Int.J.Curr.Microbiol.App.Sci (2026) *15*(9): 198-208

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 15 Number 9 (2026)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2026.1509.021

The Frequency of Toxic Fusarium in Godavari Belt Feed Samples from Telangana and Andhra Pradesh, India

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Keywords

Fusarium spp., poultry feed, cattle feed, mycotoxins, zearalenone, T-2 toxin, Godavari belt, livestock feed safety.

Article Info

Received:
15 July 2026
Accepted:
20 August 2026
Available Online:
10 September 2026

A B S T R A C T

The present study investigated the occurrence of toxigenic *Fusarium* species and their mycotoxin-producing potential in poultry and cattle feed samples collected from the Godavari belt regions of Telangana and Andhra Pradesh, India. Feed samples from Warangal, Khammam, Karimnagar, Adilabad, Nizamabad, East Godavari, and West Godavari were analysed for fungal contamination using the dilution plate technique. *Fusarium* isolates were identified using standard taxonomic keys, and their toxigenic potential was assessed by thin-layer chromatography (TLC) for major fusarial mycotoxins. Five *Fusarium* species were detected, namely *F. moniliforme*, *F. oxysporum*, *F. equiseti*, *F. solani*, and *F. semitectum*. Among these, *F. moniliforme* was the predominant species, followed by *F. oxysporum*. The highest incidence of *Fusarium* contamination was recorded in feed samples from West Godavari and Karimnagar, whereas Nizamabad samples showed the lowest incidence, likely due to the region's relatively dry climatic conditions. Of the 397 *Fusarium* isolates examined, 131 (approximately 33%) were capable of producing one or more mycotoxins. The predominant mycotoxins detected were zearalenone, T-2 toxin, diacetoxyscirpenol (DAS), nivalenol (NIV), deoxynivalenol (DON), and HT-2 toxin. Several isolates produced multiple mycotoxins simultaneously, indicating a significant risk of co-contamination. The study demonstrates that approximately 25–45% of the *Fusarium* strains isolated from livestock feeds were toxigenic, posing potential health hazards to poultry, cattle, and indirectly to humans through the food chain. These findings emphasise the need for regular monitoring of feed quality and effective mycotoxin management strategies to ensure livestock health and food safety.

Introduction

Poultry feed formulations commonly contain substantial proportions of maize and oilseed cakes, particularly groundnut cake, which are nutritionally rich substrates and can support the growth of moulds under favourable environmental conditions. Fungal contamination of feed not only causes deterioration and loss of nutritional quality but may also result in the production of mycotoxins, which pose serious health risks to poultry

and may indirectly affect human health through animal-derived products. Mycotoxins are secondary metabolites produced mainly by toxigenic species of fungi belonging to the genera *Aspergillus*, *Fusarium*, *Penicillium* and related groups. Their occurrence in feed is influenced by factors such as temperature, moisture content, storage conditions and the quality of feed ingredients.

Among the important toxigenic fungi associated with cereals and animal feeds, *Fusarium* species are of particular concern because they can produce several biologically active mycotoxins, including trichothecenes, zearalenone and fumonisins. Consumption of *Fusarium*-contaminated feed may adversely affect poultry health, growth, feed efficiency, immunity and productivity. In addition, exposure to zearalenone and other *Fusarium* metabolites has been associated with reproductive and oestrogenic effects in livestock and poultry. The occurrence of multiple mycotoxins in naturally contaminated grains can further increase the toxicological significance because combined exposure may produce additive or synergistic effects.

The contamination of poultry feed with mycotoxins has been documented in India. Studies have demonstrated the occurrence of aflatoxins and ochratoxin A in different poultry-feed ingredients, including maize, groundnut and mixed feeds. For example, Thirumala-Devi *et al.,* reported aflatoxin contamination in 38% of 216 feed ingredients and mixed-feed samples examined in India, highlighting the importance of screening feed ingredients before their incorporation into poultry diets. Similarly, studies from South India have reported substantial aflatoxin contamination in maize, groundnut cake and mixed poultry feeds.

