Journal of Animal Research and Technology 1 (1): 1–6, 2012
doi: 10.5147/jart.2012.0104

Impact of Ergot Infested Sorghum on the Reproductive Performance of Sows

G. M. Abdelrahim[1,*], R. C. Richardson[2], and A. Gueye[3]

[1] Department of Food and Animal Sciences, Alabama A & M University, Normal, AL 35762, USA; [2] Department of Agriculture, Texas State University, San Marcos, Texas 78666, USA; [3] School of Animal Science, Mt. Ida College, Newton, MA 02459, USA

Received: December 29, 2011 / Accepted: June 5, 2012

Abstract

The experiment was conducted to investigate the effects of three levels of ergot infested sorghum (EIS ; 0 ,5 and 10% of diet DM) in the diets offered for sows during two reproductive cycles on total live born pigs and weight (LBP; WLBP), survival at 28 days, weight gain at day 28 and 56 (S- 28 d;W-28; W- 56), sows feed intake and weight change during lactation (LFI; LWC), and finally weaning-to-estrus interval (WEI). The EIS contained 235 mg/kg total alkaloids (77% as dihydroergosine "DHES"). During an initial test parity period (1st period) and subsequent test parity period (2nd period) eighteen later-parity sows were fed 3 treatments consisting of a sorghum-based control diets mixed with 1) 0%; 2) 5% or 3) 10% EIS (diet DM basis). An increase in WLBP was observed when 5 and 10% EIS was included in the 2nd period's diets, although LFI was reduced when EIS was included in that period's diets. Although W-28 d was not affected when 10% EIS was included in the 1st and 2nd periods' diets and when W-28 d data of the two periods were combined, piglets W-28 was reduced when 5% EIS was included in the 1st period's diets and when W-28 d data of the two periods were combined. Although treatment diets did not impact WEI of pigs in the 2nd period, and no response was recorded when 5% EIS was included in sows' diets during the 1st period, the inclusion of 10% EIS had decreased the WEI during the 1st period.

Keywords: Ergot alkaloids, reproductive performance, sorghum, sows.

Introduction

Grain toxicity, caused by mycotoxins like the fungus ergot which produces alkaloids such as festuclavine, pyroclavine, dihydroelymoclavine, chanoclanine, and DHES, affects up to 25% of the world's food crops, including sorghum, and leads to reduction in crops' energy digestibility and consequently reduces the growth rate of animals when consumed (Blaney et al., 2000a; Kopinski et al., 2008; Naudè et al., 2005; Peadar and Lynch, 2001).

Dihydroergosine, the principal toxic alkaloid produced by sorghum ergot, which with levels as low as 1 mg/kg of it in animal feed can cause significant production losses since it mimics the effects of dopamine, and consequently hinders the usual elevation of blood prolactin prior to farrowing (Blaney et al., 2008; Kopinski et al., 2007; Molloy et al., 2003). This effect, in addition to feed refusal and reduced weight gain, causes sows not to produce milk leading to poor survival of piglets, and even to loss of the entire litters (Blaney et al., 2000b; Kopinski at al., 1999; Kopinski et al., 2007; Odvody et al., 1998; Porter et al., 1998a). In general, it can be assumed that 0.1% ergot alkaloids in grains will be able to reduce weight gain in fattening pigs; higher levels (3%) of ergot alkaloids have been implicated in feed wasting and significant growth retardation (Blaney et al., 2000a,b; EFSA, 2005; Peadar and Lynch, 2001).

Technically, it is possible to remove ergot from cereal grains; complete removal may be impossible or impractical in a commercial setting. As a result, it would be very useful to define safe upper limits for the use of ergot-contaminated grain in swine diets. Hence, in this experiment we hypothesized that the usage

[*] Corresponding author: gamal.abdrahim@aamu.edu

of up to 10% of naturally infested sorghum (equivalent of 23.5 mg ergot alkaloids /kg of grain) in diets will have no impact on the sow's reproductive performance.

Materials and Methods

Experimental Design

All animal care and handling procedures followed the farms' written guidelines set forth by FASS (1999) and all procedures involving animals were approved by the Animal Care and Use Committee of Texas Tech University (TTU). Eighteen later -parity Yorkshire, Landrace and Duroc crossbred sows (BW = 155 ± 17 kg) were used in a completely randomized block design study conducted at the Burnett Center in New Deal, Texas, and lasted for 390-d.

