters of sows from the TG was not significantly higher compared to the number of weaned piglets in the CG (0.4 piglets/litter), the authors have the same conclusion as ours, that it still means extra weaned piglets per litter.

CONCLUSIONS

Based on the results obtained from the tests carried out to determine the influence of the use of a commercial preparation with humic acids as a feed supplement on the reproductive performance of sows, the following conclusions can be drawn:

The TPWL in the CG was higher (22.62%) than in the TG (17.19%), or in absolute value, the TPWL in the CG was 0.82 piglets/litter higher than in the TG.

A statistically significant positive correlation was determined between TB and LB; TB and SB; and TB and TW ($p<0.01$). A high statistically significant correlation was determined between the LB and the TW ($p<0.01$). There is a negative statistically significant relationship between SB and TW ($p<0.05$).

No statistically significant difference was determined between the reproductive performance of the sows in the experimental groups depending on the diet with commercial preparation with humic acids as a feed supplement as a factor variable.

REFERENCES

de Andres, M.A., Occon, A., Santiago, C., Diaz, I., Pineiro, C., Aparicio, M. (2019). Evolution of reproductive performance in Spanish farms in the last 10 years and prediction for 2020. Impact of farms' size. 11th European symposium of porcine health management, Abstract book, REP-OP-02, 22-24 May 2019, Utrecht, Netherlands.

Ferronato, G., Prandini, A. (2020). A review: Dietary supplementation of inorganic, organic, and fatty acids in pig. *Animals 2020*, 10, 1740; doi:10.3390/ani10101740, Peer reviewed open access journal, www.mdpi.com/journal/animals.

HuminTech. (2004). Huminfeed-Tierfutterzusätze and Laub, R., 1998a. Acute systemic toxicity studies of Veterinär Medizin and Huminsäure Basierende Produkte. Humintech®Humintech GmbH, Heerdter Landstr. 189/D, D-40549 Düsseldorf, Germany, http://www.fulvic.de/049/ani malfeeds/products/ huminfeed.html.

Islam, K.M.S., Schuhmacher, A., Gropp, J.M. (2005). Humic acid substances in animal agriculture. *Pakistan Journal of Nutrition* 4 (3), pg. 126-134.

Kaevska, M., Lorencova, A., Videnska, P., Sedlar, K., Provaznik, I., Trckova, M. (2016). Effect of sodium humate and zinc oxide used in prophylaxis of post-weaning diarrhoea on faecal microbiota composition in weaned piglets. *Vet. Med*., 61, pg. 328–336.

Kühnert, V.M., Bartels, K.P., Kröll, S., Lange, N. (1991). Huminsäurehaltige Tierarzneimittel in Therapie and Prophylaxe bei gastrointestinalen Erkrankungen von Hund und Katze. Monatshefte *Vet. Med*., 46, pg. 4-8.

Kunavue, N., Lien, T.F. (2012). Effects of fulvic acid and probiotic on growth performance, nutrient digestibility, blood parameters and immunity of pigs. *J. Anim. Sci. Adv.* 2, pg. 711–721.

Langendijk, P., Bergman, J., Fleuren, M. (2019). Pre-farrowing supplement through drinking water reduces stillbirth. 11th European symposium of porcine health management, Abstract book, REP-OP-06, 22-24 May 2019, Utrecht, Netherlands.

Organit Ltd, Hungary. Производител на препаратот „Vitapol".

Thiel, K.D., Helbig, B., Klöcking, R., Wutzler, P., Sprössig, M., Schweizer, H. (1981). Comparison of the in vitro activities of ammonium humate and of enzymically oxidized chlorogenic and caffeic acids against type 1 and type 2 human herpes virus. *Pharmazie,* 36, pg. 50-53.

Trckova, M., Lorencova, A., Babak, V., Neca, J., Ciganek, M. (2017). Effects of sodium humate and zinc oxide used in prophylaxis of post-weaning diarrhoea on the health, oxidative stress status and fatty acid profile in weaned piglets. Vet. Med., 62, pg. 16–28.

Vetvicka, V., Baigorri, R., Zamarren˜o, A.M., Garcia-Mina, J.M., Jean-Claude, Y. (2010). Glucan and Humic Acid: Synergistic Effects on the Immune System. Journal of medicinal food, 13 (4), pg. 863–869 # Mary Ann Liebert, Inc. and Korean Society of Food Science and Nutrition. doi: 10.1089=jmf.2009.0178.

Wang, Qi., Ying, J., Zou, P., Zhou, Y., Wang, B., Yu, D., Li, W., Zhan, X. (2020). Effects of dietary supplementation of humic acid sodium and zinc oxide on growth performance, immune status and antioxidant capacity of weaned piglets. *Animals*, 10(11), 2104 – doi:10.3390/ani10112104.

Yang, X., Liu, Y., Yan, F., Yang, C., Yang, Xi. (2019). Effects of encapsulated organic acids and essential oils on intestinal barrier, microbial count, and bacterial metabolites in broiler chickens. *Poultry Science*, 98, pg. 2858–2865, http://dx.doi.org/10.3382/ps/pez031.

Zhu, L.H., Zhao, K.L., Chen, X.L., Xu, J.X. (2012). Impact of weaning and an antioxidant blend on intestinal barrier function and antioxidant status in pigs. *J. Anim. Sci.*, 90, pg. 2581–2589.