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THE POTENTIAL USE OF ZINC OXIDE AS AN ANTI-MYCOTOXIN ELEMENT IN ANIMAL FEED: A SHORT REVIEW

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Abstract. Providing the populace with high-quality animal products is one of the primary goals of contemporary agricultural science and practice. Mycotoxins impact animal health, performance, and product quality and safety through invasion of animal feed materials. Finding effective techniques to reduce mycotoxin in feedstuffs is therefore crucial. The use of generally recognized as safe (GRAS) elements such as zinc has drawn increased attention and seem to be one of the promising safe alternatives instead of synthetic fungicides. In the present short review, the occurrence of mycotoxins in animal feed, the potential use of zinc oxide (ZnO) particles as a feed supplement for farm animals, as well as its anti-fungal properties, were highlighted with the ultimate goal of elucidating the hypothesis of the potential use of ZnO as a mycotoxin-detoxifying element in animal feed.

Keywords: mycotoxins, animal feed, Zinc oxide

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ПОТЕНЦИАЛЬНОЕ ПРИМЕНЕНИЕ ОКСИДА ЦИНКА В КАЧЕСТВЕ АНТИМИКОТОКСИНОВОГО ЭЛЕМЕНТА В КОРМАХ ДЛЯ ЖИВОТНЫХ: КРАТКИЙ ОБЗОР

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Аннотация. Обеспечение населения высококачественными продуктами животноводства является одной из основных задач современной сельскохозяйственной науки и практики. Микотоксины влияют на здоровье животных, продуктивность, качество и безопасность продукции, проникая в корма для животных. Поэтому поиск эффективных методов снижения содержания микотоксинов в кормах имеет решающее значение. Использование общепризнанных безопасных элементов (GRAS), таких как цинк, привлекло повышенное внимание и, по-видимому, является одной из многообещающих безопасных альтернатив синтетическим фунгицидам. В настоящем кратком обзоре были освещены присутствие

микотоксинов в кормах для животных, потенциальное использование частиц оксида цинка (ZnO) в качестве кормовой добавки для сельскохозяйственных животных, а также его противогрибковые свойства с конечной целью прояснения гипотезы о потенциальном использовании ZnO в качестве микотоксина – детоксицирующий элемент в кормах для животных.

***Ключевые слова*:** микотоксины, корма для животных, оксид цинка

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Mycotoxins in Animal Feed: a threat for animal and human health

Livestock diets generally consist of a blend of feeds that are intended to satisfy the nutritional requirements of animals while keeping prices down, as well as to supply all the essentials for their well-being, productivity, and health [1]. The grain form of cereals, which make up a large portion of animal diets, is frequently supplied to feed mills. Various fungal species infest cereals at or after harvest, and it is sometimes impossible to prevent this invasion and the consequent synthesis of mycotoxin because of environmental predisposing factors such high humidity, severe rain during harvest, and unsuitable storage conditions [2, 3]. Grain degradation, both in raw and processed forms, is caused by fungi when they are subjected to ideal environmental factors such high humidity and warm. Additionally, fungi have the ability to create mycotoxins, particularly Fusarium sp. in field crops and Aspergillus and Penicillium sp. during storage [4]. According to the Food and Agriculture Organisation (FAO), mycotoxins infect over 25 % of global crops each year, resulting in losses of feed and food equivalent to approximately 1 billion tonnes annually [4]. Due to the transfer of some mycotoxins from the forages to specific food commodities, feedstuffs infected by mycotoxins contribute to the mycotoxin contamination of particular food items from animal origin, such as milk, dairy products, meat, or eggs [5]. This circumstance might potentially exacerbate the rise in mycotoxin exposure among humans. The chemical and thermal stability of mycotoxin and its little loss during industrial processing or heat treatments is another factor that contributes to human exposure to these substances [4, 5]. Thus, mycotoxin contamination of animal feeds is a serious concern for the livestock industry and poses a health risk to both animals and humans [3, 6, 7]. Because preventing mycotoxin production is difficult to achieve in order to minimise contamination, mitigating methods are required. As described in Figure 1, diverse techniques including biology, chemistry, and physics have been employed to avert mycotoxin invasion or eradicate harmful effects [8]. Farm animals' diets can be supplemented with natural zeolite to help the feed absorb polar mycotoxins and reduce toxicity. A common technique for lowering mycotoxins in food and feed processing is gamma-irradiation, nevertheless its efficacy is up for discussion. Sodium carbonate supplementation aids also in the elimination of mycotoxins contaminated with feed [5, 8].