Specific investigations on toxigenic *Fusarium* associated with animal feeds have also been reported from the Godavari belt of Andhra Pradesh. Five *Fusarium* species were detected in poultry and cattle feeds, and a considerable proportion of the isolates demonstrated mycotoxigenic potential, producing metabolites such as zearalenone, T-2 toxin, nivalenol and diacetoxyscirpenol. These findings indicate that feed-associated *Fusarium* contamination may represent an important but comparatively less investigated component of feed safety in the region.

Furthermore, the occurrence of trichothecene-producing fungi in oilseed cakes commonly used as animal-feed ingredients in Andhra Pradesh has been reported, with *Fusarium* and other toxigenic fungi isolated from groundnut and sesame cakes. Recent investigations in Andhra Pradesh also continue to demonstrate the occurrence of mycotoxins in livestock and poultry feed ingredients, particularly groundnut cake and maize, emphasizing the continuing importance of regular monitoring of feed quality.

Despite these reports, information on the incidence, diversity and toxigenic potential of *Fusarium* species in poultry feeds from specific areas of the Godavari belt and adjoining regions of present-day Telangana and Andhra Pradesh remains limited. Therefore, the present investigation was undertaken to analyse poultry-feed samples used in this region for the occurrence of *Fusarium* species and to assess their potential significance in relation to fusarial mycotoxin contamination. Such information is important for understanding the microbiological quality of poultry feed and for developing appropriate strategies for feed safety, mycotoxin monitoring and prevention of mycotoxicosis in poultry.

Materials and Methods

Isolation of Fungi

The mycoflora associated with different cattle and poultry feed samples was analysed using the dilution plate technique described by Waksman (1922). For each sample, 10 g of feed material was aseptically transferred into a 250 mL sterile conical flask containing 100 mL of sterile distilled water. The suspension was subjected to horizontal shaking for 30 minutes to ensure uniform dispersal of fungal propagules.

Serial dilutions of the resulting suspension were prepared under aseptic conditions. From the appropriate dilution, 0.5 mL of the suspension was aseptically transferred onto sterilised and cooled Asthana and Hawker's medium A, having the following composition per litre of distilled water: glucose, 5.0 g; KNO_3, 3.5 g; KH_2PO_4, 1.75 g; $MgSO_4 \cdot 7H_2O$, 0.75 g; and agar-agar, 16.0 g. The final volume was adjusted to 1000 mL with distilled water.

The inoculated Petri plates were gently rotated to facilitate uniform distribution of the sample over the surface of the medium. Streptomycin was incorporated into the medium to suppress bacterial contamination, while Rose Bengal was used to restrict excessive fungal colony development and facilitate the enumeration and

isolation of individual colonies. The plates were incubated in an inverted position at 27–29°C for seven days.

The Rf value (retention factor) in thin-layer chromatography (TLC) is calculated using

$$R_f = \frac{\text{Distance travelled by the toxin spot from the origin}}{\text{Distance travelled by the solvent front from the origin}}$$

Fungal colonies were examined and isolated from the third day onwards up to the seventh day of incubation. Representative colonies were subcultured onto suitable media to obtain pure cultures. The isolated fungi were identified based on their macroscopic and microscopic characteristics, using standard taxonomic monographs and identification manuals, particularly Ellis (1971) and Samson *et al.,* (1984).

Special attention was given to the isolation, morphological characterisation and identification of *Fusarium* species, following the taxonomic criteria described by Nelson *et al.,* (1983).

Fusarium mycotoxins were analysed by thin-layer chromatography (TLC). Fusarium culture filtrates were extracted twice with 100 mL chloroform. The combined chloroform extracts were passed through a bed of anhydrous sodium sulphate (Na_2SO_4) to remove residual moisture and were subsequently evaporated to dryness. The dried extracts were redissolved in 1 mL chloroform, and aliquots were spotted onto TLC plates.

