

## Techniques for Detection of Trichothecene in Food: A Comprehensive Review

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### ABSTRACT

Trichothecenes, pose significant health risks to humans and animals by contaminating food and feed. These toxins are classified into Type A and Type B. Type A trichothecenes are commonly detected in various food matrices, while Type B trichothecenes contaminate crops and are linked to alimentary toxicities, including emetic reactions. Advanced detection methods such as liquid chromatography-tandem mass spectrometry are widely used. Biological controls, such as *Debaryomyces hansenii*, have shown promise, reducing toxin content and suppressing pathogen spread. Trichothecenes exhibit ribotoxic, pro-inflammatory, and cytotoxic effects, making their management a critical focus in food safety. This review comprehensively explores detection techniques, management strategies, and the impact of trichothecene contamination on human health, emphasizing its relevance in public policy and food security.

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## **INTRODUCTION**

Mycotoxins are secondary metabolites that comes from filamentous fungi and major contaminants of crops (Čolović et al., 2019). Some agricultural products and their derivatives like human and animal food like cereals, corn, soybeans, peanuts, have a very high risk of being contaminating mycotoxins at all stages of their production process, such as wine, fruit juice, animal feed. (Gruber-Dorninger et al., 2019). Fungal pests and mycotoxins contamination of food is a major global challenge and constitute a serious dilemma for the food industry. Mycotoxins have adverse effects that can be mutagenic, carcinogenic, cytotoxic, or genotoxic to mankind. Low-molecular-weight toxic secondary metabolites known as mycotoxins are produced by some kind of fungi at warm and humidity conditions on food as well as agro-food products (Mahdjoubi et al., 2020).

Food and Agriculture Organization(FAO) they've done some research, and it turns out that, globally, around 25% of the cereals produced each year – those meant for people to eat – are actually contaminated with these secondary metabolites (Guo et al., 2021). Almost 500 distinct mycotoxins have been described till now. The most prevalent mycotoxins that can negatively impact the health of both humans and animals are aflatoxins (AFs), ochratoxins (OTs), fumonisins (FBs), patulin (PAT), and trichothecenes (TCT) – which includes compounds like deoxynivalenol (DON), T-2 toxin, HT-2 toxin, and zearalenone (ZEA). Now, when it comes to eating legumes such as soybeans, peas, and chickpeas, well, there are a few potential risks to keep in mind. You see, these foods might get contaminated by mycotoxins. These toxins are natural and are made by certain fungi. Some of these fungi belong to groups called *Aspergillus*, *Penicillium*, *Fusarium*, & *Alternaria* (Mihalache et al., 2023).

As stated, mycotoxins infection usually exists in any part of the complicated meals chain, together with harvest, industry processing, transportation and/or garage. substances of plant beginning, which includes grains (wheat, rice, oats, barley, maize, and others), are normally used in puppy meals formulations, generally hired in dog food and animal feed for electricity, proteins, fiber and other nutrients. AF, DON, FUM, OTA, and ZEA input the dog frame in extraordinary concentrations in general ingested with plant foundation components and meat, eggs, milk, and their derivates with mycotoxins residues.

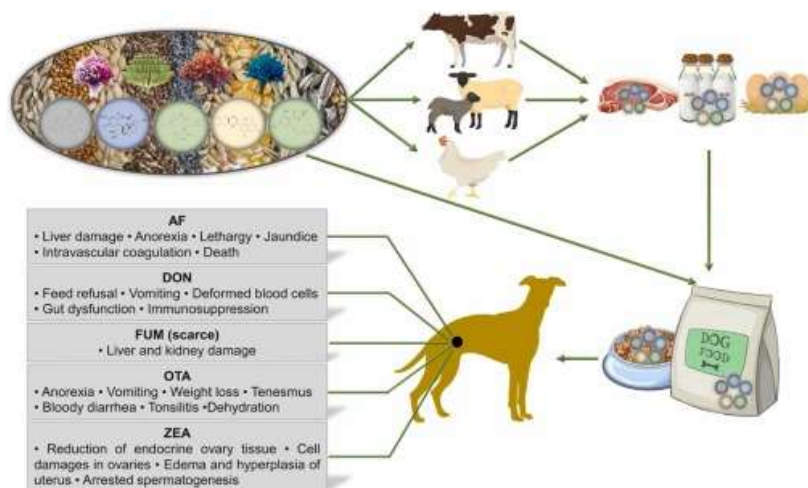


Figure 1. Mycotoxin contamination of food and toxicity on dog health. Aflatoxin B1, ochratoxin A, fumonisin B1, zearalenone, and deoxynivalenol are the most frequently found mycotoxins in the food and feed for farm animals and dogs.

