Evaluation of two toxin binders effectiveness in reducing zearalenone toxic effects on gilts

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Abstract

Zearalenone (ZEA), a mycotoxin recognized with estrogenic effects, has a contaminant prevalence in corn, sorghum and wheat, mainly being produced by fungi: *Fusarium graminearum*, and other species such as *culmorum* and *tricintum*. Zearalenone effects are estrogenic. Being swine one of the most sensitive animals. Gilts often present hyperestrogenism and manifest as vulvovaginitis and mammary glands enlargement. The objective of this study was to assess ZEA toxic effects in gilts, during 52 days' period, consuming naturally contaminated feed, using 1200 ppb levels (ZEA) and verify two commercial toxin binders efficiency to reduce their potential detrimental effects. 24 recently weaned gilts were selected; first seven days were for adaptation, then each gilt was assigned within one of the four experimental groups identified as: 1) control diet without ZEA, 2) positive control diet with 1,200 ppb of ZEA, 3) challenge diet with 1,200 ppb of ZEA and 1.5 kg / t of organoaluminosilicate, 4) challenge diet with 1,200 ppb of ZEA and 1.5 kg / t of aluminosilicate + yeast cell walls. The obtained information was analyzed through the statistical software SYSTAT, by the Tukey test where the difference of means was defined. The significance value was based on a $p < 0.05$. There were statistically significant differences in reproductive tract weight and length, vulva volume and cervix width between treatments.

Keywords: Zearalenone, gilts, reproduction, organoaluminosilicate, vulvovaginitis, hyperestrogenism, toxin binders.

Introduction

Mycotoxins contamination is a problem with serious repercussions, both economic and health, human and animal. The United States Council on Science and Technology (CAST, 2003) reported that mycotoxins have caused annual economic losses of \$932 million dollars averaged, and reported 25% of crops worldwide to be contaminated with fungi capable to produce mycotoxins. Most of mycotoxins that are considered to be important are produced by three fungi genera (*Aspergillus*, *Fusarium* and *Penicillium*); also mention mycotoxins produced by the *Claviceps* fungi and those becoming increasingly important in human health that are mycotoxins produced by *Stachybotrys* fungi. Zearalenone (ZEA) is a mycotoxin reported with estrogenic effects, usually prevalent in corn, wheat and sorghum. The main producing fungi is *Fusarium graminearum*, although other species also produce it, such as *culmorum* and *tricintum*, optimal production conditions consist in low temperatures and high levels of humidity, considered as fall mycotoxin produced in the field, before harvest. The estrogenic effects of Zearalenone are manifested in the urogenital system, swine are considered to be the most sensitive animal species, particularly in weaning piglets, gilts and sows. Lesions are expressed as vulvovaginitis and enlargement of the mammary glands and reproductive tract. It has been reported that 1 ppm is enough to produce in gilts hyperestrogenism (Kurtz and Mirocha 1978). Sever cases conduce in vaginal and rectal prolapse. (Cast, 2003).

Chemical methods that have been used to reduce mycotoxin contamination have no practical effect in the livestock industry.

Grain cleaning is recommended, however, partially reduce contamination. Aluminosilicates inclusion has not shown to be efficient in reducing ZEA problem, reason why, many different types of mixtures of aluminosilicates with organic compounds have been developed (high molecular weight polymers, enzymes, enzyme-producing microorganisms, cell wall polymers), however, available products in the market with such compound have shown different drawbacks against ZEA. (Research & Marketing press 2020).

Therefore, another alternative is the development of partially substituted organoaluminosilicates, which are chemical compounds formed through reaction of specific aluminosilicates with organic compounds, adsorption capacity increase, due that is based on the ability to adsorb polar and less

-polar compounds, as the case with ZEA. An additional feature of these adsorbents is that they are harmless and can easily incorporated into finished foods. Mallmann *et al.*, 2005; Fierro *et al.*, 2005-2006, demonstrated the effectiveness of a commercial organoaluminosilicate (completely substituted) in gilts, intoxicated with 2,000 ppb of ZEA. It is also mentioned that esterified glucomannan-based low inclusion level mycotoxin adsorbent products based with yeast cell walls (*Saccharomyces cerevisiae*) designed to adsorb a wide range of mycotoxins and act rapidly. Its use in all species is a powerful tool to limit the negative effects when consumption of ingredients naturally contaminated with mycotoxins that can affect animals. Therefore, it is necessary to evaluate them and demonstrate their proven effectiveness in ZEA control.

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Objective

Evaluate ZEA toxic effects in gilts and the efficiency of two toxin binders to reduce ZEA bioavailability during 52 days' trail period.

Material and methods

Twenty-four recently weaned sows were selected and placed in individual pens. First seven days were for adaptation. Subsequently, each animal was assigned within one of the four experimental diets, identified as: 1) control diet, without ZEA, 2) intoxication diet with ZEA, 1200 ppb, 3) challenge diet with 1200 ppb of ZEA plus 1.5 kg / organoaluminosilicate 4) challenge diet with 1200 ppb of ZEA plus 1.5 kg / Commercial Patented Aluminosilicate + yeast cell walls product classified as CPA+Y (Alltech 2020).