Experimental Animals

Before the start of treatments, sows were grouped according to their body weight and randomly assigned to three experimental groups (*n*=6/dietary treatment; the pen was the experimental unit), and fed experimental diets containing different levels of EIS (0, 5, and 10% of diet's DM which equal 0, 11.75 and 23.50 mg alkaloids/kg of grain , respectively). The 0.6 by 2.1 m group pens were located in a confinement barn equipped with a drip water system that provides free access to clean water. Then sows were checked daily for signs of estrus, and when they expressed standing estrus they were bred by artificial insemination and checked for pregnancy 4 weeks later using real-time ultrasound. At 110 day of gestation sows were moved to environmentally controlled group-farrowing room maintained between 20 and 25°C.

Farrowing occurred on days 114 or 115 of gestation. Following farrowing, every sow and her litter were checked twice daily for health, dead piglets, or farrowing problems. Standard litter management procedures at TTU were followed including clipping needle teeth, ear notching, tail docking and one injection of iron. Litters were weighed at birth and at 28 days, and individual weights were recorded. Piglets were weaned at 28 ± 1 days of age. After weaning, sows were moved to the breeding and gestation barn for rebreeding and fed the experimental diets.

During the nursery phase, pigs were housed in pens with dimension of 1.5 by 2.1 m, with one section in plastic coated slatted floor and the other section in woven wire floor. The phase was conducted with approximately 28 days old weaned pigs originating from the farrowing phase sorted into four pens per treatment to determine the performance of pigs from sows consuming control or increasing levels of sorghum ergot throughout their pervious gestation and lactation. All pens were equipped with fully slatted floors, a nipple drinker and an adjustable multiple-space dry feeder. Each room had automatic light timers (0800 to 2000 hours) and ventilation controls, including heaters, exhaust fans and powered air inlets. Room temperature was initially set at 30°C, declining to 24°C by the end of the experimental period.

Ergot Infested Sorghum (Sclerotia) Analysis

A typical U.S. No. 2 grain sorghum infested with ergot that was donated by a Hybrid Seed Production Company in the High Plains was used in the experiment. Samples were collected from approximately 3000 kgs of the infested grain were sent for chemical analysis at the USDA laboratories in Athens, Georgia. Liquid Chromatographic method for the determination of ergot alkaloids was the method used to determine ergot infested sorghum chemical composition (Porter et al., 1998b). The grain was found to contain mature sphacelia/sclerotia of Claviceps Africana which was found to include 235 mg/kg total alkaloid (Table 1). Also, the analysis indicated that the grain contained 180.67 mg/kg of DHES on DM basis, 39.39 mg/kg of dihydroelymoclavine, 12.66 mg/kg of festuclavine, and 1.85 mg/kg of tyroclavine, totaling 235 mg/kg. Further, the ergot-free sorghum used in the experiment as well as the EIS were subjected to chemical analysis at TTU laboratories to determine their nutrients contents (Table 1).

Experimental Diets and Methods

The experimental objective of the study was to evaluate effects of including EIS in sows' diets on animal and reproductive performance. Throughout the two periods observed, sows were fed a standard completely balanced sorghum-soybean meal based diets. The diets containing the EIS were formulated to meet NRC (1988) requirements (CP 16%; 3,384/ kcal/kg of ME/kg; lysine 0.95%; Table 2). The EIS replaced sorghum in the concentrate mixes so that diets contained desired amounts of EIS (0%, 5%, and 10% by dry weight (dietary concentrations were thus 0, 11.75, and 23.5 mg alkaloids/kg of feed). A 7-d adaptation period started after all sows were confirmed pregnant, followed by the feeding period during which experimental diets were offered once daily at 08:00 hours. After forrowing, piglets had free access to the dam, and free access to creep feed and water from 1 week of age. Feed refusals were weighed daily before feeding and actual feed intake was then calculated.

Table 1. Chemical analysis of grain sorghum and ergot infested sorghum[1].

Item	Ergot- free sorghum	Ergot-infested sorghum
DM	92.00	90.00
CP	11.62	11.94
EE	3.60	3.20
NDF	17.68	19.61
Cellulose	4.30	5.03
Lignin	1.65	1.94
Ash	1.88	1.95
Alkaloids[2]	0 mg/kg	235 mg/kg

[1]All values are on dry matter basis unless otherwise indicated. [2]Alkaloid level in the grain sorghum was measured at the USDA laboratories in Athens, GA.