Human beings get uncovered to mycotoxins either by means of intake of plant and plant merchandise or through animal-derived products including milk, cheese and meat merchandise (Haque et al., 2020). Regions where hunger is widespread, where safe food handling and storage practices are not promoted or upheld, and where public health laws designed to protect vulnerable populations are absent or poorly enforced, see far more exposure to mycotoxicosis (Okungbowa & Kinge, 2021). Trichothecenes (TCT) are one of the most prevalent types of mycotoxins, which include over 200 structurally related compounds with a common sesquiterpenoid skeleton (Polak-Śliwińska & Paszczyk, 2021).

## THEORETICAL REVIEW

Trichothecenes are actually these secondary metabolites that come from moulds, and they're produced by fungi belonging to the genus *Fusarium*. (You et al., 2021). There are four trichothecene instructions (sorts A-D) and the *Fusarium* species produce individuals of the type A and/or B instructions (Foroud et al., 2019). As Figure 2 illustrates:

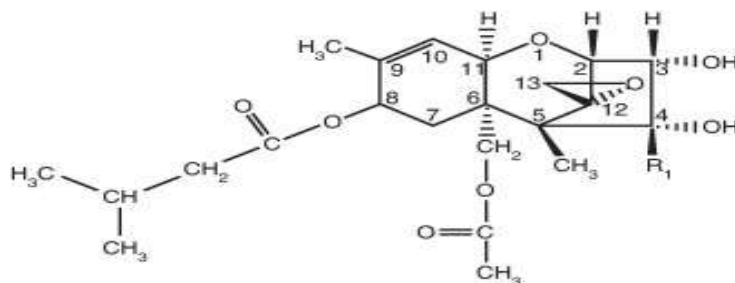


Figure 2. Trichothecene's chemical structure

### ***Types of Trichothecene***

Food matrices primarily contain Type A TCTs (TCT-A) and Type B TCTs (TCT-B), while Type C and D are substantially less common [6]. Due to all these adverse effects on the columns and as indoor air pollutants, Type D TCT have been gaining more attention (Garofalo et al., 2023). Type A and type B of trichothecenes, which are regularly discovered as contaminants in a variety of products, are the most significant and thoroughly investigated groups from a toxicological perspective.

So, when we talk about A type trichothecenes, we're looking at T-2, HT-2, DAS, and NEO. These are part of this group of mycotoxins that are, well, pretty common in various cereal grains. You know, things like wheat (which is scientifically known as *Triticum aestivum* L.), maize, or corn if you prefer (that's *Zea mays* L.), and even rice. The thing is, the presence of these mycotoxins can really mess with food safety, and that's not great for human health. Type A trichothecenes, following either acute or chronic ingestion, have a broad spectrum of biologic effects including immuno suppression and cytotoxicity (Escrivá et al., 2015). So, the European Food Safety Authority (EFSA) Panel on Contaminants in the Food Chain has actually set a tolerable daily intake (TDI) for the combined T-2 and HT-2 toxins. They've determined it to be around 100 nanograms per kilogram of body weight. That's the amount that's considered safe for daily consumption (Commission, 2013).

B trichothecenes are one of four types that belong to the most well-known toxins (trichothecene mycotoxins). Cereal staples, like oat, maize (corn), barley, and rice--all have higher levels of contamination with fumonisins than aflatoxins since these mycotoxigenic species are frequent colonizers during cereal development even when conditions in storage facilities may hamper fungal growth (Pestka, 2010). Trichothecenes, well, they're categorized into two main types: A and B. One of the notable ones in this group is deoxynivalenol. This particular mycotoxin is often found contaminating wheat, especially in some Mediterranean countries.

Congeners 15-Acetyl-deoxynivalenol (15-ADON) /3-acetyldeoxnivalenal(3-Adon(NIV) +4 -acetylriavalerol((Fusarenon X; FX). Family trichothecenes cause a number of harmful consequences like anorexic effect, abdominal pain, growth suppression, emesis,, diarrhea hemorrhage sicchasia and immunotoxicity.

