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Mycotoxins and Their Impact on Poultry Health and Productivity

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Abstract

They are known as secondary metabolic compounds resulting from fungi. To this day, more than 200 types of mycotoxins have been discovered and diagnosed, and 150 different types of molds producing these toxins have been isolated. The production of mycotoxins is not limited to one group of molds regardless of the compositional classification. Ecological distribution or sex, as these compounds are produced from a diverse group of fungal races when the appropriate temperature and humidity and suitable nutrient medium are available (Danicke, 2002). And that the fungi of the genera of Penicillium, Fusarium, and Aspergillus are among the most important fungi in the field of mycotoxins production at present, and the interest of researchers has focused on many studies on toxins produced from the aforementioned genera (Hammoudi, 2006).

Key word: Aflatoxin, Chicken poisoning, Mycotoxin, Poultry.

The most prominent types of mycotoxins

1. Aflatoxins: aflatoxin toxins are highly biologically active mycotoxins, which are products of the metabolic activities of some strains of molds known as (Aspergillus Parasitic us). 1) containing aflatoxins (Devegowada and Murthy, 2005), and there are five main forms of aflatoxins, namely B1, B2, G1, G2, and M1 (Busby and Wogan, 1981). It has been confirmed that these various shapes and images are observed in most cereal crops, especially maize and wheat, before and during harvest and during the stages of harvesting, transporting and storing the crop and even after processing, and in the harvest after processing and during storage (Leeson et al., 1995). The post-industrial stage is the most dangerous stage of its spread and the exacerbation of its danger to poultry to the point that it is difficult to control and limit its impact, and this type B1 is one of the most dangerous and toxic because it grows rapidly in forage crops, including oily (Hammoudi, 2006). (1) The chemical structure of aflatoxin.

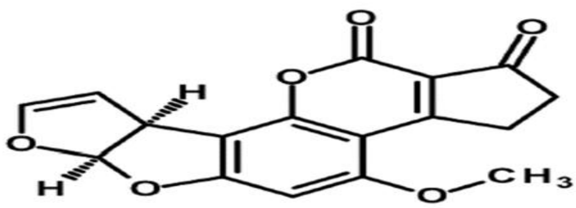

Fig 1. The structural chemical structure of aflatoxin

2. Ochratoxin toxins: These toxins are produced by the biological action of the fungus Penicillium and Aspergillus, and there are three types of ochratoxin compounds, namely A, B, and C and type A is the most dangerous and widespread being heat-resistant and its toxic effect is wide (Hamilton and others, 1982). In 1965, for the first time, a naturally occurring contaminant of ochratoxin A was found on yellow corn in South Africa, and it was less toxic than aflatoxin (Streit et al., 2013). Figure 2 shows the structural chemical structure of ochratoxin.

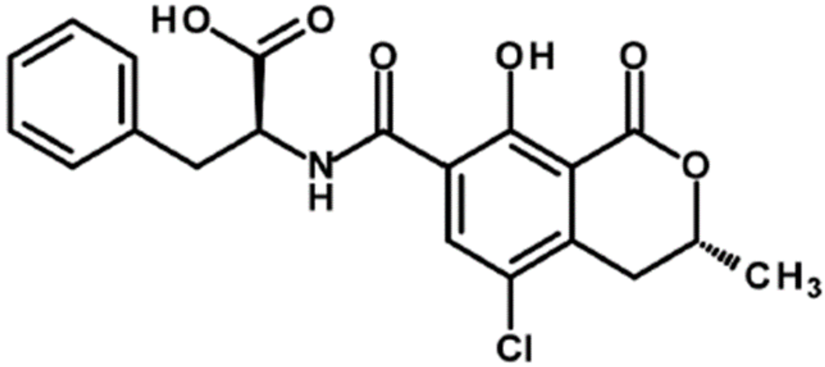

Fig. 2. The structural chemical structure of ochratoxin

3. Trichothecenes toxins: This group of mycotoxins results from several strains of Fusarium. The compounds of this group include four main types A, B, C, and D and each type includes many toxic compounds intertwined with each other (Huff et al., 1986). Trichothiazine compounds were first discovered as toxins in 1972 on rotting yellow corn when introduced to dairy cattle, which resulted in decimation among the herd fed on this feed source (Kubena et al., 1988). Below (Fig. 3), the structural chemical structure of trichothiazines is shown.

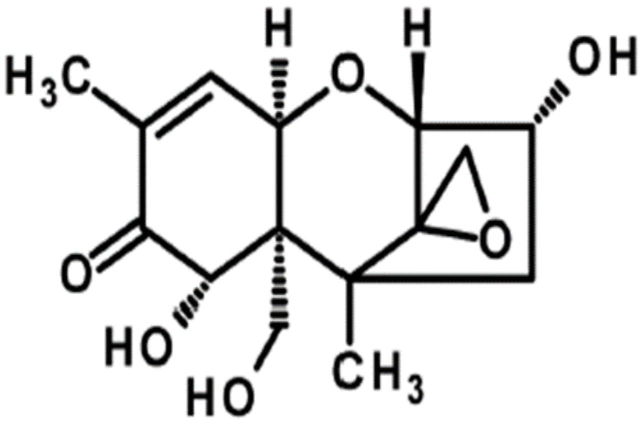

Fig 3. The structural chemical structure of trichostatin

4. Zearalenone: The toxins of this group are phenolic compounds of synthetic origin within the multi-group of kinases (Kuiper-Goodman et al., 1987). This toxic compound is produced from some strains of fungi of the genus Fusarium, and until now its toxic effect as a fodder contaminant has not been known (Tanaka et al., 1988). The chemical structural composition of this toxin is shown in Figure (4).

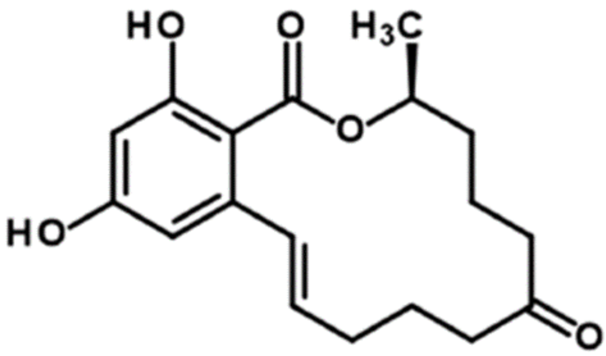

Fig. 4. The chemical structural composition of zearalenone

5.T-2-toxin: This mycotoxin is produced by species of Fusarium, which causes atrophy and cracks in the skin, but it causes atrophy of the skin, mouth, intestines, and liver (Awad et al., 2011). Figure 5 shows the structural chemical structure of this toxin.