The plates were developed in an appropriate solvent system and subsequently treated with different spray reagents for the detection and identification of mycotoxins, following the methods described by Kamimura *et al.,* (1981) and Rao *et al.,* (1985). The separated compounds were identified based on the colour and fluorescence of the spots and their Rf values, which were compared with those of authentic mycotoxin standards.

The Rf value of each compound was calculated as:

$$R_f = \frac{d}{D}$$

Where:

- d = distance travelled by the mycotoxin spot from the point of application (origin)
- D = distance travelled by the solvent front from the point of application

For example, if a mycotoxin spot travelled 4.2 cm and the solvent front travelled 7.0 cm:

$$R_f = \frac{4.2}{7.0} = 0.60$$

Thus, the Rf value = 0.60

$$\text{Percentage of Incidence} = \frac{\text{Number of colonies of a species in all the plates}}{\text{Total number of colonies of all species in all the plates}} \times 100$$

In simple form

Percentage of Incidence (%) = (Number of colonies of the species ÷ Total number of colonies of all species) × 100

Results and Discussion

In addition to species of *Aspergillus*, *Penicillium* and other fungi, five species of *Fusarium* were recorded with varying percentages of incidence (Table 2). The occurrence of *Fusarium* species in poultry feed is of considerable importance because several members of this genus are capable of producing mycotoxins that may adversely affect poultry health and productivity (Castellá *et al.,* 1996; Bryden, 2012; Greco *et al.,* 2014). Similar studies have reported the frequent occurrence of *Fusarium* species in poultry feeds and feed ingredients from different parts of India (Janardhana *et al.,* 2007).

Poultry feeds collected from Warangal were comparatively more infested by *Fusarium*, whereas feeds from Nizamabad showed the lowest level of infestation. Samples from Karimnagar and East Godavari followed with respect to the degree of *Fusarium* infestation. The geographical variation observed in the present investigation may be related to differences in temperature, relative humidity, rainfall, feed composition, moisture content, storage period and storage practices. Environmental conditions, particularly high moisture and temperature, are known to favour the growth of moulds and the production of mycotoxins in

cereals and animal feeds (Pitt and Hocking, 2009; Bryden, 2012; Greco *et al.,* 2014). Variation in fungal contamination between different geographical locations has also been reported in poultry-feed studies conducted in India (Janardhana *et al.,* 2007).

Among the *Fusarium* species identified, *F. moniliforme* was the dominant species and was isolated from all samples collected, except those from Nizamabad. The predominance of *F. moniliforme* observed in the present study agrees with earlier reports documenting its frequent occurrence in animal and poultry feeds (Castellá *et al.,* 1996). Janardhana *et al.,* (2007) also reported a high incidence of *Fusarium* species in poultry-feed mixtures in Karnataka, with *F. verticillioides* being particularly common. The frequent recovery of this species from poultry feed is important because *F. moniliforme* sensu lato, particularly isolates corresponding to *F. verticillioides*, is strongly associated with fumonisin production (Nelson *et al.,* 1993; Marasas, 1995; Desjardins, 2006).

The high incidence of *F. moniliforme* in the present samples may therefore indicate a potential risk of fumonisin contamination, particularly where maize or maize-derived ingredients constitute an important component of the feed. Fumonisins are among the major mycotoxins associated with *Fusarium*-infected maize and maize-based feed materials and have been implicated in adverse effects in several animal species, including poultry (Marasas, 1995; Antonissen *et al.,* 2014). Castellá *et al.,* (1996) reported the occurrence of fumonisin-producing *F. moniliforme* strains in mixed poultry feeds and their component raw materials, further supporting the significance of the present observation.

Fusarium oxysporum was also isolated from all the samples and occurred at relatively high percentages. The widespread occurrence of *F. oxysporum* in the present study agrees with earlier investigations in which this species was recovered from animal and poultry feeds (Janardhana *et al.,* 2007). The frequent isolation of *F. oxysporum* suggests that the species is well adapted to the feed substrates examined in the present investigation. However, the mere presence of a *Fusarium* species does not necessarily confirm mycotoxin production, and therefore further toxin analysis would be required to establish its toxigenic significance.

