A Brief Communication on Mycotoxicosis in Livestock

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Abstract: Mycotoxin contamination in certain agricultural commodities has been a serious concern for human and animal health. Major mycotoxin producing fungi are Aspergillus, Penicillium, Fusarium genera. Mycotoxicosis may affect livestock performance and productivity, in particular located in tropical zone such as Thailand. Moreover, mycotoxins exhibit wide range of biological effects in animals such as: anorexia, gastro-intestinal problem, liver and kidney toxicity, reproductive insufficient, reduce ability of immune responses and others. Economic losses due to low yields of crop and animal productions are major consequence effect. Although mycotoxicosis caused by direct consumption of contaminated food and feedstuffs poses the risk to animals, the entry of mycotoxins or their metabolites into the food chain is of important for consumer. This review article will concentrate on five major mycotoxins including aflatoxin, deoxynivalenol, ochratoxin, fumonisin and zearalenone and their effect which are of greatest concern for livestock.

Keywords: Mycotoxin, Toxicity, Livestock

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บทคัดย่อ: การป้องกันของการพิษจากเชื้อราในผลิตภัณฑ์กิจการเกษตรอาจทำให้เกิดปัญหาต่อสุขภาพพืชและสัตว์ โดยเชื้อราที่ผลิตสารพิษสามารถเกิดจากเชื้อราที่มีอยู่ นอกจากมีผลกิจการผลิตสัตว์ นั้น  yönetici ต้องการความเจริญของสารพิษจากเชื้อราที่ดีส่งผลต่อกระบวนการเกิดปุ๋ยสัตว์ โดยเฉพาะอย่างยิ่งไปยังอาหารของกิจการที่มีรายได้ทางการผลิตสัตว์แบบ เช่น เกิดการเปลี่ยนอาหาร ที่มีปัญหาต่อสุขภาพพืชและสัตว์ นั้น ให้เกิดผลกระทบต่อระบบทางเดินอาหาร ดังนั้นความสามารถในการป้องกันการเกิดปุ๋ยสัตว์ที่มีความปลอดภัยจะเป็นการป้องกันการพิษจากเชื้อราที่ดีส่งผลต่อกระบวนการผลิตสัตว์ที่ส่งผลต่อสุขภาพและสัตว์กิจการที่มีรายได้ทางการผลิตสัตว์ 

คำสำคัญ: สารพิษจากเชื้อรา ความเป็นพิษ ปุ๋ยสัตว์

[ต่อ]
and *Claviceps* and *Alternaria* (Bennett and Keller, 1997).

Animal fed with mycotoxin contaminated stuff may cause of death if exposed the toxins at very high levels. However, low dose of mycotoxin contamination may also exhibit a variety of biological effects in animals such as: liver and kidney damage, immune suppression, central nervous system abnormalities, estrogenic responses and others. Table 1 shows a summary of certain mycotoxins and its impact on livestock. Figure 1 presents schematic of cell injury mechanism by mycotoxin (Riley and Norred, 1996). It is well known that livestock such as pig, duck and chicken are sensitive to feed contaminated with mycotoxins. Hence, regularly monitoring on feeding stuff is necessary to prevent cause of herd health hazard and to minimize economic loss.

**Major detected mycotoxin in feeds and their effect.**

**Aflatoxin**

Aflatoxin mostly produced by *Aspergillus flavus* and *A. parasiticus*. The primary target of aflatoxin intoxication is the liver which known as a potent of hepatotoxic agent. Moreover, aflatoxicosis commonly responsible for carcinogenicity, mutagenicity, teratogenicity, genotoxicity and immunotoxicity in both term of acute and chronic toxicity, (Creppy, 2002). Sensitivity and severity of aflatoxicosis in animals depend on species, age, sex, diet, host stress and other factors.

Four aflatoxin analogues produced by *Aspergillus* genera are aflatoxins B1, B2, G1, and G2 and its two metabolites frequently found in milk; aflatoxin M1 and M2. Among those aflatoxin B1 is considered as an extremely hepatocarcinogenic agent. Aflatoxin causes liver damage such as fatty change, cirrhosis lobular necrosis and bile duct proliferation. Aflatoxin is commonly contaminate in corn, peanuts, cottonseed, rice and other improperly storage-grains.