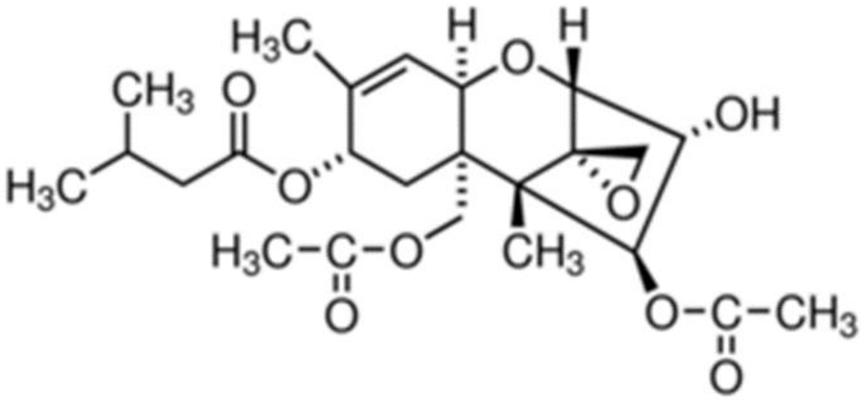

Figure 5. The chemical structure of T-2-Toxin

Harmful effects of mycotoxins on agricultural animals and poultry

The effects of mycotoxins on poultry and other farm animals can be divided into three forms of poisoning, depending on the poisoning status, the dose of the toxin, and the type of fungus that causes the poison:

1) High levels of mycotoxins can cause severe illnesses that lead to high mortality among poultry, preceded by the emergence of a group of symptoms that have clear characteristics such as hepatitis, internal hemorrhage, death of some cells of the digestive system, kidney failure (Grenier and Applegate, 2013)

2) Medium levels of mycotoxins may lead in most cases to cases of chronic poisoning associated with animal life, causing deterioration in growth rates, a decrease in the efficiency of food conversion, and a decrease in production and quality (Murugesan et al., 2015).

3) Low levels of mycotoxins cannot be underestimated, as it has been proven that they cause types of cancers, genetic mutations, genetic abnormalities, deterioration of growth rates, and work to cause a major imbalance in the immune abilities of birds, which exposes them to diseases easily by destroying the cellular immune system. The body does not produce antibodies and then harms the health of the animal and exposes it to death through disruption of the vital activities of birds (Osweiler et al., 2011).

Effects of mycotoxins on avian body organs

Effects of aflatoxin (AFB1) on poultry organ function, productivity, consumer health, and dietary factors that may have these effects. The presence of aflatoxin in poultry diets leads to impaired functioning of the body's organs and changes in their size, as aflatoxin stimulates the production of cytochrome P450 enzymes to convert AFB1 into AFB1-8,9-exposed, as the most toxic form of AFB1), oxidative damage, inhibition of organ function, This results in reduced productivity, decreased reproductive performance, higher disease exposure, and accumulation of AFB1 in eggs and food intake, which may harm consumers' health (Zhang et al., 2016). The addition of inorganic AFB1 bonds can bind AFB1 and reduce AFB1 accumulation in eggs. And the meat according to its efficiency. AFB1-binding organics, such as probiotics, can bind or uptake AFB1 to reduce the conversion of AFB1 to AFBO by inhibiting cytochrome P450 enzymes, as well as mitigate oxidative damage to organs and reduce AFB1 accumulation in eggs and meat. Adding antioxidants, such as selenium and turmeric, can reduce the conversion of AFB1 to AFBO by inhibiting cytochrome P450 enzymes and mitigating oxidative stress and organ damage (Fouad et al., 2019). As shown in Figure (6), illustrates the mechanism of aflatoxin action in disrupting organ function.

As for the toxin of Ochratoxin, Tao et al. (2018) showed that upon entering the toxin, the toxin targets the liver, kidney, and lymph tissue cells, and the action of the toxin is directly on the genetic material DNA and RNA, hindering the cell from producing the enzymes needed to complete the functions of this cell, causing damage to the genetic material. Resulting in cell death as shown in Figure 7.