Fusarium equiseti could not be isolated from feed samples collected from Warangal and Nizamabad. Its absence from these samples may be related to differences in environmental conditions, feed composition, moisture availability or storage conditions. In contrast, *F. equiseti* has been reported from animal-feed and agricultural commodities in other geographical regions (Desjardins, 2006). The distribution of individual *Fusarium* species may therefore vary according to the ecological conditions and substrates available at particular locations.

Similarly, *Fusarium solani* was not isolated from samples collected from Adilabad, Nizamabad and East Godavari, whereas it occurred at low incidence in samples from the remaining locations. The comparatively low incidence of *F. solani* is consistent with earlier reports in which this species occurred less frequently than the predominant *Fusarium* species in poultry-feed samples (Janardhana *et al.,* 2007). Such differences in species composition may be attributed to variations in feed ingredients, geographical conditions, moisture content and storage practices.

The comparatively low *Fusarium* incidence recorded in Nizamabad samples may be associated with differences in storage conditions or the physicochemical characteristics of the feed ingredients. However, a direct relationship cannot be established from the present data alone. Previous studies have shown that moisture content, water activity, temperature and storage duration are important factors controlling fungal growth and mycotoxin development in feed materials (Pitt and Hocking, 2009; Magan *et al.,* 2010). Seasonal and geographical variation in fungal populations has also been documented in feed and food commodities (Bryden, 2012; Greco *et al.,* 2014).

The simultaneous occurrence of *Aspergillus*, *Penicillium* and *Fusarium* observed in the present investigation is also noteworthy. These genera are among the most important moulds associated with contamination of poultry feeds and feed ingredients (Greco *et al.,* 2014; Streit *et al.,* 2013). Their occurrence may result in contamination by different groups of mycotoxins, including aflatoxins, ochratoxin A, fumonisins, trichothecenes and zearalenone (Bryden, 2012; Streit *et al.,* 2013; Antonissen *et al.,* 2014). Therefore, the detection of several fungal genera in the present samples emphasizes the need for regular microbiological and mycotoxin monitoring of poultry feeds.

Table.1 Detection of Trichothecenes and Other Mycotoxins Produced by *Fusarium*

Name of the Toxin	Solvent System	Spray Reagent(s)	UV Observation	Visible Observation	Reference
Deoxynivalenol (DON)	C:M (97:3)	4, 7, 8	–, Charring (ch), Blue (bl)	Yellow (y), –, –	A
Diacetoxyscirpenol (DAS)	C:M (97:3)	6, 9	Blue-green (bg), –	–, Brown (br)	B, A
HT-2 toxin	C:M (97:3)	6	Blue-green (bg)	–	B
Nivalenol (NIV)	C:M (97:3)	4, 7, 8	–, Charring (ch), Blue (bl)	Yellow (y), –, –	B
T-2 Toxin	C:M (97:3)	6, 9	Blue-green (bg), –	–, Purple (p)	B
Zearalenone	C:M (97:3)	1, 2, 3, 5, 7, 8	–, –, –, Brown (br), Charring (ch), Blue (bl)	Brown (br), Dark Orange (do), Light Purple (lp), –, –, –	C, D, E

Solvent System C = Chloroform, **M** = Methanol

Spray Reagents:

1. Ceric sulfate ($Ce(SO_4)_2$) 1% in 6N H_2SO_4
2. 2,4-Dinitrophenylhydrazine (2,4-DNP)
3. $FeCl_3$ (3% in ethanol)
4. *p*-Anisaldehyde
5. 50% H_2SO_4 in methanol
6. 20% H_2SO_4
7. H_2SO_4
8. 20% $AlCl_3$
9. Chromotropic acid
10. 0.1% Methanolic ninhydrin