Journal of Animal Research and Technology - ISSN 2153-3504. Published By Atlas Publishing, LP (www.atlas-publishing.org)

Journal of Animal Research and Technology - ISSN 2153-3504. Published By Atlas Publishing, LP (www.atlas-publishing.org)

Table 2. Ingredient composition of treatment diets and chemical composition of grain sorghum and ergot infested sorghum fed in gestation and lactation[1].

Item	Treatment diets (Ergot-infested sorghum %)		
	0 (control)	5	10
Ingredient composition (DM basis)			
Grain sorghum	76.30	71.30	66.30
Ergot-infested sorghum	0.00	5.00	10.00
Soybean meal (44% CP)	17.20	17.20	17.20
Yellow grease	2.00	2.00	2.00
Salt, plain	0.45	0.45	0.45
Dicalcuim phosphate	2.60	2.60	2.60
Calcium carbonate	0.70	0.70	0.70
Potassium chloride	0.25	0.25	0.25
Vitamin Premix[2]	0.50	0.50	0.50
Total	100.00	100.00	100.00

[1]All values are on dry matter basis unless otherwise indicated. [2]Dicalcium phosphate, calcium carbonate, salt, processed grain by-products, pyridoxine hydrochloride, choline chloride, magnesium sulfate, potassium sulfate, chromium tripicolinate, mineral oil, menadione dimethylpyrimidinol bisulfite (source of vitamin K), biotin, calcium pantothenate, vitamin E supplement, folic acid, riboflavin supplement, zinc sulfate, dried yucca shidigera extract, niacin supplement, vitamin B-12 supplement, grain products, ferrous sulfate, manganous oxide, vitamin A supplement, dried aspergillus niger fermentation extract, thiamine, choline chloride, zinc oxide, vitamin D3 supplement, ferrous carbonate, ethylenediamine dihydriodide, copper sulfate, calcium iodate, magnesium oxide, sodium selenite, brewers dried yeast and selenium yeast.

Statistical Analysis

Data were analyzed for the effects of treatment on sow reproductive performance. The completely randomized design was utilized for statistical analysis using the GLM procedure of SAS (SAS Inst. Inc. Cary, NC). Pen was the experimental unit. The model included effects of diets, diets experiment residual and total pigs born as a covariate. Total pigs born were included in the model as a covariate to adjust the means for differences caused by the effect of differences in total pigs born. Analysis of covariance (ANCOVA) was used to analyze data for the 1st and 2nd periods. In addition, data for the 1st and 2nd periods were combined and analyzed using ANCOVA. Linear and quadratic contrasts were used to test the response of the treatments, and means were separated by PDIFF procedure. Diet x experiment was used as an error term for linear and quadratic contrast. Significance was declared at the level of $P < 0.05$, whereas $P < 0.10$ was interpreted to indicate a trend.

Results

There were no treatment effects on LBP, S- 28 d, W- 56 d, and LWC (Tables 3, 4, and 5, respectively); similar results were obtained when LBP, S- 28 d, W- 56 d, and LWC data of the two parties were combined ($P > 0.05$). An increase in WLBP (Table 3) was observed when 5- 10% EIS were included in the 2nd period's diets, although LFI was significantly ($P < 0.05$) reduced when EIS was included in that period diets. Although W-28 d (Table 4) was not affected when 10% EIS was included in the 1st and 2nd periods' diets and when W-28 d data of the two parities were combined ($P > 0.05$), piglets weight gain at 28 days was reduced ($P < 0.05$) when 5% EIS was included in the 1st period's diets and when W 28 d data of the two parities were combined ($P < 0.05$). No influence of treatment on LFI in the 1st period was observed (Table 5). However, including 5 or 10% EIS in the second period diets significantly reduced LFI by 29-42%, and there was a tendency for LFI to be reduced in sows fed the diets containing EIS when the two periods were combined ($P < 0.10$). Weaning-to-estrus interval is presented in Table 6. No response was recorded when 5% EIS was included in sows' diets during the 1st period, while the inclusion of 10% EIS had significantly decreased the WEI ($P < 0.05$). However, in the 2nd period there was no response detected when the 10% EIS was included in the diets; similar result was obtained when WEI of the two parities were combined ($P > 0.05$).