At the beginning all gilts were weighed (28 days old) individual weight was recorded every week, until the end of the experiment. Because ZEA estrogenic effects manifests vulva inflammation and redness, and growth in reproductive organs, these parameters were considered to measure ZEA toxicity, feed conversion was calculated weekly, as well, vulva (length x width x depth). Environmental and all animal health conditions were recorded daily.

All sows were euthanized and the reproductive system was removed to measure its dimensions, length, width and weight, including the weights of the vulvas. The percentage of the weight of the reproductive tract in relation to the weight of the animal was calculated. Reproductive tract samples were obtained for histopathological tests and if organs were observed with some damage, lesion were recorded.

The obtained information was analyzed through the statistical software SYSTAT, by the Tukey test where the difference of means was defined. The significance value was based on a $p < 0.05$.

Results and Discussion

Macroscopically, ZEA toxic effects were observed between treatments, vulva and the reproductive tract increased for some treatments, but not in the negative control group. There were statistically significant differences in the percentage of the weight of the reproductive tract, vulva and reproductive tract length; cervix width and vulva volume (table 2 and 3). Regarding the productive parameters such as weight gain, feed conversion and feed consumption (table 5), there were no statistically significant differences among treatments for uterus and uterine horns, only numerical (Table 4),

Histopathological analyzes showed ZEA effects in animals within positive treatments, and as expected in the control group, no effect was observed.

The efficiency of organoaluminosilicate product, calculated based on its capacity to reduce the increase of the relative weight of the reproductive tract, was 61.5%. Otherwise, in the case of product composed of aluminosilicate plus yeast cell walls (CPA+Y), the relative weight of the reproductive tract has a significant increase, which means that its efficiency was zero percent. The organoaluminosilicate showed effectiveness, unlike yeast wall-based products, and has proven to be a secure option against ZEA prevalent in many food and feed ingredients.

Table 1: Experimental treatments

Treatments	Organoaluminosilicate (kg/t)	CPA+Y (kg/t)	Zearalenone (mg/kg)
Negative Control	0	0	0
Positive Control	0	0	1,170
Organoaluminosilicate	1.5	0	1,200
CPA+Y	0	1.5	1,150

Table 2: Relative weights of the reproductive tract and vulva

Treatments	Reproductive tract % weight in relation to animal weight.	Vulva % weight in relation to the weight of the animal
	Mean $\pm$ S. E	Mean $\pm$ S. E
Negative Control	1.12 $\pm$ 0.172 ^a	0.241 $\pm$ 0.028 ^a
Positive Control	2.34 $\pm$ 0.196 ^b	0.465 $\pm$ 0.047 ^{ab}
Organoaluminosilicate	1.87 $\pm$ 0.179 ^{ab}	0.401 $\pm$ 0.006 ^{ab}
CPA+Y	2.43 $\pm$ 0.382 ^b	0.620 $\pm$ 0.101 ^b

Means with different letters are statistically significant for $p < 0.05$

Table 3: Reproductive tract scores

	Reproductive tract length (cm)	Vulva volume (1000*cm ³ /kg)	Cervix width (cm)
	Mean $\pm$ S. E	Mean $\pm$ S. E	Mean $\pm$ S. E
Negative Control	22 $\pm$ 1.40 ^a	0.100 $\pm$ 0.017 ^a	1.8 $\pm$ 0.216 ^a
Positive Control	28.1 $\pm$ 1.13 ^b	0.620 $\pm$ 0.057 ^b	2.9 $\pm$ 0.150 ^b
Organoaluminosilicate	24.3 $\pm$ 1.11 ^{ab}	0.563 $\pm$ 0.074 ^b	2.2 $\pm$ 0.132 ^{ab}
CPA+Y	28.5 $\pm$ 1.77 ^b	0.864 $\pm$ 0.189 ^b	2.9 $\pm$ 0.229 ^b

Means with different letters are statistically significant for $p < 0.05$

Table 4: Reproductive tract dimensions II

Treatments	Uterus width (cm)	Uterine horns length (cm)
	Mean $\pm$ S. E	Mean $\pm$ S. E
Negative Control	1.5 $\pm$ 0.202 ^a	37.5 $\pm$ 1.89 ^a
Positive Control	2.0 $\pm$ 0.309 ^a	50.0 $\pm$ 6.42 ^a
Organoaluminosilicate	1.6 $\pm$ 0.075 ^a	39.3 $\pm$ 3.30 ^a
CPA+Y	2.1 $\pm$ 0.160 ^a	51.4 $\pm$ 3.26 ^a

Means with different letters are statistically significant for $p < 0.05$

Table 5: Productive Parameters

Treatments	Weight gain (kg)	Feed conversion	Feed intake (kg)
	Mean $\pm$ S. E	Mean $\pm$ S. E	Mean $\pm$ S. E
Negative Control	30,466 $\pm$ 1003 ^a	1.87 $\pm$ 0.055 ^a	56,717 $\pm$ 1319 ^a
Positive Control	30,113 $\pm$ 1192 ^a	1.89 $\pm$ 0.059 ^a	56,508 $\pm$ 1285 ^a
Organoaluminosilicate	30,793 $\pm$ 1186 ^a	1.81 $\pm$ 0.036 ^a	55,492 $\pm$ 1621 ^a
CPA+Y	31,405 $\pm$ 781 ^a	1.80 $\pm$ 0.027 ^a	56,458 $\pm$ 1409 ^a

Means with different letters are statistically significant for $p < 0.05$

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