This paper reviewed the current progress of biodetoxification in trichothecenes detoxification from food and feed, looking at these processes with different perspectives. Followed by the well explained detoxification mechanism of every method, a discussion on its challenges as well and future developments. Biotherapy (which is a Practiced example strategy) as usually neglected in talks on detoxification despite the good toxicological research evidence that it functions. The insights supplied in this review are of high importance for the incorporated management against mycotoxins to make certain that meals and feed protection is maintained, thereby shielding human health as well as animal manufacturing (Qiu et al., 2024).

### ***Sources of Trichothecene***

Under settings, with temperatures from 32°F to 122°F (1°C to 50°C) humidity at 70%, moderate moisture levels between 10% and 20% and appropriate water activity, above 88% fungi can grow and produce increased levels of trichothecene mycotoxins (TCNs). The structure activity and toxicity of all TCN is mainly due to the presence of epoxy ring (Polak-Śliwińska & Paszczyk, 2021).

### ***Impacts on Human Health***

T-2 toxin can cause poisoning that might not always be lethal, affecting both humans and pets. This type B trichothecene mycotoxin has a significant negative impact on rapidly dividing cells and actually hinders the production of healthy proteins (You et al., 2021). While vomiting serves to induce a defensive reaction against food poisoning, consistent and excessive vomiting can lead to serious health causes due to imbalance of electrolytes and nutrient transformation (Wei et al., 2023). Abstract Fusarium head blight (FHB) is a cereal disease with global importance. Over 20 species and subspecies belonging to the genus *Fusarium* cause it, (Ji et al., 2019), primarily of wheat associated *Fusarium graminearum* (teleomorph *Gibberella zeae* Schwabe), prevalent in Europe, Asia (Ji et al., 2019) and North America. (Crippin et al., 2019).

### ***Toxicity of Trichothecene: Adverse Effects on Human and Animal Health***

TCNs are businesses of chemically coupled toxins that might be prepared from using some species of filamentous fungi like *Fusarium*, *Myrothecium* and *Stachybotrys* that have been noticeable global and impart true threats on human and animal.

The presence of kind B trichothecenes and D3G in meals is related to acute and persistent toxicity symptoms in humans and animals, which includes food refusal, reduced frame weight, diarrhea, hematological disorders, vomiting, nausea, abortion, neural disturbances, immunosuppression, and a robust suppressive effect at the synthesis of proteins, RNA, and DNA. Cytotoxic potential of TCNs varies depending on the mycotoxins produced by the exposed fungus species and different environmental conditions. While the same fungus often makes DON (deoxynivalenol) at low oxygen levels, it also creates zearalenone, an estrogenic mycotoxin that is not TCN, at high oxygen levels. The likelihood of *Fusarium* infection in crops is further increased by the use of corn in crop rotation and the no-till farming technique. T-2 toxin is this thing that messes with protein synthesis, it's got a strong grip on peptidyl transferase, which is part of the 60S ribosomal subunit. When it binds, it kind of throws everything off balance, leading to what's known as a ribotoxic stress response.

Now, here's the interesting part – T-2 toxin doesn't stick around for too long. In both humans and animals, it's usually metabolized pretty fast and then gets kicked out in urine, with hardly any of it hanging out in the tissues (Schelstraete et al., 2020). Moreover, oxidative stress caused by the T-2 toxin actually seems to lower the expression of Nrf2, which is that nuclear factor erythroid 2-related factor 2, and also aggrecan, with this alteration contributing

to changes in apoptosis regulatory proteins, such as caspase family members, ultimately leading to cell death by activation of the apoptotic pathway.

The effect these chemical releases have on animal health is complex and dependent on various factors like the amount, toxicity of feedstock ingested or inhaled by humans/animals; body weight/species/age/physiological condition/sensitivity difference/allergic constitution [63]; mode/manner/mechanism/state-of-action of functioning classification particular functional group/firebase compound (Lemos et al., 2021). TCT's cytotoxicity was evaluated in intestinal cells IEC-6 that had not undergone transformation.