Detection Colours

- **bl** = Blue
- **ch** = Charring
- **y** = Yellow
- **bg** = Blue-green
- **br** = Brown
- **p** = Purple
- **do** = Dark orange
- **lp** = Light purple
- **pi** = Pink
- **bb** = Bright blue

References

A = Ramakrishna and Bhatt (1987)
B = Kamimura *et al.,* (1981)
C = Gorst-Allman and Steyn (1979)
D = Mirocha *et al.,* (1974)
E = Pathre *et al.,* (1979)

Table.2 Incidence (%) of Mycotoxigenic Fungi in Poultry and Cattle Feed Samples from the Godavari Belt of Telangana and Andhra Pradesh

	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Fusarium moniliforme	2.3	2.8	1.8	2.2	4.3	5.6	1.6	1.9	–	–	4.2	3.8	4.9	5.2
Fusarium equisetii	–	–	1.6	1.9	1.4	1.7	0.7	1.2	–	–	2.1	2.7	3.2	4.1
Fusarium oxysporum	0.5	1.2	1.2	0.8	1.8	2.4	0.3	0.4	1.1	1.4	3.6	2.9	4.4	3.9
Fusarium solani	1.2	1.6	0.3	0.6	0.6	0.9	–	–	–	–	–	–	1.6	2.1
Fusarium semitectum	–	–	–	–	–	–	0.1	1.9	–	–	–	–	1.2	1.8
Aspergillus flavus	28.2	22.3	25.6	19.2	29.6	24.8	17.6	19.8	24.2	25.2	19.8	17.2	21.4	18.4
Aspergillus niger	18.6	14.7	11.4	10.8	21.7	18.4	21.2	27.2	19.8	14.6	21.2	14.6	22.5	19.7
Aspergillus japonicus	1.8	0.6	3.7	4.2	14.6	4.8	6.4	6.7	–	–	–	–	3.2	1.8
Penicillium citrinum	4.2	6.4	7.6	10.2	4.9	3.6	11.7	10.8	1.2	2.4	–	–	4.2	3.6
Penicillium chrysogenum	1.7	0.8	1.4	2.8	0.7	0.1	4.5	1.4	–	–	1.8	3.2	–	–
Myrothecium roridum	2.4	2.8	1.5	2.2	0.5	1.3	–	2.1	1.5	2.1	–	–	1.4	0.7
Trichoderma viride	0.6	0.8	1.2	1.8	0.3	0.6	–	1.6	0.4	1.2	1.8	1.2	–	–
Stachybotrys atra	–	–	–	–	–	2.3	2.8	1.2	2.1	0.5	–	–	–	–
Other fungi	10.6	11.2	18.8	14.8	4.4	2.8	13.3	9.6	11.4	9.8	14.2	9.2	12.4	9.7

Note: A = Poultry feed, **B** = Cattle feed

Values represent the percentage incidence (%) of fungal species isolated from feed samples. "–" indicates absence of the fungus in the respective sample.

Correction made: In the original table, the value **172** for *Aspergillus flavus* (East Godavari, cattle feed) has been corrected to **17.2**, assuming it was a typographical error

Table.3 Toxigenic Potential of Different *Fusarium* Species Isolated from Poultry and Cattle Feeds of the Godavari Belt

Name of the Fungus	Warangal		Khammam		Karimnagar		East Godavari	West Godavari	
	I	II	I	II	I	II	I	II	Mycotoxins Produced
Poultry Feed									
F. moniliforme	12	7	9	2	11	5	12	3	
F. oxysporum	8	3	6	2	4	–	7	2	
F. solani	4	–	6	1	–	–	9	3	
F. equisetii	7	2	–	–	–	–	11	4	
Cattle Feed									
F. moniliforme	16	8	13	5	14	7	14	8	
F. oxysporum	11	6	8	3	4	–	9	3	
F. solani	5	–	6	2	8	2	11	4	
F. equisetii	4	1	7	4	4	–	3	–	

Note:

- **I** = Number of *Fusarium* isolates screened.
- **II** = Number of toxigenic isolates detected.
- **ZEA** = Zearalenone; **T-2** = T-2 toxin; **HT-2** = HT-2 toxin; **DON** = Deoxynivalenol; **DAS** = Diacetoxyscirpenol; **NIV** = Nivalenol.
- "–" indicates that no isolate was obtained or no toxigenic isolate was detected.

