

VÄLISAUTORID

EFFICACY OF *TOXY-NIL PLUS DRY* IN THE DIETS FOR FATTENING PIGS

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Abstract

Feeding mycotoxin-containing feeds to fattening pigs reduced the growth performance by 3,4% and increased feed consumption per kg gain by 3.3%. Feeding zearalenone-containing feeds caused clinical signs characteristic to this mycotoxin in 1.5 months. Supplementation of diets with *Toxy-Nil Plus Dry* (1.5 kg/t) increased daily weight gain of pigs by 8.9% and reduced feed consumption per kg gain by 6.8%. The usage of this product did not decrease the carcass and meat quality and was beneficial to the health of pigs fed mycotoxin-containing feeds.

Key words: mycotoxins, fattening pigs, pig feeding.

Introduction

Mould fungi decrease the quality of grain crops, and, besides, chemical substances (mycotoxins) produced by these fungi are detrimental not only to animal growth performance and health but also probably to human health through contamination of the animal products (Golinski, Grabarkiewicz-Szcesna, 1985; Butkus *et al.*, 1987; Diekman *et al.*, 1988; Pettersson *et al.*, 1989; Holmberg *et al.*, 1990; Plauska, 1995). As the fungal growth and formation of mycotoxins are closely related to environmental factors, it becomes impossible to avoid metabolism products from these fungi. Often it is distinguished between field- and storage fungi (Talanov, Chmelevskij, 1991; Pasteiner, 1994; Johnsson *et al.*, 1995). Typical storage fungi from the genera *Aspergillus* and *Penicillium* are found if the corn is harvested with a high moisture content and then stored without much drying or if it is moistened once stored. Of the many toxins produced by *Aspergillus* and *Penicillium*, *Aflatoxins* and *Ochratoxin A* are most often found. *Aflatoxins* are highly carcinogenic and accumulated in the animal body. The common symptoms are pale spots on the liver. *Ochratoxins* endanger the kidney which in turn damages the water regime of the animal. Like other mycotoxins these also lead to reduced feed efficiency, poorer growth performance and suppression of the immune system (Diekman *et al.*, 1988; Holmberg, 1992).

The most important field fungi are those belonging to the *Fusarium* species. Toxins from the *Trichothecene* group are also fusariotoxins considered to be a hundred-times more toxic than pesticides *Trichothecene* mycotoxins are deoxynivalenol (DON or vomitoxin), nivalenol, 3-acetyldeoxynivalenol, T2, HT-2 and others. These mycotoxins cause reduced feed intake and disturbance the digestive tract (Johansson, 1990; Bergsjö, 1994; Pettersson, Olvang, 1995).

One more fusarium toxin which also causes severe damage in pig production is zearalenone. Zearalenone is an oestrogen and entails reproductive disorders like enlargement and reddening of the vulva, enlargement of the uterus, lower semen quality of boars that results in lower fertility or even infertility (Lee *et al.*, 1987; Kostin, 1987).

The addition of special antimycotoxic products to the diets of pigs may be beneficial. One of these products is *Toxy-Nil Plus Dry* characterized by highly effective and specific absorption and presence of enzyme ingredients. This product is environmentally friendly, and all its ingredients comply with the EU requirements for feed additives.

The present study was designed to investigate the effect of *Toxy-Nil Plus Dry* on the growth performance, feed efficiency, feed intake and general health of fattening pigs as well as carcass quality, physical values and chemical composition of meat in feeding mycotoxin-containing feeds.

Materials and Methods

In 1999, a study was conducted at the Lithuanian Institute of Animal Science to determine the efficiency of the antimycotoxin product *Toxy-Nil Plus Dry* in the pig diets containing mycotoxins. The experimental design is presented in Table 1.

Table 1. Experimental design

Group of pigs	No. of pigs	Description of compound feeds
Control 1	7	Good quality compound feed
Experimental 2	7	Mycotoxin-containing feed
Experimental 3	7	Mycotoxin-containing feed supplemented with <i>Toxy-Nil Plus Dry</i> (1.5 kg/t)

Three analogous by parentage, age and weight groups of 7 weaned pigs each were formed. Pigs in all groups were fed *ad libitum* compound feed composed of barley and protein-vitamin-mineral supplement N 23 manufactured at the joint-stock company “Kėdainių biochemija”. The composition and nutritive value of the diets is presented in Table 2. Pigs were fed three times a day from troughs with moistened feed and had free access to water. Weight gains were determined by weighing pigs at the start, later each month and at the end of the experiment. Housing conditions were the same for all groups of pigs. Four pigs were chosen by analogue principle from each of the three groups for control slaughtering. Meat quality was determined by taking the samples of meat from the *musculus longissimus dorsi*. Physical (pH, cooking loss, colour, water-binding capacity) and chemical (dry matter, protein, fat, mineral matter contents) indicators of meat were determined at the Analytical Laboratory of the Lithuanian Institute of Animal Science.