Discussion

The present study investigated the effects of the inclusion of up to 10% EIS (DM basis) on LBP; WLBP, S- 28 d,W-28, W- 56, LFI, LWC, and WEI. The current results showed that diet containing 10% EIS (18.1 mg DHES/kg of feed) had no effect on WLPB and with exception of LFI which was depressed in the second period in sows fed diets containing (7.5 or 18.1 DHES) , and

Table 3. The effects of including ergot infested sorghum (EIS) in the diets fed to gestating and lactating sows over two reproductive cycles on the number and weight of live born pigs[1].

	Treatment diets (Ergot-infested sorghum %)			SEM
Item	0 (control)	5%	10	
Number of live born pigs (LPB)				
1st period	10.70	10.30	10.80	0.21
2nd period	8.60	9.40	8.80	0.33
Combination 1st and 2nd periods	9.70	9.90	9.80	0.08
Weight of live born (WBLP (kg)				
1st period	1.40	1.40	1.50	0.06
2nd period	1.40[b]	1.60[a]	1.60[a]	0.05
Combination 1st and 2nd periods	1.40	1.5	1.55	0.08

[1]Each period included 18 sows (n = 6/dietary treatment). [a-b]Means within a column with different superscripts differ (P<0.05).

Table 4. The effects of including ergot infested sorghum (EIS) in the diets fed to gestating and lactating sows over two reproductive cycles on the survival of piglets to weaning at 28 days, and weight gain during lactation and weight gain birth to weaning at day 28 and piglet weight gain post weaning[1].

Item	Treatment diets (Ergot-infested sorghum %)			SEM
	0 (control)	5	10	
Pigs survival at 28 days (S-28) (days)				
1st period)	9.50	8.50	9.60	0.49
2nd period	7.80	8.20	7.80	0.19
Combination 1st and 2nd periods	8.70	8.30	8.90	0.25
Weight gain birth to weaning at day 28 (kg)				
1st period	5.50[a]	5.00[b]	6.00[a]	0.15
2nd period	9.60	8.20	9.10	0.57
Combination 1st and 2nd periods	7.30[a]	6.60[b]	7.40[a]	0.16
Piglet weight gain post weaning (W-56) (kg)				
1st period	17.10	15.70	17.00	0.63
2nd period	16.40	14.60	15.00	0.77
Combination 1st and 2nd periods	16.70	14.90	16.10	0.74

[1]Each period included 18 sows (n = 6/dietary treatment). [a-b]Means within a column with different superscripts differ (P<0.05).

most other reproductive traits were not adversely affected at the highest inclusion rate tested.

Previous literature (Bandyopadhyay et al., 1996; Odvody et al., 1998; Porter et al. 1998c; Kopinski et al., 2007) suggested that as much as 1% of ergot alkaloid was tolerated by pigs, and higher concentration induced small, weak litters with poor vitality. Kopinski et al. (2007) reported a 87% piglets death in 28-day-old pigs when a diet containing 5.7 mg ergot alkaloids/kg feed was fed; meanwhile, Kopinski et al. (2008) reported that feeding diets that contains 3% sorghum ergot (14 mg DHES /kg) resulted in smaller live piglets contrary to the increase in WLBP we observed when up to 10% EIS (18.1 mg DHES /kg where ? it must be writen in results) was included in sows' diets in the 2nd period.

Feeding up to 1.5 mg/kg total ergot alkaloids can be safe for feeding sows around farrowing, but might exert undesirable adverse effects in gilts (Blaney et al., 2000a; Peadar and Lynch 2001; Kopinski et al., 1999; WHO, 1990). Others (Blaney et al., 2000a; Kopinski et al., 1999; Kopinski et al., 2007) reported that sows fed diets containing 8-70 mg ergot alkaloids/kg produced no milk and all of their piglets died despite intensive and prolonged supplementary feeding and fostering. Blaney et al. (2000a) observed poor feed conversion when diets contains up to the 5% sorghum ergot alkaloids was fed; consequently growth was reduced by about 30% in pigs receiving 70 mg alkaloids/kg, as a result of poor feed intake and feed conversion. Total live born pigs was lower in the second litter when 5 and 10% EIS was included in the 1st period's diets; however, this may have been caused by the very low LFI of sows during the first lactation. Also, for unknown reasons, there is a marked difference in weight gain to 28 days between period 1 and 2 when 5 and 10% EIS diets were fed; the low weight gain in the first lactation was probably due to the very low feed intake of sows in lactation.