Trichothecenes could be categorized as follows thanks to these data: T-2 > DAS > FX > NIV > NX > DON. The classification is in line with the literature, even though, to the best of our knowledge, this is the first direct comparison and rating of TCT cytotoxicity in IEC-6 cells. With an IC<sub>20</sub> that is roughly 1000 times higher than other TCTs, T-2 toxin is in fact recognized as the most dangerous TCT. DAS is more cytotoxic than FX but marginally less so than T-2 (Garofalo et al., 2023), and FX is more cytotoxic than NIV and DON. Cells co-exposed to genotoxins and TCT survive and could therefore pursue their cell cycle and division following repair of DNA damage. Further studies are needed to examine whether cells co-exposed to TCT and genotoxins could accumulate mutations, ultimately resulting in cellular transformation (Garofalo et al., 2023).

T-2 toxin is actually a powerful inhibitor when it comes to protein synthesis, it really messes with this thing called peptidyl transferase, and it does this because it has a strong binding affinity. This, in turn, affects the peptidyl transferase found in the 60S ribosomal subunit. As a result of all this, c-Jun N-terminal kinase (often called JNK) and p38 mitogen-activated protein kinase (or p38 MAPK). Fusarium is the main producer of the type A to D toxins sesquiterpenoids of the mycotoxin family. Type B trichothecene mycotoxins are the most common and potent among four classes of trichothecene mycotoxins. The presence of such a panel of mycotoxins usually affects food crops (owing to rice, oat, maize cultivation) at extremely high concentrations and represents a potential public health issue.

Since the TCNs are very well absorbed molecules, we suppose that they would be specially dangerous and toxic. Their metabolites induce intoxication of various organs and systems – skin, gastrointestinal tract, liver, kidneys or the immune system causing a spectrum of health problems. For example, the gastrointestinal tract is filled with enteroendocrine cells that release various gut hormones such as cholecystokinin (CCK), gastric inhibitory peptide (GIP) glucagon-like-peptide-1 (GLP-1), and 5-hydroxytryptamine which serve to be carried to the brain as TCNs via a single or multi synaptic connections. The effects of these compounds and how they interact with animal health is determined by the concentration, time in which exposure occurs, toxicity level when ingested, weight and species age among other factors related to consumers physiological condition targeted mechanism (Lemos et al., 2021). Trichothecene toxins have been considered as Category A, Safe and Naturally Occurring Food Contaminants since they were isolated from Fusarium viruses commonly

identified in cereals such as *Fusarium oxysporum* back to 1973 FAO/WHO (Ye et al., 2021). As shown in figure 3:

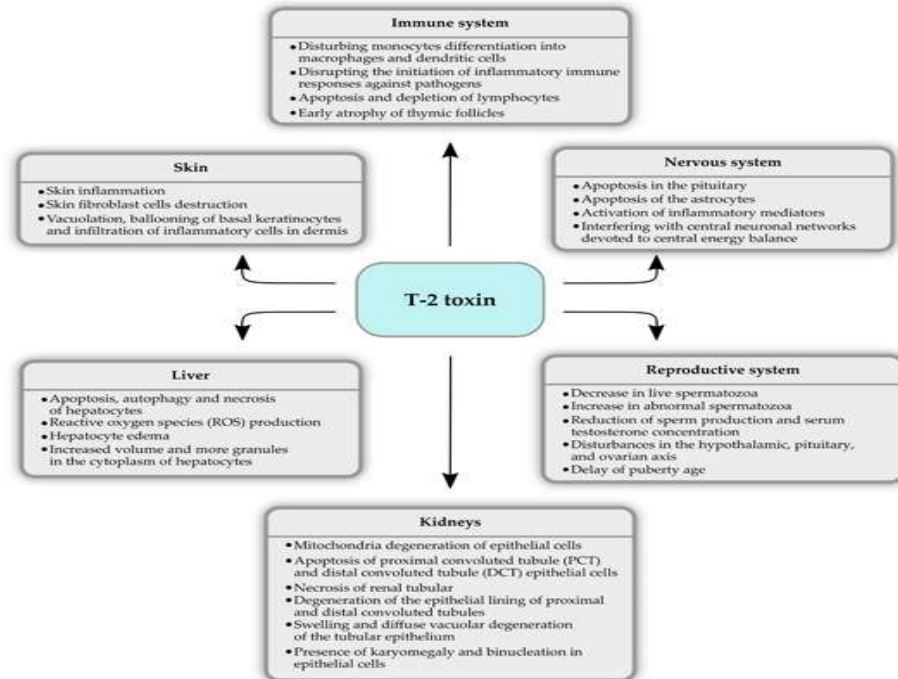


Figure 3. The main toxic effects of T-2 toxin in the organism (Janik et al., 2021).