Table 2. Composition and nutritive value of the diets

Item	Pigs under 60 kg weight		Pigs over 60 kg weight	
	Group 1	Groups 2 and 3	Group 1	Groups 2 and 3
Good quality barley, %	80	30	86	–
Mouldy barley, %	–	50	–	86
PVMS, %	20	20	14	14
Analysis (/kg feed):				
Metabolizable energy, MJ	11.1	11.1	11.0	11.0
Crude protein, g	167.7	167.2	149.8	148.8
Fibre, g	53.9	53.9	53.9	53.9
Fat, g	24.3	24.3	23.2	23.2
Calcium, g	7.6	7.6	5.6	5.6
Phosphorus, g	5.3	5.3	4.6	4.6
Lysine, g	8.2	8.2	7.0	7.0
Methionine+Cystine, g	4.7	4.7	4.3	4.3

The toxic level of aflatoxin in meat was determined at the National Veterinary Laboratory and the content of mycotoxins was determined at the joint-stock enterprise “Labtarna”. All the main data with the exception of the chemical composition of feeds and feed consumption were processed biometrically. $P < 0.05$ was an indicator of the data of significance.

Results and Discussion

Quality of feeds. Barley naturally contaminated with mouldy fungi was used to manufacture compound feeds for Groups 2 and 3. The analysis of barley indicated fungi from the genera *Penicillium*, *Alternaria*, *Mucor*, *Fusarium* species and *Aspergillus flavus*. The levels of mycotoxins in the manufactured feeds (the grain part of which was exceptionally

contaminated barley) were 0.0015 mg/kg of aflatoxin, 0.09–0.13 mg/kg of ochratoxin and 0.66 mg/kg of zearalenone. Mycotoxin T2 was also detected. It can be understood that the compound feed contained also other mycotoxins produced by these fungi the levels of which, however, cannot be detected in Lithuania.

Growth performance. Growth performance data of pigs is shown in Table 3.

Table 3. Growth performance of pigs

Item	Group 1	Group 2	Group 3
Average weight, kg			
at the start	34.5±0.72	34.5±0.72	34.4±0.76
at 5 months	61.6±2.17	62.1±0.75	64.4±1.08
at the end	100.1±3.63	97.9±1.57	103.4±2.48
Average daily gain, g			
at 3–5 months	522±36.7	530±15.2	576±15.2
at 5–7 months	592±37.7	552±23.4	601±27.7
Total average	561±26.6	542±12.3	590±21.1

Note: Differences between the groups were statistically insignificant ($P > 0.05$).

The data from the experiment indicated that in the first fattening period the growth performance of pigs fed the mycotoxin-containing feed in Group 2 was similar to that of control pigs (the difference between the groups was only 1.5%). Thus, the diet containing only 50% of mouldy barley may have no negative effect on the growth rate of pigs. The daily gain of pigs (Group 3) fed the mycotoxin-containing feed supplemented with *Toxy-Nil Plus Dry* was on the average by 8.7 and 10.4% higher than that of pigs in, respectively, Group 2 and Group 1.

In the second fattening period, pigs (Group 2) fed ochratoxin, T2 (supposedly also other mycotoxins affecting the growth rate), zearalenone and little aflatoxin containing compound feeds gained daily on the average by 6.8% less in comparison with the control group of pigs. The pigs in Group 3 gained daily by 8.9% more than the pigs in Group 2. The daily gain of pigs in Group 3 did not differ significantly from that of pigs in Group 1. Thus, supplementation of mycotoxin-contaminated diets with *Toxy-Nil Plus Dry* (1.5 kg/t) was efficient in inactivation of the mycotoxins.