Feeding 10% EIS in the present study did not impact piglets W-28 d and W-56 d in disagreement with Kopinski et al. (2008), who reported weight increase in litters produced by sows fed diets containing 3% sorghum ergot. However, similar to previous data (Oresanya et al., 2002; EFSA, 2005) where significant reduction in average daily gain was reported when finishing pigs were fed more than 0.25% sclerotia, W-28 d in the current study, for reasons we are yet to know, was reduced in

Journal of Animal Research and Technology - ISSN 2153-3504. Published By Atlas Publishing, LP (www.atlas-publishing.org)

Journal of Animal Research and Technology - ISSN 2153-3504. Published By Atlas Publishing, LP (www.atlas-publishing.org)

Table 5. The effects of including ergot infested sorghum (EIS) in the diets fed to gestating and lactating sows over two reproductive cycles on Lactation feed intake and Lactation weight Change[1].

Items	EIS (%)			SEM
	0	5	10	
Lactation feed intake (LFE) (kg)				
1st period	75.00	83.00	77.00	3.40
2nd period	173.00[a]	100.00[b]	122.00[b]	14.90
Combination 1st and 2nd periods	113.00	90.00	100.00	9.35
Lactation weight change (LWC) (kg)				
1st period	-23.80	-31.80	-33.20	4.11
2nd period	-29.00	-23.60	-23.30	2.60
Combination 1st and 2nd periods	-25.00	-30.20	-27.70	2.11

[1]Each period included 18 sows (n = 6). [a-b]Means within a column with different superscripts differ ($P<0.05$).

Table 6. The effects of including ergot infested sorghum (EIS) in the diets fed to gestating and lactating sows over two reproductive cycles on weaning to estrus interval[1].

	EIS (%)			SEM
	0	5	10	
Weaning to estrus interval (WEI) (day)				
1st period	4.70[a]	6.00[a]	2.70[b]	0.66
2nd period	5.20	4.90	4.90	0.14
Combination 1st & 2nd periods	5.00	5.20	4.00	0.52

[1]Each period included 18 sows (n = 6). [a-b]Means within a column with different superscripts differ ($P<0.05$).

the 1st period and when data of the two parties were combined as a result of feeding 5% EIS. Further, a very low feed intake during the first lactation was observed; this may explain the impact of EIS on reproduction since alkaloid intakes were only 50-60% of the levels in period 2. It was also noticeable that in the 2nd period inclusion of 5% or 10% EIS in the sow's diet reduced LFI by 29-42 %. Both, reduced lactation feed intake caused by heat stress, and increase in the demand for milk during lactation can cause significant tissue catabolism and increased maternal tissue loss in sows, leading to an increase probability of a prolonged weaning-to-estrus interval and suppressing litter weight gain (Eissen et al., 2003; Kim and Easter, 2001; Reese et al., 1982; Spencer et al., 2003). Meanwhile, an increase in voluntary feed intake could help offset the catabolic losses incurred by the sow and permit maintenance of body condition for long-term productivity (Kim and Easter, 2001; Trottier and Johnston, 2001). Inadequate feed intake lead to increased losses of backfat and BW, resulting in more culling of sows due to reproductive failures and a reduced lifetime performance (Eissen et al., 2003). Previous data (Blaney et al., 2000a; Kopinski et al., 2008; Peadar and Lynch, 2001) illustrated that the inclusion of up to 3% ergot sclerotia causes severe reduction in pigs' feed intake and lactation body weight. EFSA (2005) also reported that feeding a diet containing 1% ergot can cause agalactia that often leads to starvation of piglets, and a reduction in the growth of pigs with higher concentrations causing feed wastage and slowing growth.

Weaning-to-estrus interval, together with litter size and farrowing rate, influences the number of litters produced per sows per years (Pettigrew, 1998). In agreement with the result we observed in the 2nd period of the present study when 5% EIS was included in sows' diets, reported average wean to 1st service interval in sows is 5-6 days (Estill, 2000; New Technology, 2007). Contrary to what we observed in the 2nd period of the present study when EIS was significantly reduced to 2.7 days when 10% EIS was included in sows' diets, Diekman and Green (1992) suggested that a factor like synthesis of mycotoxins by molds in livestock feedstuffs impairs reproductive efficiency and can extend estrous cycles between day 5 and 20 when sows fed 5 to 10 mg/kg of Zearalenone. Moreover, others (Boyd et al., 2000; Eissen et al., 2003; Kim and Easter, 2001; Reese et al., 1982; Spencer et al., 2003) suggested that factors like breed differences, heat stress, litter size and extra piglet, increase the demand for milk during lactation, lactation feed intake, and protein mass in lactating sows can also affect WEI.