### *Trichothecene Control and Regulations*

Consequently, researchers have screened many microorganisms and enzymes that may biotransform trichothecenes into much less/toxic merchandise due to the removal of or with out recognize their poisonous shape. A key structural feature that significantly affects the toxicity of trichothecenes is the presence of a C-12,thirteen epoxide organization which is notion to be required for expression many its organic interest (Lu et al., 2022). Trichothecenes are toxin mycotoxins that have been drastically studied and validated with open epoxide ring to convert the pollution into low toxicity deepoxidation (DE) metabolites.

Glycosylation and glucuronidation, a type of phase II reaction, is the process in which glucose or glucuronic acid are covalently linked to the C-3 hydroxyl group of T2 reducing their toxicity. This process actually detoxifies trichothecenes by changing their chemical structure into one that is less harmful to living organisms. The fact that glycosylation and glucuronidation can reduce the toxicity of trichothecenes is noteworthy; however there is a worry that these altered versions could serve as a concealed form of the toxins potentially concealing their existence and complicating detection efforts. This brings up worries, about the discreet exposure, to trichothecenes, which may still present health hazard

In conclusion, biosorption, biotransformation and biotherapy are all promising procedures to trichothecenes cleansing, which have their respective utility scopes and benefits. purposeful integration or combination use is beneficial to present complete play to the advantages of different strategies.

laptop-aided biotransformation improvement has begun, that is expected to turn out to be an important tool for rapid screening, optimization and mechanism investigation of biotransformation, and may provide specific answers for diverse contaminant conditions within the future. interest must be paid to the problems that need to be solved from laboratory to sensible application of biotransformation, consisting of generation, registration and law (Qiu et al., 2024).

## **METHODOLOGY**

The use of TCNs' techniques is essential for looking at occurrences, potential preventions, and controls. The number of TCNs was previously calculated using bioassays from different biological systems or biological functions (Watson & Lindsay, 1982). For the final identification and quantification of TCNs, physicochemical approaches are required due to the susceptibility of biological methods and their lack of specificity and reproducibility.

### ***Methods of Chromatography***

Two of popular techniques in the realm of physicochemical analysis, thin layer chromatography (TLC) and high-performance liquid chromatography (HPLC) really stand out. HPLC is often referred to as high-overall performance liquid chromatography, and it gets a bit complex when you throw in tandem mass spectrometry. There's also this combination with magnetic resonance and liquid chromatography coupled with tandem mass spectrometry (LC-MS/MS).

Then, there's also gas chromatography paired with tandem mass spectrometry (GC-MS/MS), which is another analytical method worth mentioning. These methods are crucial for precise analysis and detection in various fields. Prior to analysis, the representative pattern wishes to be equally ground, and subsamples are taken out for trying out. The poison should then be extracted from the meals and feed matrix, and cleanup must be carried out to assure powerful purification and minimize any interference (Meneely et al., 2011).

Currently, chromatographic methods for TCNs detection mainly rely on solvent extraction procedures to extract polar organic TCNs into a few polar organic solvent mixed solution with methanol and acetonitrile (Singh & Mehta, 2020). TCNs have a unique structure that results in weak ultraviolet (UV) absorption, making them difficult to detect using traditional HPLC along UV detection, unlike other mycotoxins (Lattanzio et al., 2009). HPLC with fluorescence detection requires derivatization but the unrivalled selectivity of LC-MS/MS gives the most reliable results and meets regulatory standards for the detection of correctly annotated TCNs without derivatization. (Gab-Allah et al., 2021).

Simultaneous detection of type A and B TCNs using GC-MS coupled with FID has been reported by multiple studies [2, 3]. In contrast, GC techniques rely on derivatization of TCN's hydroxyl group with trimethylsilylation or fluoroacylation for sensitive detection. Nevertheless, the aforementioned chromatographic methods need sophisticated and high-class facilities,

painstaking clean-up and derivatization procedures, and professional technicians.