Health implication of aflatoxin contamination in livestock feed shows vast variety symptoms. In swine, piglets are very sensitive to aflatoxins but susceptibility decreases with age. Exposure of aflatoxin at low-level (20-200 ppb) and/or chronic feeding may observe sign of decrease feed intake, reduce feed efficiency and growth rate, reduce reproductive performance, suppress immune function, reduce milk production, icterus, embryonic death and therefore decrease potential of swine productivity (Jones *et al.*, 1994). Cattle are less susceptibility to aflatoxin. In dairy, reduced milk production may occur. Aflatoxin M1, an aflatoxin B1’s metabolite, could be excreted via milk and may generate health hazard to public consumer. In poultry, duck is the most aflatoxicosis sensitive species followed by turkey, broiler and laying hen. In laying hen, aflatoxin is cause of decrease egg production and it could be remained in egg component.
Figure 1 A schematic mode of action of mycotoxin on cell-physiology (Riley and Norred, 1996).

(Bintviho, et al., 2002). Chronic aflatoxicosis may affect shell strength by decreasing rate of conversion of dietary vitamin D3 (cholecalciferol) and also resulting in lowered serum protein, lipoproteins and carotenoids. Aflatoxicosis in broilers by bruising, subcutaneous hemorrhages could be observed. Clinical sign of aflatoxicosis in horse has been reported including inappetence, depression, fever, tremor, ataxia and cough (Caloni and Cortinovis, 2011). Aflatoxin could also suppress immune system function even when exposure at low levels (Jones et al., 1994). Thus farm animals may easily infected by microorganism and shows poor performance.

**Deoxynivalenol**

Deoxynivalenol (DON), known colloquially as vomitoxin, is a family of trichotheccenes toxin which most produced by *Fusarium* fungi. It is also one of the most prevalent Fusarium toxin naturally contaminated in animal feed in tropical climatic condition such as Thailand. The main bio-mechanism of DON is inhibits the synthesis of DNA and RNA and protein synthesis by binding to the 60S subunit of eukaryotic ribosomes and impair the function of the peptidyltransferase. During protein synthesis, DON predominantly acts as an inhibitor of elongation phase whereas some other the trichotheccenes; Diacetoxyxcripenol (DAS), Nivalenol (NIV), T-2 toxin, inhibit at the initiation phase (Ehrlich and Daigle, 1987). The immunologic effect of DON in farm animal remains unclear. However, in laboratory studies noted DON may suppress humoral and cellular immunity (Pestka, 2007).

In experimental studies, DON may affect to reproductive and teratogenic effects
but it is graded as “not classifiable” for carcinogenicity to humans. Swine is most susceptible specie to DON followed by mice > rat > poultry ≈ ruminant. DON is rapidly absorbed in pig, may be within half an hour to reach the peak after dosing (Prelusky et al., 1984). An acute dose of DON can induce vomiting (emesis) or even refuse feed in pigs, other clinical sign depend on timing and concentration include abdominal distress, increased salivation, malaise and diarrhea. A former report showed that pig will loss of appetite and decrease feed consumption (anorexia) when diet containing DON above 2 mg/kg of feed (equivalent to 0.08 mg/kg bw. per day), resulting in reduced weight gain (Trenholm et al., 1984). Poultry is tolerable to DON may due to toxicokinetic profiles by showing low degree of absorption into plasma and tissues (≈ 0.01) as well as rapid clearance (Prelusky et al., 1986). Regarding a study of Boston, no obvious adverse effects could be seen when duck consumed grain containing moderate levels of DON (Boston et al., 1996). More recently, there is a report noted that DON cause of injury to the gastrointestinal tract and has negative effects on the active transport of some nutrients in the small intestine of chickens (Awad et al., 2009). Luckily, ruminant is extremely tolerance to DON. The study in dairy cow showed that less than 0.01 % of the parent DON toxin was systemically absorbed after dosed with 1.9 mg/kg b.w. (Prelusky et al., 1984). As above mentioned, DON contamination in feed at 1-2 ppm may affect to swine production whereas ruminants and poultry tolerate to DON up to 20 ppm.