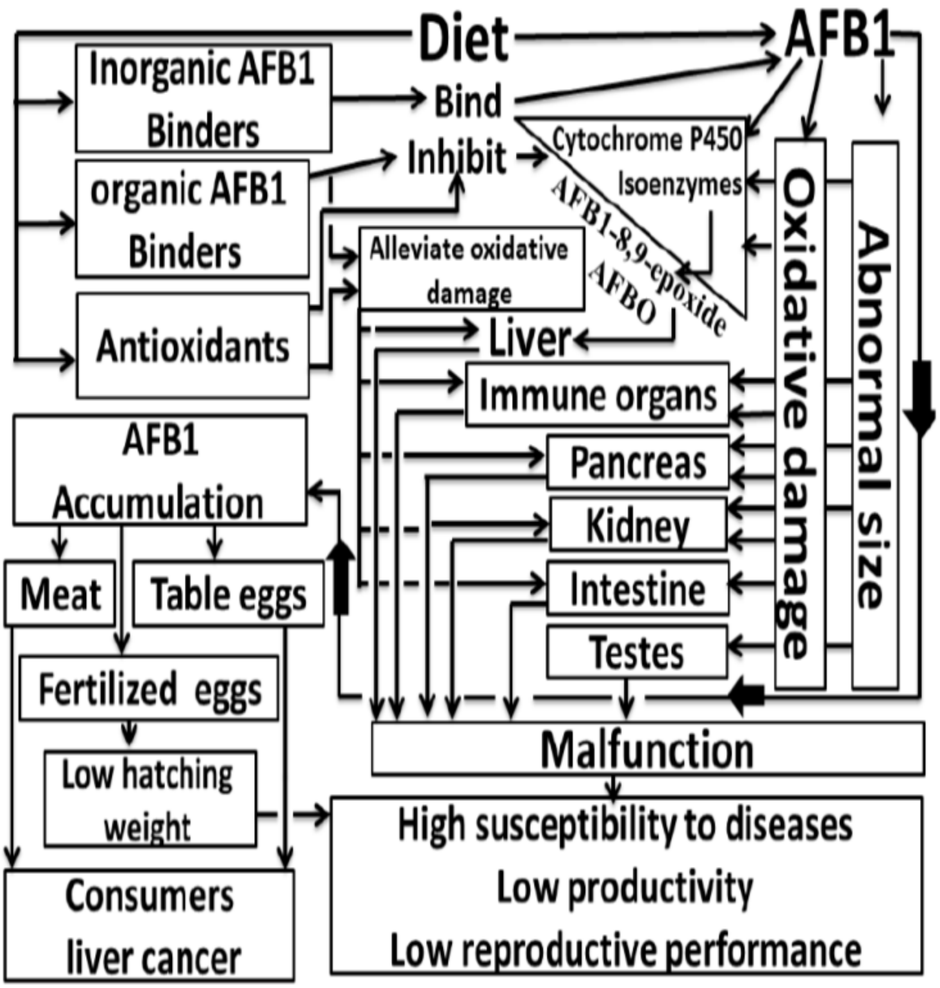

Fig 6. The mechanism of aflatoxin disrupting organ function

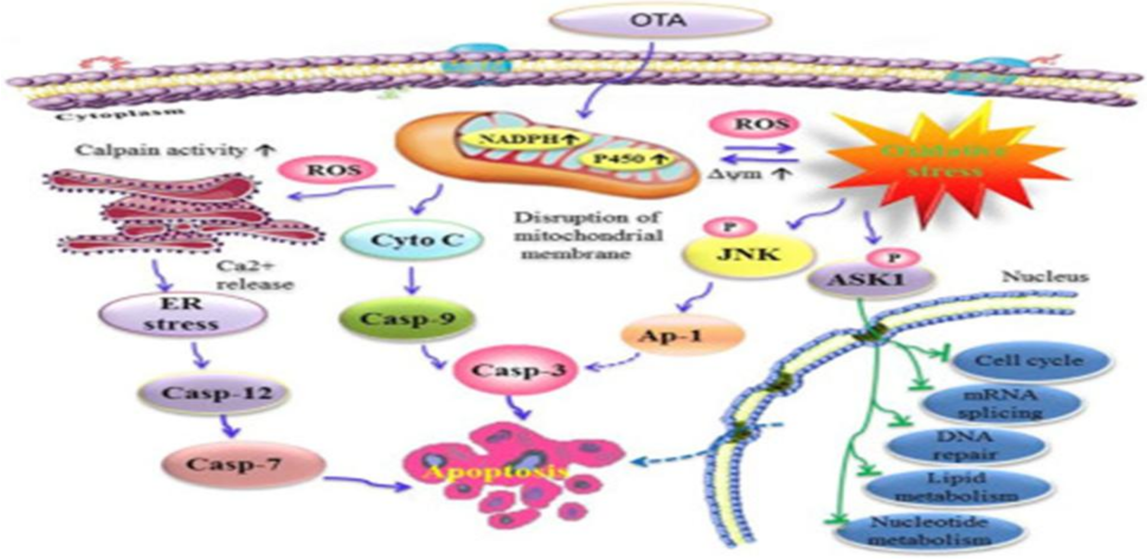

Fig 7. Mechanism of action of ochratoxin toxin inside cells

in a recent study on the mechanism of action of zearalenone, Zheng and others (2018) indicated when entering the body and according to the location of the cells, in some cells it behaves or resembles the action of the estrogen hormone, leading to the cells' overreacting to the toxin as estrogen, which leads to the occurrence of cancerous tumors, in addition to that. It may behave in some cells, leading to the production of free radicals, leading to the destruction of the genetic material and disrupting the respiratory cycle in the mitochondria of cells, which leads to the death of the living cells of the flying body or the organism in general, as shown in Figure 8.