Zinc Oxide as an Anti-Mycotoxin element

In order to prevent mycotoxin contamination, a number of organic synthetic fungicides are used in the commercial preservation of cereal crops, which are the main source of nutrition for farm animals. However, it seems that these synthesised preservatives are harmful to both human and animal health and the environment. The use of generally recognised as safe (GRAS) substances in place of synthetic fungicides has gained more attention recently. Zinc (Zn) is a trace element currently recognized as generally recognized as safe (GRAS) element. In addition, Zn is a crucial element for plants and is recommended to be used as a crop fertiliser. In agriculture, Zn compounds are mainly used as fungicides [9]. Also, the low concentrations of Zn compounds can have a high antimicrobial activity [10].

Due to its adaptable and potential uses in agricultural sciences (antibacterial and antifungal), as well as the fact that their action does not need photoactivation, ZnO nanoparticles (ZnO NPs) have drawn a lot of interest [11]. Numerous applications for plant protection use ZnO NPs, which are thought to be nontoxic, biosafe, and biocompatible. Many in vitro studies have examined the effectiveness of Zn NPs in combating

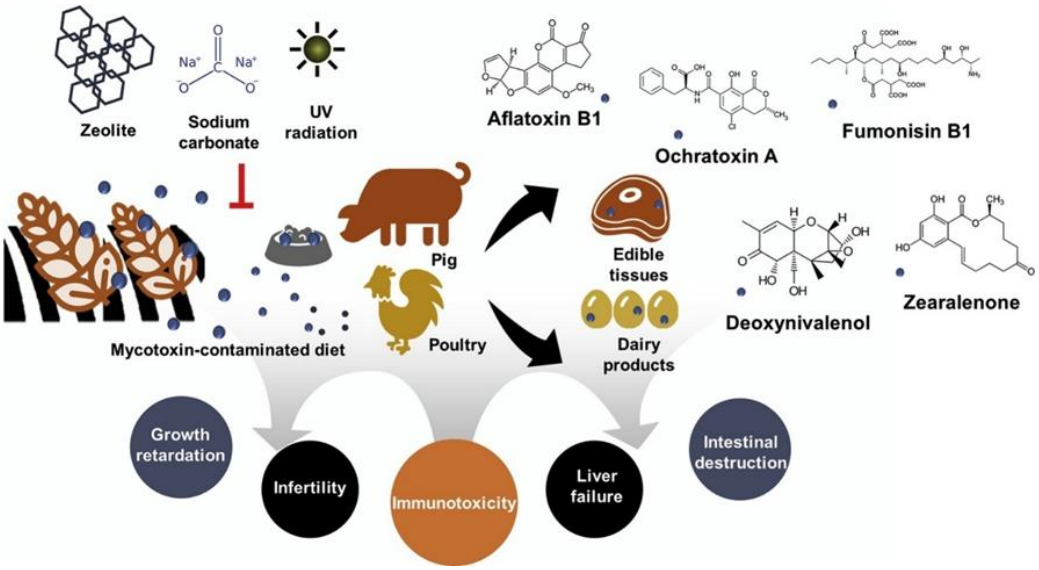

Fig. 1. Mycotoxin contamination of animal feed, their consequence for human/animal health and decontamination strategies [5]

various crop-contaminating fungi [12, 13]. However, in planta or in vivo study are lacking. Furthermore, there is little to no information on how different ZnO-NP concentrations interact with environmental factors to inhibit the development of fungi and the buildup of mycotoxin.