**Ochratoxin**

Ochratoxins produced mostly by genera of fungi, *Aspergillus* and *Penicillium* which generally has member designated as A, B and C. However, ochratoxin A (OTA), a chlorinated compound, is considered to be the most toxic followed by OTB. Kidney is the main target of action of OTA in mammalian species. Therefore, OTA may impair kidney function and cause of kidney lesions both acute and chronic exposure (Mantle, 2002). Moreover, OTA may disturb cellular physiology and link to the inhibition the phenylalanine tRNA complex synthesis (Marquardt and Frohlich, 1992).

The International Agency for Research on Cancer (IARC) classified OTA as a possible carcinogen in category Group 2B. Moreover, it considered being a wide range of toxicological effects including nephrotoxic, hepatotoxic, neurotoxic, immunotoxic, genotoxic and teratogenic in several species of mammals (O’Brien and Dietrich, 2005). Thus, ochratoxicosis adversely affect to animal production particular swine and poultry industry.

Among farm animals, pig is high susceptible specie to OTA. Ochratoxicosis in swine may cause of cystitis and nephritis,
enteritis birth-defects, decrease weight gain and semen quality as well as increasing herd mortality. High incidence of OTA accumulation in pork might be due to its long serum half-life (>8 hr.), by the high affinity for proteins and the entero-hepatic circulation rate (Duarte et al., 2011). In poultry production OTA may suppress immune function, reduce growth rate, reduced egg production and increase susceptibility to diseases and mortality rate but rare incidence residue in eggs (Verma et al., 2004; Politis et al., 2005). Tansakul (2011) mentioned that low-dose of OTA contamination may cause of immune suppression in duckling.

Fumonisins

Fumonisins are produced by Fusarium fungi spp., known as pre-harvest or soil fungi. They reportedly have 28 structural analogs but fumonisin B1 (FB1) is the major detected toxicant. Fumonisins have potential to affect sphingolipid biosynthesis (Šegvic and Pepeljnjak, 2001). Moreover, they reportedly have hepatotoxicity effects and are classified in group 2B as a possibly carcinogenic substance to humans (Murphy et al., 2006).

In livestock, fumonisins increasingly have become a problem in farm production. However, toxicosis of fumonisin is vary following contamination level and species range from 5 ppm for horses, pigs to 50 ppm for adult ruminants. The toxin causes softening of the white matter in the brain (leukoencephalomalaciation) and is known as “Moldy Corn poisoning” in horses and (Bucci and Howard, 1996). Fumonisins toxicosis in pig was also presented. It reported that cause of huge economically lose in swine production by induce lung disease namely Porcine Pulmonary Edema (PPE) (Haschek et al., 2001). Furthermore fumonisin may reduce lymphocyte viability in chicks and pigs which can have a negative impact on the immune system. Fortunately, monitoring for residues of fumonisin B1 in animal products might be ignored as there is insignificantly carry-over of fumonisin B1 or its metabolites in animal products such as milk, meat and eggs (Jonker et al., 1999). Poultry are relatively resistant to fumonisin toxicity. Moreover, ability of fumonisin tolerance by ruminant might be due to minimally toxin absorption to blood circulation.

Zearalenone

Zearalenone (ZEN) is a mycotoxic most produced by Fusarium spp. and may co-occurrence with deoxynivalenol. It frequently found in maize, wheat, oats and barley. It has many derivative forms such as α-zearalenol (α-ZOL), β-zearalenol (β-ZOL), zearalanone (ZAN), α-zearalanol (α-ZEL) and β-zearalanol (β-ZEL) (Zinedine et al., 2007). To date, zearalenene is recommended a new nomenclature abbreviation as “ZEN” related to its chemical structure (Metzler, 2010).
Table 1: Summarized five major mycotoxins and its effect on livestock.