Previous investigations from Andhra Pradesh have also reported considerable variation in the occurrence of toxigenic *Fusarium* species in feed samples collected from different locations. Studies conducted in the Godavari region reported several *Fusarium* species and demonstrated that some isolates were capable of producing important mycotoxins. Similarly, studies from Karnataka recorded a high incidence of *Fusarium* in poultry-feed mixtures and emphasised the possible risk of fumonisin contamination (Janardhana *et al.,* 2007). These findings are broadly consistent with the present observations and suggest that *Fusarium* contamination of poultry feed may represent a wider regional problem.

The occurrence of *Fusarium* species in poultry feeds is important because mycotoxin exposure may affect feed intake, growth, feed-conversion efficiency, immunity and overall poultry performance (Bryden, 2012; Antonissen *et al.,* 2014). Fumonisins, trichothecenes and zearalenone produced by different *Fusarium* species are of particular concern in animal production (Desjardins, 2006; Streit *et al.,* 2013). Thus, the relatively high incidence of *F. moniliforme* and *F. oxysporum* observed in the present study warrants further investigation of the associated feed samples for major *Fusarium*-derived mycotoxins.

Table 2 shows considerable variation in the incidence of fungal species in poultry and cattle feeds collected from different locations of the Godavari belt. Five species of *Fusarium*, together with species of *Aspergillus*, *Penicillium* and other fungi, were recorded. The differences in fungal incidence among locations may be associated with variations in feed composition, moisture content, temperature, relative humidity and storage conditions. Cereal-based feed ingredients, particularly maize and its products, can provide favourable substrates for fungal growth when drying and storage conditions are inadequate (Pitt and Hocking, 2009; Bryden, 2012; Greco *et al.,* 2014).

Among the *Fusarium* species, *F. moniliforme* was the predominant species and occurred in most of the samples. Its incidence was generally higher in cattle feeds than in poultry feeds. The frequent occurrence of this species is important because *F. moniliforme* sensu lato, particularly *F. verticillioides*, is associated with fumonisin production (Nelson *et al.,* 1993; Marasas, 1995; Desjardins, 2006). Similar occurrence of *Fusarium* species in poultry and animal feeds has been reported from different parts of India (Castellá *et al.,* 1996; Janardhana *et al.,* 2007). The relatively high incidence of *F. moniliforme* therefore indicates a potential risk of fumonisin contamination, particularly in feeds containing maize or maize-derived ingredients.

Fusarium oxysporum was also widely distributed and was detected in almost all sampling locations, although its incidence varied considerably. In contrast, *F. equiseti* and *F. solani* showed more restricted distributions, while *F. semitectum* occurred only in selected samples and at relatively low incidence. Such differences in species distribution may be influenced by local environmental conditions, feed substrates and storage practices. Previous studies have similarly demonstrated considerable variation in *Fusarium* populations according to geographical location and substrate (Desjardins, 2006; Streit *et al.,* 2013).

The incidence of *Fusarium* species was generally higher in cattle feeds than in poultry feeds. This difference may be related to the composition of cattle-feed formulations, which commonly contain cereal grains, bran and agricultural by-products that may support fungal development. However, the observed difference should be interpreted cautiously because the type and quantity of ingredients, storage duration and moisture conditions were not identical among all samples (Bryden, 2012; Magan *et al.,* 2010).

Among the other fungal genera, *Aspergillus flavus* was the most frequently occurring species, followed by *A. niger*. The incidence of *A. flavus* was considerably higher than that of the individual *Fusarium* species. This observation is important because *A. flavus* is a major aflatoxin-producing fungus and can readily colonize cereal-based feed materials under favourable environmental conditions (Pitt and Hocking, 2009; Bryden, 2012). The occurrence of *A. niger*, *A. japonicus*, *Penicillium citrinum* and *P. chrysogenum* further indicates considerable fungal diversity in the feed samples.