The total average daily gain of pigs in Group 2 was by 3.4% lower than that the control group of pigs. Thus, even partial feeding in pigs with mycotoxin-containing feeds results in certain losses. The daily gain of pigs in Group 3 was on the average by 8.9 and 5.2% higher than that of pigs in Groups 2 and 1, respectively. Thus, 1.5 kg of *Toxy-Nil Plus Dry* per ton of feed was sufficient for absorption and decomposition of mycotoxins and beneficial to the growth of pigs. Weight of pigs fed the *Toxy-Nil Plus Dry* (1.5 kg/t) supplement diet was by 5.6% higher in comparison with Group 2.

Feed intake. Intake of compound feeds is presented in Table 4.

Table 4. Compound feed intake

Item	Group 1	Group 2	Group 3
Daily feed intake per pig, kg			
at 3–5 months of age	1.78	1.89	1.90
at 5–7 months of age	2.92	2.82	2.87
Total	2.37	2.41	2.44
Feed intake per kg gain, g			
at 3–5 months of age	3.41	3.57	3.31
at 5–7 months of age	4.92	5.10	4.78
Total	4.30	4.44	4.14

In the first fattening period, pigs in Group 2 consumed daily on the average by 6.2% more feed than pigs in Group 1. However, at the same time feed consumption per kg gain was by 4.7% higher. Supplementation of the diet with *Toxy-Nil Plus Dry* had no significant influence on the intake, however, it reduced feed intake per kg gain. The pigs in Group 3

consumed by 7.3 and 2.9% less feed per kg gain in comparison with the pigs in Group 2 and Group 1, respectively.

In the second fattening period, the pigs in Group 2 consumed daily on the average by 3.4% less feed and feed intake per kg gain was by 3.7% higher in comparison with Group 1. Pigs in Group 3 consumed by 6.3 and 2.8% less feed per kg gain in comparison with the pigs in Group 2 and Group 1, respectively.

The total daily feed intake for the pigs in Group 2 was almost the same as for the pigs of the control group (the difference between the groups was only 1.7%), but the feed intake per kg gain was by 3.3% higher. Thus, if pigs are offered mycotoxin-containing feeds, feed intake per kg gain will be higher than that of pigs fed high quality feeds even if feed intake is not reduced. Pigs in Group 3 fed the diet supplemented with *Toxy-Nil Plus Dry* consumed by 6.8 and 3.7% less feed per kg gain in comparison with pigs in Group 2 and Group 1, resp. It can be concluded that this antimycotoxic product has not only a positive effect on the growth performance of pigs, but also reduces feed expence per kg gain and has no negative influence on feed intake.

Health of pigs. In the course of the experiment, all diseases of pigs as well as usage of veterinary preparations were recorded. No death cases were recorded in any of the groups. No cases of diarrhoea or other disturbance of digestive tract were observed. Clinical signs characterized to ochratoxins, aflatoxins and T2 were not observed as well as any disturbance of behaviour. However, genitalia changes were determined for immature pigs in Group 2 in 1.5 months after the start of the experiment. It was determined that 0.66 mg of zearalenone per kg feed resulted in clinical signs characteristic to this toxin. Similar results were also obtained by other authors in their studies on the influence of zearalenone on pigs (Kostin, 1987). However, clinical signs characteristic to zearalenone were not determined for pigs fed the diet supplemented with *Toxy-Nil Plus Dry*. Thus, *Toxy-Nil Plus Dry* was efficient in inactivation of zearalenone in the diets for fattening pigs. Blood analysis of pigs in all groups did not indicate the significant difference between the groups.

Carcass quality. Control slaughtering results presented in Table 5 showed that the dressing percentage and ham weight of pigs fed the feed contaminated with mycotoxins (Group 2) did not differ from the values in the control group. However, backfat thickness at 6–7th rib was by 1.3 mm or 4.5% thinner and loin lean area by 1.9 cm² or 5.8% smaller for the pigs in Group 2 in comparison with the control group. Thus, carcass quality of pigs fed the mycotoxin-containing feed was lower. The dressing percentage and ham weight of pigs in Group 3 fed the diet supplemented with *Toxy-Nil Plus Dry* did not differ significantly from those in the control group. However, backfat thickness at 6–7th rib was by 2.3 mm or 8.3% higher than that of the pigs in Group 2 but did not differ significantly from that of the control group. The loin area of the pigs in Group 3 was by 12.4 and 5.8% higher than that of pigs in Group 2 and Group 1, respectively. Hence, *Toxy-Nil Plus Dry* had no negative effect on the carcass quality.