<table>
<thead>
<tr>
<th>Toxin</th>
<th>Fungal spp.</th>
<th>Crop affected</th>
<th>Predisposing factors</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aflatoxin</td>
<td><em>Aspergillus flavus</em></td>
<td>corn, rice, peanuts,</td>
<td>drought, excessive heat</td>
<td>reduced feed intake, milk &amp; egg production, suppress immune function, liver cancer</td>
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<td></td>
<td><em>A. parasiticus</em></td>
<td>milo, cotton seed,</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>tree nuts</td>
<td></td>
<td></td>
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<tr>
<td>Vomitoxin</td>
<td><em>Fusarium graminearum</em></td>
<td>corn, barley, wheat,</td>
<td>warm day, cool nights, high</td>
<td>vomiting, feed refusal, diarrhea, weight loss,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mids, bran, flour,</td>
<td>rainfall, floods</td>
<td>reduced milk production</td>
</tr>
<tr>
<td></td>
<td></td>
<td>rice, malt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zearalenone</td>
<td><em>Fusarium graminearum</em></td>
<td>corn, barley, wheat,</td>
<td>warm days, cool nights, high</td>
<td>vulvovaginitis, rectal prolapse, ovarian atrophy,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mids, bran, flour,</td>
<td>rainfall, floods</td>
<td>low birth weights, reduced litter sizes, abortions,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>rice, malt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ochratoxin</td>
<td><em>A. ochraceus</em></td>
<td>cereal grains, coffee</td>
<td>drought, excessive heat</td>
<td>retarded growth, feed refusal, nephropathy, kidney disfunction, mortality</td>
</tr>
<tr>
<td>Penicillium spp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fumonisin</td>
<td><em>Fusarium moniliforme</em></td>
<td>corn</td>
<td>drought or humidity &amp;</td>
<td>equine leukoencephalomalacia: blindness, head</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>moisture</td>
<td>butting, and pressing, incoordination, death</td>
</tr>
<tr>
<td></td>
<td><em>F. proliferatum</em></td>
<td></td>
<td></td>
<td><em>swine</em>: pulmonary edema, liver and pancreatic</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>lesions</td>
</tr>
</tbody>
</table>

ZEN acts as an estrogen to disrupt breeding cycles and reduce the viability of litters. Swine is particularly sensitive specie to ZEN and may result to reproductive problems. Its mechanism of action involves with estrogen receptors, translocation of receptor-ZEN complex to the nucleus, and increased permeability of the uterus to glucose, RNA and protein precursors (Zinedine et al., 2007). Moreover, ZEN may affect to lutenizing hormone by biophasic alteration. Except for ZEN, other trichothecenes are non-estrogenic toxicant including deoxynivalenol (DON), nivalenol, monoacet-oxyscirpenol (MAS), diacetoxyscirpenol (DAS) and T-2 toxin.

As ZEN is a nonsteroidal estrogenic mycotoxin, animal exposed the toxicant have effect mainly on reproductive system. ZEN reportedly causes of infertility, reduced milk production, and hyperestrogenism reduced feed intake, vaginitis, vaginal secretions, poor reproductive performance and mammary...
gland enlargement in cow and cattle (D'Mello et al., 1999). In gilts, ZEN contamination in feed resulting in the vulva swollen, edematous, reddened, vaginal prolapse, rectal prolapsed, enlargement of the uterus, nymphomania, prepubertal, pseudopregnancy and ovarian atrophy. In addition, impact of ZEN on swine reproductive may include infertility, sterility, stillbirths, fetal mummification, and reduced litter size. Unlike mammal livestock, poultry are much less sensitive to ZEN (Minervini and Dell' Aquila, 2008)

**Conclusion**

Mycotoxin is naturally and hardly avoidable contaminated in feed by fungal infection in grain and feed stuff. Mycotoxin may generate great impact on livestock production and their performance. As mentioned above, mycotoxins exhibit a variety of biological effects in animals such as: liver and kidney toxicity, reproductive insufficient, reduce ability of immune responses and others. Therefore, quality control of feed stuff to prevent mycotoxicosis and economic lose is needed. Furthermore, monitoring on mycotoxin contamination by both screening test and confirmatory laboratory level is regularly required.

**References**