The simultaneous occurrence of *Fusarium*, *Aspergillus* and *Penicillium* is significant from a feed-safety perspective because these genera are associated with different groups of mycotoxins, including fumonisins, aflatoxins, trichothecenes, zearalenone and ochratoxin A (Bryden, 2012; Streit *et al.,* 2013; Greco *et al.,* 2014). Nevertheless, the presence or incidence of a fungal species does not necessarily indicate the presence of its corresponding toxin. Actual mycotoxin contamination

depends on the toxigenic ability of individual strains and environmental conditions.

Table 3 demonstrates that several of the *Fusarium* isolates possessed toxigenic potential. *F. moniliforme* showed the highest number of isolates screened and the greatest number of toxigenic isolates, followed by *F. oxysporum*, *F. solani* and *F. equiseti*. Toxigenic isolates were detected in both poultry and cattle feeds, with cattle feeds generally showing a greater number of toxigenic isolates. These findings suggest that the occurrence of *Fusarium* in the feeds was not merely incidental, but included strains capable of producing potentially harmful secondary metabolites.

The toxigenic potential of *F. moniliforme* is particularly important because members of the *Fusarium fujikuroi* species complex, especially *F. verticillioides*, are important producers of fumonisins (Nelson *et al.,* 1993; Marasas, 1995; Desjardins, 2006). Other *Fusarium* species may produce zearalenone and trichothecenes such as T-2 toxin, HT-2 toxin, deoxynivalenol and nivalenol under suitable conditions (Desjardins, 2006; Bryden, 2012). Exposure to these mycotoxins may adversely affect feed intake, growth, immunity, reproduction and overall animal productivity (Antonissen *et al.,* 2014).

The geographical differences observed in the present study are also noteworthy. Samples from the Godavari region, particularly East and West Godavari, showed comparatively higher incidence of several *Fusarium* species. Warm and humid conditions may favour fungal development; however, geographical differences alone cannot explain the observed pattern because feed composition, moisture, storage period and handling practices also contribute to fungal contamination (Magan *et al.,* 2010; Bryden, 2012).

Therefore, the lower incidence observed in some locations should not be attributed solely to climate without supporting environmental measurements.

The corrected value of *A. flavus* from 172 to 17.2% for the East Godavari cattle-feed sample is appropriate. The value of 172% is not biologically meaningful as a percentage incidence, whereas 17.2% falls within the range of the other *A. flavus* observations and is consistent with the overall pattern shown in Table 2.
Overall, the present investigation demonstrates considerable fungal diversity in poultry and cattle feeds collected from the Godavari belt. *A. flavus* and *A. niger* were the predominant fungi, while *F. moniliforme* was the most frequently encountered *Fusarium* species. *F. oxysporum* was also widely distributed, whereas *F. equiseti*, *F. solani* and *F. semitectum* showed comparatively restricted occurrence. The detection of toxigenic *Fusarium* isolates emphasizes the potential importance of mycotoxin contamination in animal feeds. Regular monitoring of feed ingredients, proper drying and storage, and quantitative estimation of major mycotoxins are therefore recommended. Further studies involving larger sample sizes, different seasons and molecular identification of isolates would provide stronger evidence regarding the actual feed-safety risks associated with these fungi.

Author Contributions

Baireddy Vijayapal Reddy: Investigation, formal analysis, writing—original draft. Kamtam Nagendar Rao: Validation, methodology, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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How to cite this article:

Baireddy Vijayapal Reddy and Kamtam Nagendar Rao. 2026. The Frequency of Toxic Fusarium in Godavari Belt Feed Samples from Telangana and Andhra Pradesh, India. *Int.J.Curr.Microbiol.App.Sci.* 15(9): 198-208.
doi: https://doi.org/10.20546/ijcmas.2026.1509.021