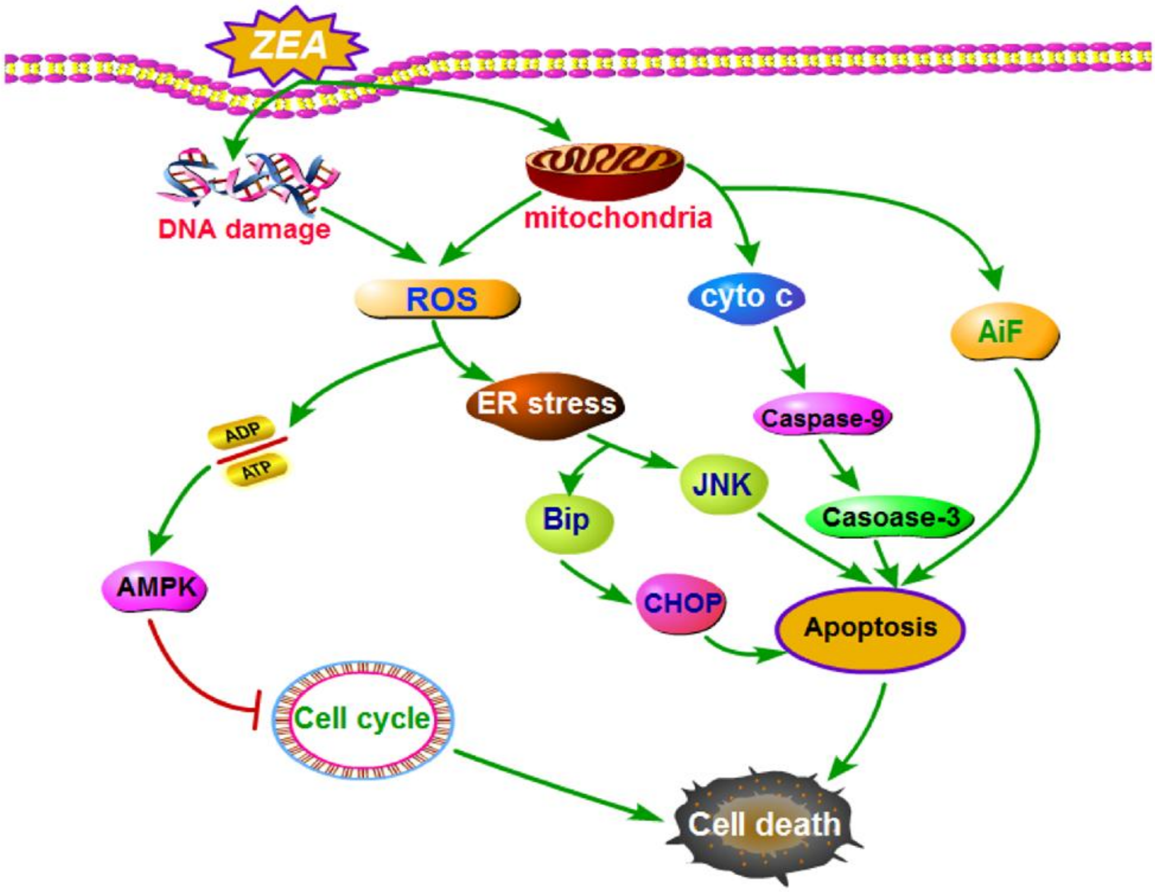

Fig 8. The mechanism of action of zearalenone poison inside cells

Wu et al. (2019) indicated that T-2-Toxin is one of the most dangerous toxins, as it leads to targeting liver cells by penetrating its cells and binding to the site P62 / SQSTM1, a complex component LC-3II, which in turn gives the green light or Activating the autophagy process, which in turn stimulates the lysosome enzymes, releasing their enzymes and cell death, which in turn leads to liver necrosis, as shown in Figure 9.

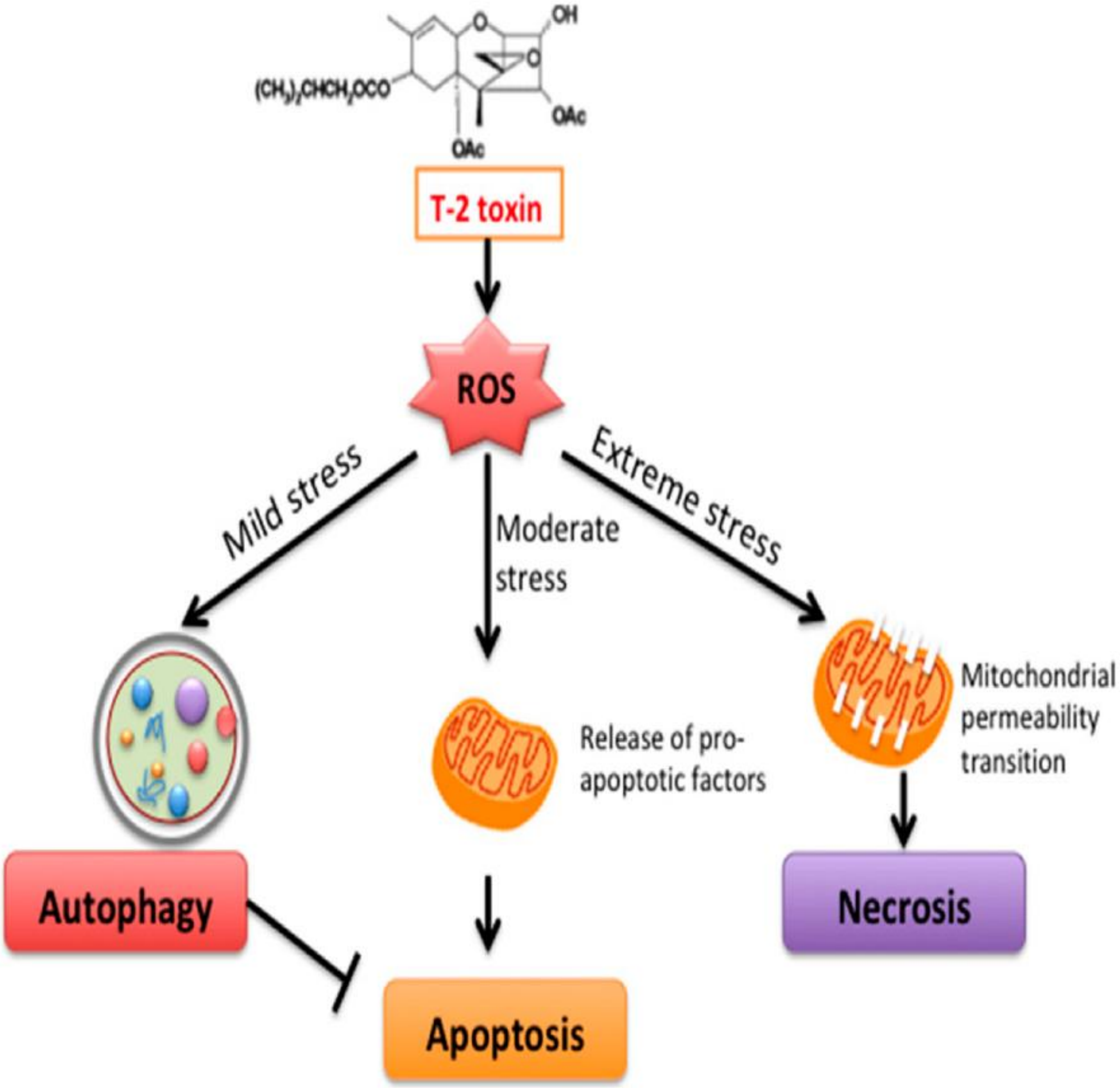

Fig 9. Demonstrates the mechanism of action of T-2-Toxin

As for Trichothecenes toxins, they are no less dangerous than previous toxins, as these toxins work to produce free radicals through their interaction inside cells, in addition to reducing the formation of antioxidant enzymes in addition to their effect on the respiratory cycle of the mitochondria, which is one of the toxins dangerous to human health in addition to its effect on vitamin metabolism And minerals as well as the genetic material of liver cells (Wu et al., 2017). Its mechanism of action is illustrated in Figure 10.