Table 5. Control slaughter results

Item	Group 1	Group 2	Group 3
Finnish weight, kg	108.3±2.18	102.9±1.08	109.5±3.13
Carcass weight, kg	78.9±2.09	74.7±1.24	79.9±1.63
Dressing percentage	72.9±0.48	72.6±0.79	73.0±0.62
Backfat thickness at 6–7 th rib, mm	28.9±3.85	27.6±2.08	29.9±3.58
Ham weight, kg	8.3±0.34	8.3±0.17	8.4±0.33
Loin lean area, cm ²	32.6±0.27	30.7±1.55	34.5±2.95

Note: Differences between the groups were statistically insignificant ($P > 0.05$).

Physical values and chemical composition of meat. Physical and chemical indicators of meat are presented in Table 6.

The analysis of the physical qualities of meat indicated that the feed contaminated with mycotoxins had no significant influence on the pH-value, colour, cooking losses and water binding capacity of meat. Insignificant reduction of the pH value and colour intensity of meat were determined for pigs in Group 3. *Toxy-Nil Plus Dry* had no significant influence on the other physical characteristics of meat.

Table 6. Physicochemical indicators of the *musculus longissimus dorsi*

Item	Group 1	Group 2	Group 3
Meat pH	5.38±0.095	5.45±0.044	5.38±0.071
Colour intensity, units	56.67±12.269	57.0±9.339	55.38±10.379
Cooking losses, %	41.14±0.551	40.88±0.873	40.81±0.358
Water binding capacity, %	54.80±3.535	55.12±1.089	54.37±1.651
Dry matter, %	25.16±0.553	24.79±0.367	24.88±0.325
Protein, %	22.44±0.350	22.21±0.442	22.13±0.253
Fat, %	1.67±0.445	1.39±0.367	1.48±0.604
Ash, %	1.04±0.017	1.09±0.038	1.17±0.062
Tryptophan, %	313.37±4.386	309.68±7.441	314.6±5.085
Oxyproline, %	58.87±3.708	65.04±2.113	58.08±1.180
Try / Oxy ratio	5.36±0.260	4.77±0.063	5.42±0.127

Note: Differences between the groups were statistically insignificant ($P>0.05$).

The analysis of the chemical composition of meat indicated that the feed contaminated with mycotoxins had no significant influence on the contents of dry matter, protein, fat and ash in meat. However, the content of tryptophan in the muscular tissue was lower by 3.67% and the content of oxyproline in the connective tissue was higher by 6.17% for the pigs in Group 2. These differences were statistically insignificant. The tryptophan : oxyproline ratio was lower for the experimental group in comparison with the control group of pigs. This is an indication of the lower protein value of meat when pigs are fed mycotoxin-containing feeds. *Toxy-Nil Plus Dry* supplementation of the diet resulted in by 4.9% higher content of tryptophan and by 6.96% lower content of oxyproline in comparison with Group 2. The content of these amino acids did not differ significantly from that of the control group. The ratio of these amino acids leads to the conclusion that *Toxy-Nil Plus Dry* had a positive effect on the protein value of meat.

The level of aflatoxin was determined in the meat of pigs, because *Aspergillus flavus fungi* were detected in the feed offered for the pigs in experimental groups. Notwithstanding the fact that traces of aflatoxin were detected in feed, no aflatoxin was detected in meat. This can be explained partially by different methods applied for detection of aflatoxin in feed and meat.

Conclusions

Daily weight gain of pigs fed mycotoxin contaminated feeds were by 3.4% lower and feed intake per kg gain was by 3.3% higher compared with the control group. Clinical signs characteristic to zearalenone were determined for pigs in 1.5 months of such feeding. Backfat thickness at 6–7th rib and loin lean area were lower for pigs fed contaminated feeds. The level of tryptophan has decreased by 3.67% and the level of oxyproline increased by 6.17% in the meat of pigs fed contaminated feeds.

Toxy-Nil Plus Dry supplementation of feeds contaminated ochratoxins, zearalenone, slightly aflatoxin and T2 increased the daily gain of fattening pigs by 8.9% and decreased the feed intake per kg gain by 6.8%. This product improved the health of pigs. Clinical symptoms characteristic to the analysed mycotoxines were not observed for the experimental pigs. *Toxy-Nil Plus Dry* had no negative influence on the carcass and meat quality of pigs.

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