Conclusion

Based upon the findings of this research, ergot-contaminated grain can be included in swine diets. However, producers who chose to include the grain should realize that when diets are formulated with ergot infested grain sorghum, careful consideration should be given to the level of alkaloids present. Sows fed the infested grain tolerate different levels of ergot alkaloids during gestation and lactation but seem sensitive in lactation based on LFI effects. The number of live born pigs was lower in the second litter and this may have been caused by the very low LFI of sows during the first lactation. Further work is needed to determine a safe level of feeding ergot infested sorghum to sows.

Acknowledgements

This project was supported in part by the Brunette Center at Texas Tech University, and Texas Grain Sorghum Association. The authors would like to acknowledge Crosbyton Seed Company in Crosbyton, Texas for donating grain sorghum used in the study.

References

Bandyopadhyay R, DE Frederickson, NW Mclaren, and GN Odvody (1996) Ergot: a new disease threat to sorghum in the Americas and Australia. International sorghum and Millet Newsletter No.37. Sorghum Improvement Council of North America, Ga.

Blaney BJ, JS Kopinski, MH Magee, RA McKenzie, GW Blight, R Maryam, and JA Downing (2000a) Blood prolactin depression in growing pigs fed sorghum ergot (Claviceps fricana). Australian Journal of Agricultural Research 51:785-791.

Blaney BJ, RA McKenzie, JR Walters, LF Taylor, WS Bewg, MJ Ryley, and R Maryam (2000b) Sorghum ergot (Claviceps fricana) associated with agalactia and feed refusal in pigs and dairy cattle. Australian Veterinary Journal 78 (2): 102-107.

Blaney BJ, MJ Ryley, and BD Boucher (2008) Early harvest and ensilage of forage sorghum infected with ergot (Claviceps fricana) reduces the risk of livestock poisoning. Australian Veterinary Journal 88 (8): 311-312.

Boyd RD, KJ Touchette, GC Castro, ME Johnston, KU Lee, and IK Han (2000) Recent advances in amino acid and energy nutrition of prolific sows. Asian-Australasian J. of Animal Sciences 13: 1638–1652.

Diekman MA, and ML Green (1992) Mycotoxins and reproduction in domestic livestock. J. Animal Sci. 70: 1615-1627.

EFSA Journal (2005) Opinion of the Scientific Panel on Containments in Food Chain on a request from the Commission related to ergot as undesirable substance in animal feed 225: 1-27.

Eissen JJ, EJ Apeldoorn, E Kanis, MWA Verstagen, and KH de Greef (2003) The importance of a high feed intake during lactation of primiparous sows nursing large litters. J. Animal Sci. 81:594–603.

Estill CT (2000) Current concepts in estrus synchronization in swine. J. Animal Sci. 77: 1-9.

FASS (1999) Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching. 1st rev. ed. Fed. Animal Science Society, Savoy, IL.

Kim SW, and RA Easter (2001) Nutrient mobilization from body tissues as influenced by litter size in lactating sows. J. Animal Sci. 79 (8): 2179-218.

Kopinski JS, BJ Blaney, JF McVeigh, and SA Murray (1999) Tolerance of sows to the regulatory limits of 0.3% sorghum ergot feed before and after farrowing. Darling Downs Bacon Pig Science Seminar (2005) In the EFSA: European Food Safety Authority Journal 225: 1-27.

Kopinski JS, BJ Blaney, JA Downing, JF McVeigh, and SA Murray (2007) Feeding sorghum ergot (Claviceps fricana) to sows before farrowing inhibits milk production. Australian Veterinary Journal 85 (5): 169-76.

Kopinski JS, BJ Blaney, SA Murray, and JA Downing (2008) Effect of feeding sorghum ergot (*Claviceps africana*) to sows during mid-lactation on plasma prolactin and litter performance. Journal of Animal Physiology and Animal Nutrition (Berl) 92 (5): 554-61.