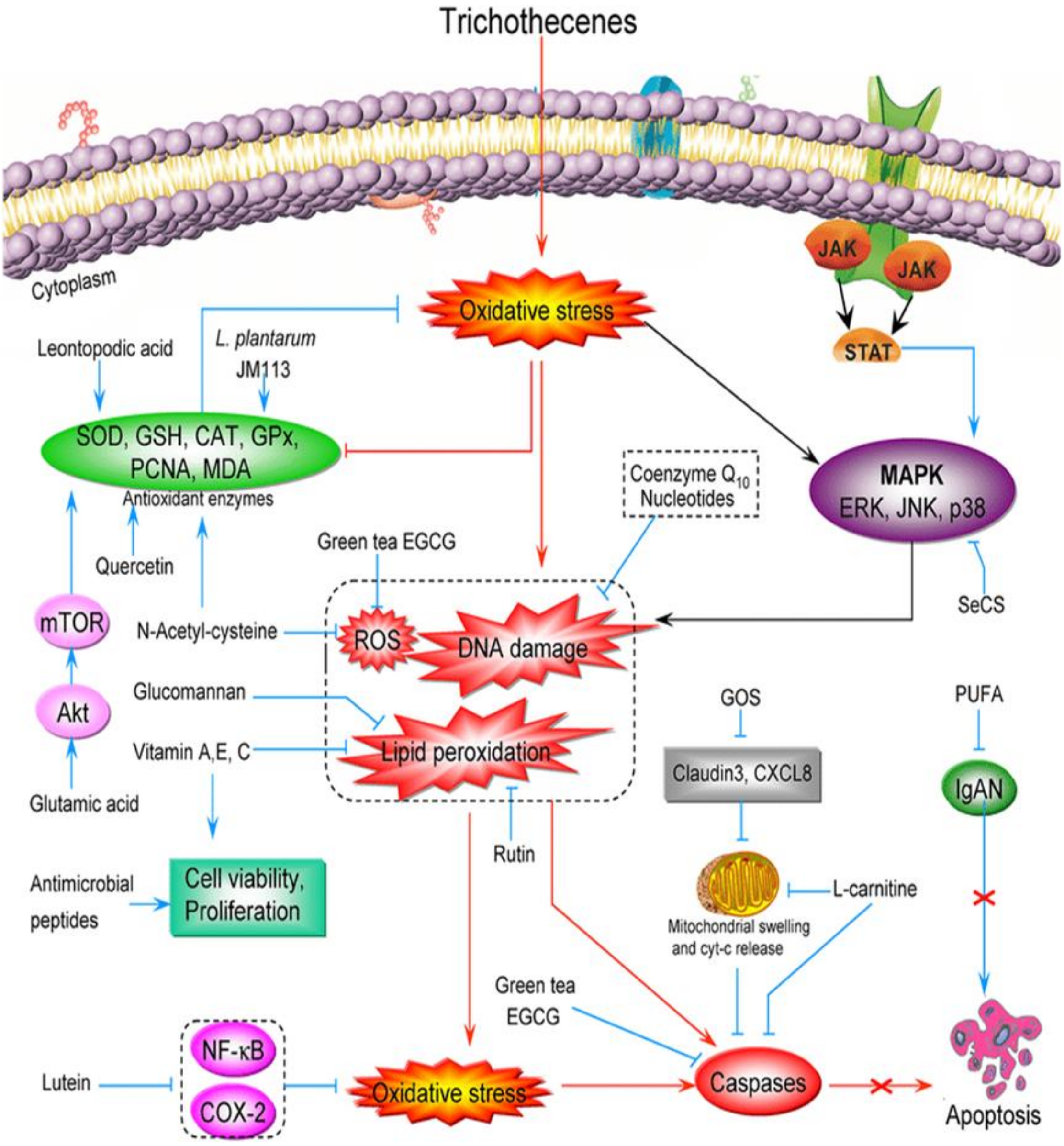

Fig 10. Mechanism of making Trichothecenes toxin

Effect of mycotoxins on vitamin metabolism

The metabolism of both fats and vitamins is affected by the effect of the toxins of these fungi on the enzymes responsible for metabolizing fats and reducing the liver content of the group of fat-soluble vitamins A, E, D, and K. Research results have indicated an increase in the level of fat in the liver and the formation of what is known as (Fatty Liver).) Cirrhosis of the liver, especially in chicks of ducks and turkeys, comes second in chickens (Dietrich et al., 2012).

The effect of mycotoxins on the immune system of birds

Mycotoxins can bind to both (DNA and RNA) and inhibit molecular synthesis by interfering with transcription and other aspects of protein synthesis. Inhibition of protein synthesis is also considered to be trichothecenes including DON and T-2 by binding to ribosomes in eukaryotic cells. As well as OTA, by blocking the enzyme phenylalanine tRNA synthetase and zearalenone disrupts the action of estrogen (the most important female hormone), as zillion binds to the estrogen receptors on cells, preventing estrogen from carrying out its vital functions (Diaz et al., 2008). It has been demonstrated that rapidly dividing and active cells with a high protein turnover rate (such as immune cells, intestines, and hepatotoxins) are primarily affected by mycotoxins, and some recent research embodies this last point where low doses of mycotoxins were able to impair the proliferation of specific lymphocytes that were prepared. They are activated by an antigen (for example, after inoculation), while no effect on the total lymphocyte count (i.e. not recognizing the antigen) was observed (Grenier et al., 2011). Mycotoxins do not possess immune properties, which means that they are unable to induce an immune response unlike pathogens, but they do interfere with the signaling pathways (MAPKs) implicated in cell growth, apoptosis, or immune responses. As a result, the processes that lead to the establishment of an effective immune response weaken the animal and make the animal more susceptible to infection (Grenier et al., 2013).

Fungal diseases

Fungi include two classes of microorganisms, molds, and yeasts, both of which belong to the Mycota family according to the scientific classification of microorganisms. Molds are dangerous to the health of birds in general, as they cause two types of disease, the first type is caused by mold and the condition is called (Mycosis) such as Aspergillus disease, and the second type is caused by the toxin produced by the mold that is called this condition (Mycotoxicosis). The following is a simplified explanation of these two diseases:

1- Aspergillosis

This disease is called Aspergillus miliaria, Fungal pneumonia, and Brooder pneumonia. The disease affects young chicks during the first week at most and is caused by the fungus (Aspergillus fumigatus). Infection may occur inside the hatcheries contaminated with the fungus or its spores, where the appropriate heat and humidity help the fungus to grow and be inhaled by the hatched chicks and its entry into the respiratory tract and the disease occurs, but the disease often occurs inside the field as a result of using a wet mattress, especially if the mattress is of red sawdust Or the spores that have been exposed to rainwater or any source of moisture, these conditions will encourage the growth of mold and its production of spores, which are transferred to the inside of the chick after inhalation with the inhaled air, the wet feed is also considered suitable habitat for the growth of mold and the occurrence of infection.