Zinc oxide as a supplement in animal feed

Zn plays a crucial role in animal growth and development, as it is essential for various physiological processes, including protein synthesis, immune function, and DNA synthesis. Figure 2 illustrates the role of zinc in poultry and livestock. ZnO, zinc sulphate ($ZnSO_4$), and zinc chloride ($ZnCl_2$) are examples of feed-grade inorganic salts that are traditionally added to the diets of livestock animals [14]. However, because Zn from inorganic sources has a limited bioavailability, an excessive and unabsorbed amount of Zn discharged in faeces may provide problems for the environment. Aside from that, the animal's body's capacity to maintain vitamins and other minerals may be impacted by the high Zn dietary supplement [15]. Zn is more bioavailable in its organic form – such as Zn propionate, Zn methionine, and Zn acetate – than in its inorganic form. However, because organic Zn is more expensive than inorganic Zn, its use in animal diets is restricted [16]. Numerous methods have been explored to increase Zn bioavailability and decrease cost since nanotechnology first appeared [17]. The effects of ZnO NPs on animal production and their possible use as a dietary supplement in place of traditional Zn have been extensively researched [18, 19].

ZnO NPs have been added to animal feed because of their tiny size with high surface area and high chemical stability, which has improved the rate of Zn absorption in the gastrointestinal system [18]. This has increased the amount of Zn ingested by the animal and its bioavailability. By using ZnO NPs, feeding efficiency was improved, and the amount of Zn excreted into the environment was reduced. Interestingly, several data have indicated that Zn NPs could be used at lower concentration rather than the one used for inorganic Zn form to achieve the same health target beneficial [15, 20, 21].

Conclusion and Future Directions

The agricultural sector is very concerned about mycotoxin contamination in animal feeds, which is considered potentially hazardous for both animal and human health. Thanks to their small size, large surface area, and strong chemical stability, supplementing animal diets with ZnO at nanoscale (ZnO NPs) has improved Zn bioavailability, therefore ameliorating the physiological function of the animals. Parallelly, the anti-fungal and anti-bacterial properties of ZnO NPs are well documented; however, in planta or in vivo studies are lacking. Consequently, these findings support the theory that adding ZnO NPs to animal feed might be a safe and effective way to produce high-quality animal products and shield human health from the risk assessment issued by mycotoxins exposure.

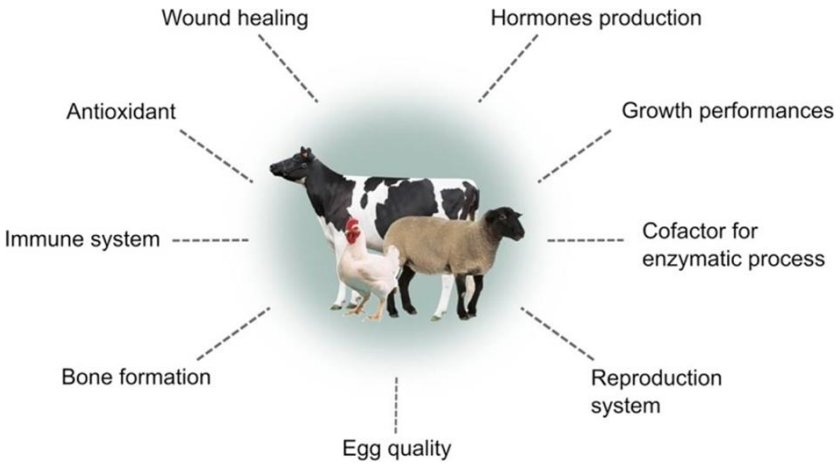

Fig. 2. The function of zinc supplementation in cattle and poultry. Zinc is a crucial trace element for the body's biochemical and physiological processes [15]

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