Molloy JB, CJ Moore, AG Bruyeres, SA Murray, and BJ Blaney (2003) Determination of DHES in sorghum ergot using an immunoassay. J. Agricultural and Food Chem. 51 (14): 3916–3919.

Naudè TW, Botha CJ, JH Vorster, C Roux, EJ Van der Linde, SI Van der Walt, GE Rottinghaus, L Van Jaarsveld, and AN Lawrence (2005) Claviceps cyperi: A new cause of severe ergotism in dairy cattle consuming maize silage and teff hay contaminated with ergotised Cyperus esculentus (nut sedge) on the Highveld of South Africa. Onderstepoort Journal of Veterinary Research 72 (1): 23-37.

New Technology (2007) Sexual Maturity and Ovulation. Available in http://www.piggene.com/female_reproductive_tract.htm Accessed on October 26, 2010.

NRC (1988) Nutrient requirements of swine; 9th rev. ed. Natl. Acad. Press, Washington, D.C.

Oresanya TF, JF Patience, RT Zijlstra, AD Beaulieu, DM Middleton, BR Blakley, and DA Gillis (2002) The Effect of Ergot on the Performance of Weanling Pigs. Advances in Pork Production, Volume 13, Abstract #19.

Odvody GN, R Bandyopadhyay, RA Fredericksen, T Isakeit, H Kaufman, J Dahlberg, R Velasquez, and H Torres (1998) Sorghum ergot goes global in less than three years. APSnet: The American Phytopathological Society Feature June 8-30, 1998, St Paul, Minnesota.

Peadar GL, and PB Lynch (2001) Mycotoxins in Pig Feeds 2: clinical aspects. Irish Veterinary Journal 54: 172 –176.

Pettigrew JE (1998) Nutrition and prolificacy. In: Proceedings of the 15th IPVS Congress, Birmingham, U.K. pp319–323, In: Van den Brand et al. (2000) Dietary energy source at two feeding levels during lactation of primiparous sows: I. Effects on glucose, insulin, and luteinizing hormone and on follicle development, weaning-to-estrus interval, and ovulation rate J. Animal Sci. 78: 396-404.

Porter JK, CW Bacon, G Kuldau, EM Wary, and FI Meredith (1998a) Alkaloids and other Mycotoxins associated with ergot damaged sorghum. In: Proceedings of the 112th AOAC International Annual Meeting and exhibition, Montreal, Quebec, Canada, Sept, 13-17.

Porter JK, Bacon CW, FI Meredith, EM Wray, and JP Wilson (1998b) GC/MS analysis of the TMS-clavine alkaloids in Claviceps fricana-infected sorghum from Georgia. In: Proceedings of the 112th AOAC International Annual Meeting and exhibition, Montreal, Quebec, Canada, 13-17.

Porter JK, EM Wary, and RM Eppley (1998c) Zearalenone and fusaric acid in the diet of nursing dams enhances both mycotoxins' lactational transfer to the suckling neonate. In: 112th AOAC International Annual Meeting and exhibition, Montreal, Quebec, Canada, 13-17.

Reese DE, BD Moser, ER Peo, AJ Lewis, DR Zimmerman, JE Kinder, and WW Stoup (1982) Influence of energy intake during lactation on the interval from weaning to first estrus in sows. J. Animal Sci. 55: 590–598.

Spencer JD, RD Boyd, R Cabrera, and GL Allee (2003) Early weaning to reduce tissue metabolism in lactating sows and milk supplementation to enhance pig weaning weight during extreme heat stress. Journal of Animal Science 81: 2041–2052.

Trottier N L, and LJ Johnston (2001) Feeding gilts during development and sows during gestation and lactation. Pages 725–769 in Swine Nutrition. A. J. Austin and L. L. Southern, ed. CRC Press, Washington, DC. In: McPherson et al. (2004) Growth and compositional changes of fetal tissues in pigs. J. Animal Sci. 82 (9) 2534-2540.

WHO (1990) World Health Organization: International Progress on Chemical Safety. Environmental Health Criteria 105. Selected Mycotoxins: Ochratoxins, Trichothecenes, and Ergot. Available in: http://www.inchem.org/documents/ehc/ehc/ehc105.htm#Section Number: 3.2 Accessed December 24, 2010.

Journal of Animal Research and Technology - ISSN 2153-3504. Published By Atlas Publishing, LP (www.atlas-publishing.org)