Infected chicks lose their appetite to eat feed, and they appear diarrhea and feel very thirsty, so they crowd to drink water from the manhole and appear shivering with high body temperature and difficulty breathing, and this is why the chicks open their beak during breathing, but without any sound or sneezing appearing, and this is what distinguishes this The case about infection with other respiratory diseases, the infected chicks also appear trembling, and their eyes may be swollen due to the gathering of yellow materials under the eyelid. Small, greenish-yellow tubercles appear on the lungs, liver, and intestines, and sometimes a cloudy red fluid is observed inside the abdominal cavity as a result of ascites. The air sacs are filled with a yellow-colored filtrate, the affected birds do not respond to treatment. Therefore, the most important treatment procedure is to change the wet bed or wet feed immediately and preferably Changing the brooding site and raising the chicks to a new nursery site after brushing it with a new bed and preparing manholes, feeders, and incubators.

2- Mycotoxicosis

The problem of fungal poisoning of feed materials is one of the most important problems facing the poultry industry in developing countries because these countries do not possess modern technology in drying forage crops, especially yellow corn, which is often included in poultry diets at high rates of 50% or more. Yellow corn is grown. Usually, on two dates (two loops) spring and autumn, the problem appears more in drying the autumn loop of yellow corn, as the harvest takes place during almost the cold months (September and October), so it is difficult to dry it by traditional methods and this exposes it to the growth of molds that secrete their toxins on the corn and the introduction Such grains in the diets will generate a case of fungal poisoning, and for this reason, some countries require that the moisture content of yellow corn be not higher than 10% when received by farmers and stored in the silos for grain storage.

There are many mycotoxins secreted by dozens of types of fungi, but the most important and most dangerous to bird health is the aflatoxin toxin produced by the fungus (Aspergillus), and this is why fungal poisoning is sometimes called (Aflatoxicosis).

The most important external symptoms, macroscopic lesions, and physiological changes that appear on birds infected with fungal poisoning can be summarized as follows:

A- Refrain from eating feed and a clear decrease in food consumption, and for this reason, the birds resort to eating the bed and the fodder scattered in it. This is why the birds appear weak and start plucking their feathers, so the feathers appear irregular, and the legs appear bluish, then the lameness appears and the inability to move and finally the bird turns on its back and legs Raised to the top (Opisthotonos). It is a characteristic sign of the state of poisoning, these symptoms appear 1-2 weeks after eating the poisoned feed, and sometimes they appear after only 1-3 days depending on the amount of poison present in the feed, noting that the minimum amount of poison in the feed is sufficient to show the state of the poisoning of 100-200 parts per billion (ppb).

B- Birds suffer from steatorrhea, and the stool turns into a dark, greasy color because mycotoxins cause an imbalance in the activity of the pancreas, so the secretion of the enzyme lipase, which is responsible for digesting fats, decreases.

C- Upon dissection, the first thing that strikes the eye is the white muscle, that is, the color of the muscles turns to white, a condition similar to the case of muscular dystrophy resulting from a lack of vitamin (E) and selenium in the diets.

D- It is noticed that the liver is enlarged, dark in color, congested, and has a strong consistency when trying to compress it between two fingers of the hand, after that the color of the liver begins to change and may turn pale yellow as a result of the accumulation of fats within the hepatocytes, the cyst of jaundice also appears enlarged and large, also the kidney appears Light-colored enlarged and hemorrhagic spots. These spots may appear on the pancreas and under the skin of the legs as well. Sometimes ascitis appears, where fluid collects in the abdominal cavity and inside the pericardium, causing hydropericardium.

E. When examining the blood, it is noticed that the blood does not clot and the number of white blood cells increases, while the number of red blood cells decreases significantly, as well as the proportion of hemoglobin in the blood and the proportion of blood proteins (albumin and globulin) and the bird becomes anemia (Anemia).

And the. Presence of hemorrhagic ulcers in the lining of the true stomach (Proventriculus) with duodenal enlargement and apparent inflammation within it.

The most important treatment and preventive measures for fungal poisoning are:

1) Withdraw the contaminated feed and fasten the herd for 12-24 hours.

2) Change the feed immediately with another healthy, free of toxins, then start searching for the source of toxins in the feed, often yellow corn and sometimes soybean meal, and poisoning may occur with wheat and barley grains, but this case is rare.

3) Add 0.5 - 1 kg of antibiotic (Oxytetracycline) to the feed provided to the flock for five consecutive days.

4) Doubling the number of vitamins in the feed with a focus on adding vitamin (E), biotin, and selenium to drinking water at a rate of 0.5 g / liter for five consecutive days.

5) He tried adding vinegar to drinking water at a rate of 0.5 - 1 ml/liter of water, with preparing the herd with green fodder (jet and alfalfa) for five days and it gave good results.

6) Recent studies have proven that adding bread wine to the feed at a rate of 0.5 kg/ton, as well as adding 2 kg of sand or clay soil for each ton of feed helps to link mycotoxins and excrete them with bird droppings, thus preventing their absorption into the gastrointestinal tract. For birds.

7) The latest scientific research has proven that the addition of probiotic enhancers is considered one of the most successful ways to reduce the effects of mycotoxins in poultry diets.

As for the most important modern technologies to reduce mycotoxins

Farooqui et al. (2019) used a new combination of aluminum silicate with baking yeast in chicken diets contaminated with mycotoxins (aflatoxin and ochratoxin) at a concentration of (57 and 23) parts per billion, respectively. It was observed that there was a significant increase in the average weight per square meter, the rate of feed consumption, and the increase. Weight loss, which reflected positively on improving the nutritional conversion factor for negative addition and control treatments compared with the positive control, which indicates the effectiveness of the substance used in the experiment to reduce the risk of mycotoxins. Also, Farooqui et al. (2019) indicated that there was no effect on the relative weight of the members. (Heart, kidney, and spleen) in all the experimental treatments except for a significant increase in the relative weight of the liver in the positive control treatment that contains toxins and this inflation is due to the presence of toxins in the diet and the absence of substances to disrupt the action of the toxin compared to the additional factors of the binding substance.