### *High Performance Liquid Chromatography (HPLC)*

One not unusual analytical approach is high-performance Liquid Chromatography (HPLC), has massive programs in fields like scientific evaluation, diagnostics, and studies. When HPLC paired with fluorescence detection (FD) or diode array UV detection, it really shines—literally! It can effectively quantify various mycotoxins, which makes it an essential tool for spotting and assessing these harmful substances. Some researchers have also turned to HPLC to dive into studying the major type A trichothecenes.

So, in summary, quite a bit of research has pointed towards using HPLC with fluorescence detection for measuring type A trichothecenes. These trichothecene mycotoxins, especially T-2, HT-2, DAS, and NEO, have been accurately quantified in a variety of products like barley, maize, sorghum, feed for livestock, and even chicken feed. Plus, T-2 has been identified in compound feeds, specific feeds, and premixed feeds (Wang et al., 2013) as well as in wheat flour (De Angelis et al., 2013).

### *LC-Tendom Mass Spectrometry*

**Introduction** Trichothecenes are a group of naturally occurring MYCOTOXINS that can contaminate food and feed, posing health risks in humans and animals. Although many analytical methods exist for their detection, few are based on ID-LC/MS/MS. In this presentation, we discuss the development of an ID-LC/MS/MS candidate reference method for the accurate measurement of trichothecenes. Validation of the ID-LC/MS/MS method by looking at samples that were spiked with the target mycotoxins at three different concentration levels. The results showed the precision, hanging around 98.2 to 102.6%. The relative expanded uncertainties were between 1.3 and 3.8%, which is acceptable. We also used this method to figure out DON in both reference materials and quality control samples. This analytical approach verified to possess a better order metrological quality and displayed significantly improved efficiency over other techniques described in literature.

In addition, this method will also be used for the value-assignment of various certified reference materials currently being developed in this laboratory (Gab-Allah et al., 2021). The impressive separation capabilities of HPLC, combined with the highly sensitive detection offered by MS/MS, allow LC-MS/MS to analyze multiple mycotoxins in a single run. This not only boosts efficiency but also enhances accuracy. In a study conducted by Hoogenboom et al. [20], the researchers employed LC-MS/MS to examine type A trichothecenes in barley and some other agricultural samples for checking multiple mycotoxins simultaneously such as NEO, DAS, HT-2, and T-2—especially when it comes to crops like sorghum and rice. It's quite fascinating how far technology has come in improving our analysis techniques.

### ***Enzyme-Linked Immunosorbent Assay (ELISA)***

Many chromatographic approaches are available for monitoring TCNs in industries, but when compared to other techniques, ELISA is one of the best for monitoring quickly. Although ELISA is inexpensive and quick to measure, it is not very effective in detecting high sensitivity. Trichothecene is detected utilizing the competitive format of the enzyme-linked immunosorbent assay (ELISA), which employs an enzyme-conjugated trichothecene antibody or an anti-trichothecene antibody. Created a mAb that can identify the T-2 toxin in milk with specificity. For the coating-antigen, T-2HA was conjugated with Keyhole limpet hemocyanin (KLH). The constructed ic-ELISA method showed a limit of detection (LOD) at 0.827 ng/mL. Studied T-2 toxin in cereals and found that ELISA and UPLC/FLD have a good correlation with each other (Efsa, 2019), with a coefficient of correlation (r) between 0.995–.905 probably dependent on food matrix (Han et al., 2019).

### ***Gas Chromatography and GC-MS/MS***

Gas chromatography is a pretty crucial tool for looking at those tricky unstable compounds – analytes, that can be vaporized without falling apart. GC was heavily relied upon for identifying type A trichothecenes. These type A trichothecenes don't really interact much with ultraviolet light, which made them a bit of a challenge.

So, if we want to ramp up the sensitivity and volatility of these type A trichothecenes, most of the time, the GC methods need to tweak those hydroxyl groups. Once we've made those adjustments, we can then detect the modified compounds using techniques like mass spectrometry (MS) or electron capture detectors (ECD) (Krska et al., 2001). when we coupling gas chromatography with tandem mass spectrometry – yeah, that's GC-MS/MS – it really turns out to be an impressive method. It's like, super effective for evaluating multiple mycotoxins, and it does this with a high level of sensitivity and selectivity. For instance, if we're looking at rice, we could actually use GC-MS to detect various toxins like NEO, DAS, HT-2, and T-2 (Rodríguez-Carrasco et al., 2014). When combine the gas chromatography (GC) with tandem mass spectrometry (GC-MS/MS), it becomes quite the powerhouse for analyzing various mycotoxins. Like in rice by using GC-MS, we can actually spot NEO, DAS, HT-2, and T-2.