The growth and increase in the relative weight of the lymphoid organs from the thymus gland and Fabricia in addition to the increase in the weight of all the additional factors compared with the positive control treatment were observed, while the relative weight of the pancreas was not affected (Farouqi et al., 2019), and the same study indicated that there was a significant increase in the parameters. The volumetric effect of Newcastle in all trial treatments compared with the negative control treatment, which in turn indicates the effectiveness of the combination to reduce the effect of toxins on the immune system growth of broilers. A significant decrease in ALT was observed in the blood serum of birds whose diets contained the binder compared with the negative control treatment, while there were no significant differences in serum creatine, uric acid, and AST. Jia et al. (2016) indicated that the addition of The biological product of Bacillus subtilis in laying hens' diets at a constant rate of 1 kg/ton led to an improvement in the production performance in the percentage of egg production and the feed conversion factor, and there were no significant differences in the weight of eggs and the amount of feed consumed. In another study, Fan others (2015) indicated that the addition of Bacillus subtilis bacteria from the ANSB060 strain to chicken diets containing field pistachios contaminated with aflatoxin toxin showed that Table 7 showed a significant increase in the mean weight of the toxin for all the additional treatments compared with the treatment (M0). Which was free of additive and containing the toxin, as, for the relative weight of the internal organs (heart, liver, spleen, fabrics follicle, and gland), no significant differences were observed during this study. The effect of adding B. subtilis bacteria to chicken diets was also studied. Meat in the evidence of antioxidants in liver and blood serum, as Fan et al. (2015) indicated that there was a significant improvement in the additional factors and that high levels of glutathione peroxidase enzyme (GSH-PX) compared with the additive-free treatment that contained the toxin (M0). This reflected positively on the decrease in the concentration of malondaldehyde (MDA) in the blood serum, while there were no significant differences in the total subroxide of the blood lipid (SOD), but in the liver tissue, the concentration of malondaldehyde decreased in the addition treatments compared with the treatment (M0) while there were no significant differences in total blood lipids (SOD) and glutathione peroxidase (GSH-PX) superoxide in liver tissue.

The rapid development of nanoparticles in the past decade as a solution to disease-causing antibiotic-resistant bacteria. The application of this program was restricted initially against fungi or mycotoxins due to the differences between bacteria and fungi because bacteria are single-celled, while most fungi are multicellular; Bacteria have three distinct forms, while fungi have different shapes that lead to the formation of fungi. Bacteria reproduce sexually, whereas fungi can reproduce sexually or asexually, all these differences make the fungi more tolerant and resistant to some antibiotics (Sureka et al., 2014). So far, the research tends to focus on antibacterial nanoparticles rather than on anti-fungal nanoparticles, and the most recent findings in the field of antifungal nanoparticles were summarized between 2016 and 2017 (Niemirowicz et al., 2017; Voltan et al., 2016).

Through experiments, it may be possible to inhibit the growth of fungi and the production of their toxins using anti-fungal nanoparticles, which are easy to produce on a large scale. According to recent scientific articles (summarized in Table 8), the anti-fungus strategy is directed in two directions. Firstly, an antifungal compound is encapsulated in polymeric nanocages, perhaps the most serious disadvantage of this method is the instability in the air, although the nanopolymers allow the cargo to be released under the right conditions (for example, the presence of enzymes, high temperature, change PH), and secondly, the damping effect is achieved by the nanoparticles alone. This method is mainly based on stable metallic nanoparticles, works instantly, and provides green synthesis potential. Moreover, the advantage of green synthesis is the formation of nanoparticles using plant, microorganism, and animal sources that exhibit less toxicity and improve their main features (Adelere et al., 2016).

Table 8. Nanocomposites that act as anti-fungi and their toxins

Fungi	Type of nano-particle	Inhibitory dose
Alternaria brassicicola	Nano- silver	100 ppm
Alternaria solani	Nano- silver	10 ppm
Aspergillus flavus	Thyme oil with benzoic acid	300 mg/L
Aspergillus flavus	Peppermint oil with chitosan in a nano-ceramic acid gel	500 ppm
Aspergillus flavus	Turmeric oil loaded with nano chitosan	650 ppm
Aspergillus flavus	Nanodispersed Cinnamaldehyde	1 mM
Aspergillus flavus	Nano- silver	5 µ.g/ml
Aspergillus niger	Titanium Oxide Nanoparticles	1 g/L
Aspergillus niger	Copper, nickel and silver nanoparticles	65 µ.g/ml
Aspergillus parasiticus	Nano- silver citrate	1.7 mg/g
Aspergillus parasiticus	Nano- silver	50 ng/ml
Fusarium culmorum	Nano- silver	180 µ.g/ml
Fusarium graminearum	Nano chitosan	20 mg/l
Fusarium oxysporum	Chitosan and silver nanoparticles	5000ppm
Fusarium oxysporum	Nano- AL	100 µ.g/ml
Fusarium solani	Silver bonded with titanium oxide	400mg/l
Penicillium expansum	Silver silicate nanoparticles	0.43 mg/plate
Penicillium digilatum	Nano - OZn	20-60 µ.g/ml
Penicillium verrucosum	Nano - OZn	5-100 ppm
Penicillium and Mucor	Nano - OZn	5 mg/ml
Alternaria brassicicola	Nano - OZn	100 ppm

(Niemirowicz et al., 2017; Voltan et al., 2016)

It showed that many nanomaterials were used in the field of reducing the effect of mycotoxins in the diets in the laboratory where it was observed that the efficiency against mycotoxins (AFL, OTA) ranged from 0.065 to 1000 mg / g depending on the nanomaterial used (magnetic graphene oxide, magmite). Halloysite nanoparticles, diamond nanoparticles, composite montmorillonite nanoparticles, chitosan nanoparticles). Scientific research indicates the toxic effect of the most common mycotoxins in the range of 1-30 mg / kg diet (Alshannaq et al., 2017). In theory, only 30 mg of nanoparticles per 1 kg of compound feed would suffice to eliminate the toxic effect. In the case of the oxidation of selected nanoparticles, we found from the research that the safe level for mice ranges from an average of 0.3 to 16000 mg / kg, the results of the nanoscale absorption efficiency against mycotoxins would have been more convincing if the researchers looked at the actual practical feeding dose of mycotoxins. As shown in Table (9)

Table 9. Possible nanocomposites that have been used to reduce mycotoxins in rat feed

Nano Material	safe dose	toxins on which binding	capacity acts
Nanodiamonds	25 mg/ Kg	Aflatoxin	10 µg/mg
		Ochratoxin	15 µg/mg
Magneticgraphene oxide	0.3 mg/ Kg	**Zearalenone**	0.065 µg/mg
Surface activemaghemitenanoparticles	10 mg/ Kg	Strene	175 µg/mg
Chitosannanoparticles	16 g/ Kg	Aflatoxin	0.8 µg/mg
		Ochratoxin & Zearalenone	1 µg/mg
Montmorillonitenanocomposite	1 g/ Kg	Aflatoxin	67 µg/mg
Modifiedhalloysite nanotubes	10 mg/ ml	**Zearalenone**	1000 µg/mg