Other type A trichothecenes, like DAS and MAS, along with a bunch of T-2 metabolites like T-2 triol and T-2 tetraol were also identified and measured in maize using LC-MS/MS. (Ryu et al., 1996).

### ***U-HPLC-HRMS/MS Method***

To figuring out the exact amounts of HT-2 and T-2, along with their glycosides, this method relies on IAC purification and then checks things out using U-HPLC-HRMS/MS.

Quantitative analysis for HT-2 and T-2, with an oat sample didn't have any HT-2 or T-2 in it. 25 grams of that spiked it with a stock solution of HT-2 and T-2. The concentration of each was a hefty 10,000 µg/L in acetonitrile.

After mixing everything up, we just let the samples sit at room temperature for about two hours to let the solvent evaporate. It's a bit of a process to get accurate results.

### RESEARCH RESULT

Samples were then extracted and purified. As in shown in table 1:

**Table 1:** Trichothecenes in food and feed applications worldwide

Food	Toxin	Technique	LOD	LOQ	Detector	Country	References
Pizza	DON	GC-ECD	13.8	-----	-----	Argentina	(Pacin et al., 2011)
Barley	T-2	ELISA	50 µg/kg	-----	Flow-through immunoassay	-----	(Lattanzio et al., 2009)
Cereal based products	DON	LC-MS/MS	34-2582018	-----	-----	United States	(K. Zhang et al., )
Oats	T-2	GC/MS	2406	-----	-----	UK	(Edwards, 2009)
Wheat	DON	LC-UV	70-4730	5.8		India	(Mishra et al., 2013)
Wheat	DON	LC-MS/MS	60.7	14.5 - 1580	-----	China	(Ji et al., 2014)
Refined wheat flour	DON	LC-PDA	< LOQ-250.6	150.0	-----	Chile	(Foerster et al., 2020)
Biscuits	DON	LC-MS/MS	31.2-71.3	35.0	HPLC-FLD	Turkey	(Golge & Kabak, 2020)
Corn	(DON) and zearalenone (ZEA)	Liquid chromatography	87-2967	13.0 µg/kg	RP-LC-UV	Pakistan	
Barley	DAS	HPLC	138-973	200 µg/kg	HPLC-FLD	Turkey	
Paddy Rice	DON	LC-MS/MS	136-256	0.50 µg.kg <sup>-1</sup>	HPLC-FLD	Turkey	

<b>Pasta</b>	DON	Gas chromatography and GC-MS/MS	10.9–623.3	20 $\mu$ g kg <sup>-1</sup>	HPLC-FLD	Turkey	
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## CONCLUSION AND RECOMMENDATIONS

This latter study performed an *in silico* analysis, which identified a select number of trichothecenes that were presumed to be most relevant for food safety and showed potential as human TAS2R46 receptor agonists. Our results uncover robust evidence that TCNs can target TAS2R46 which would motivate a more fine-grained follow-up experimental exploration. . Although trichothecenes themselves are not genotoxic, they may amplify the mutagenicity of other dietary compounds like pesticides or those synthesized by gut microbiota. This novel interaction could influence a large proportion of the populace because TCNs and genotoxicants are very common. This is necessary when considering the increasing worries over their health effects. In more than a single instance, the health-related problems attributed to trichothecenes use ranged from growth retardation, neuroendocrine disruption, gastrointestinal disturbance, vomiting, diarrhea and nausea headache. They temper the necessity of inclusive detection strategies above using conventional chromatographic based techniques. Although the presence of masked or modified substances is toxic to food safety and therefore worth reporting, developments in biosensor aided approaches have addressed these however. In the unlikely event that current control ideas are not implemented, exposure to understand and reduce the effects of masked TCNs will be the Long range goal of this study. Since food is recognized as a vector to human and animal health hazards due to contamination, this work highlights the need of embedding contamination risk evaluations in the management efforts of TCNs.

## FURTHER STUDY

For the next researches, it is suggested to find the trichothecenes cellular effects and ways of their detoxification.

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