(Alshannaq et al., 2017)

In addition, Horky et al. (2018) illustrated a scheme for the mechanism of action of nanoparticles loaded on polysaccharides or chitosan, as they are intertwined with TPP in the CS structure to be Q. The positive charge of NPs interacts electrostatically with the negatively charged epithelial cell wall. Quercetin triggers a protective cascade of the liver that leads to protection from antioxidants and mycotoxins through stimulation of nuclear factor-associated nuclear factor E2 (NRF2) induced by heme-oxygens-1. The transcriptional response is mediated by the labeled representation element (ARE) present in the stimuli of genes that encode detoxification enzymes. Lipid polysaccharide (LPS) induced by nitric oxide synthase (iNOS) and to production via IKB kinase from the gene site (IKKp38) by metogen-activated kinase (p38MAPK)) as in Fig.12.

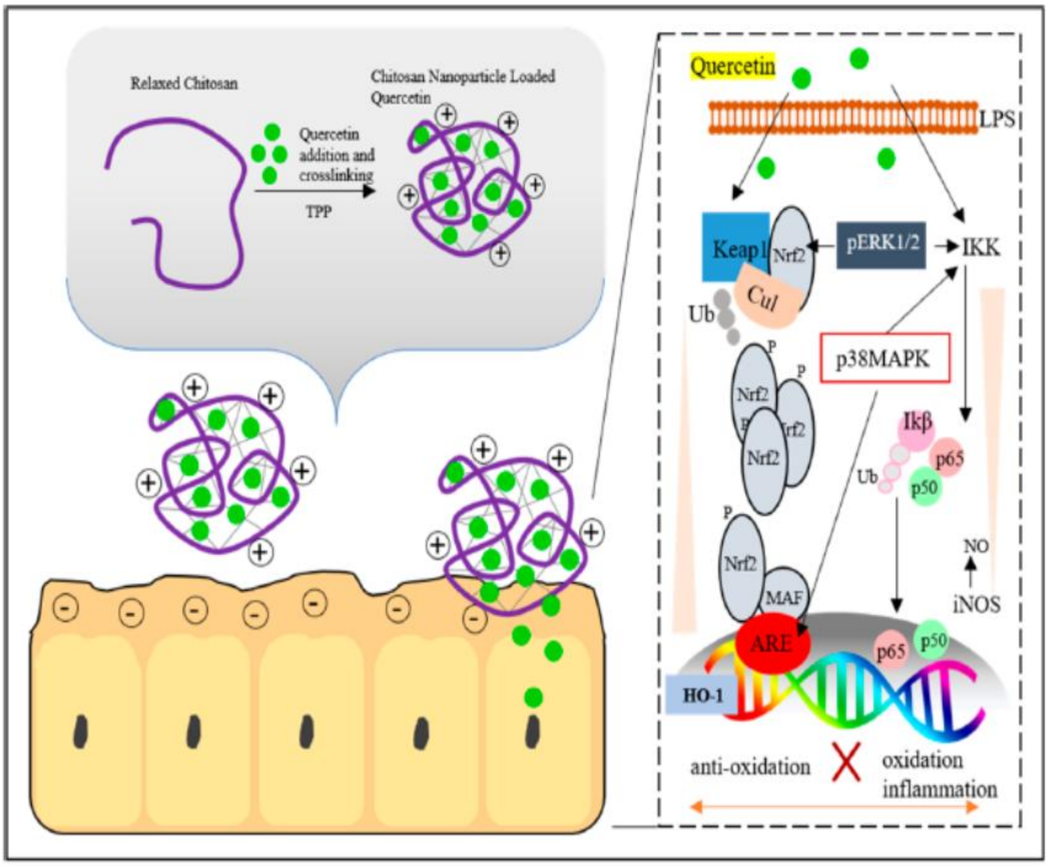

Fig 12. The mechanism for protecting liver cells from nanoparticles from mycotoxins

One of the most recent ways to reduce the effect of mycotoxins in poultry diets is the use of nanoparticle techniques to reduce or remove the toxicity of mycotoxins in contaminated diets. Graphene oxide with chitosan) at a rate ranging from 0.25-0.50% to broiler feeds, which led to a significant increase in the weight increase rate of additional treatments during the trial periods (1-21 days), (22-35 days) and (1-35 days) compared with the control treatment. Positive (T6), as well as for the rate of feed consumed during the second period (22-35 days) and the cumulative period (1-35 days). The consumption of feed increased besides factors compared with the control treatment, while no significant differences were observed in the first period (1 -21 days) in the rate of feed consumption, which in turn was positively reflected in the improvement of the feed conversion factor for the additional treatments compared with the positive control treatment (T6). As for the percentage of mortality during the breeding period, no significant differences were found between the experimental parameters. In the same study, it was observed. The use of nano-composite magnetic graphene oxide with chitosan, at a ratio of 0.25-0.50% to broiler diets, improved the physiological and health status of birds whose nanomaterial was added to their diets compared to the contaminated feed without addition (T6).), While no clear tissue changes were observed between the trial treatments in the tissues of the meat broiler liver samples, in good, a significant decrease in the absorption of the toxin was observed in the two treatments (T4 and T5) compared with the treatment (T6) in which the higher or higher toxicity absorption was observed in Small intestine.Recently various methods have been developed to reduce the incidence of mycotoxins in feed; Nonetheless, nutritional supplementation with mineral or clay binders is one of the main methods used by farmers and the large-scale feed industry. Due to its high negative surface area, pore size, swelling ability, and high cation exchange capacity, mineral sorbents including bentonite, zeolite, montmorillonite, and aqueous calcium sodium aluminosilicate can bind or absorb mycotoxins to interlayer spaces, and the outer surface Edges (Moreno-Maroto et al., 2018). Several studies, as shown in Table (12), have shown that these substances are partially or completely effective in countering the toxic effects of mycotoxins in farm animals that feed on contaminated diets, and therefore they are widely used in animal production to reduce the risk of exposure to mycotoxins. (Elliott et al., 2020).

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