codex alimentarius commission

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

WORLD HEALTH ORGANIZATION

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JOINT FAO/WHO FOOD STANDARDS PROGRAMME

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PROPOSED DRAFT CODE OF PRACTICE FOR THE PREVENTION OF CONTAMINATION OF CEREALS BY ZEARALENONE

BACKGROUND

1. The 31st CCFAC requested Norway to prepare a Proposed Draft Code of Practice for the Prevention of Contamination of Cereals by Zearalenone, subject to the approval of the Commission as new work, for circulation, comment and consideration at its next Session (ALINORM 99/12A, para.112). The 23rd Session of the Commission approved the elaboration of the proposed draft Code as new work (ALINORM 99/37, Appendix VIII).

> **NOTE:** Due to time constraints, the proposed draft Code of Practice for the Prevention of Contamination of Cereals by Zearalenone is not being circulated for comments at Step 3 prior to the 32nd Session of the CCFAC. Therefore, comment summary paper CX/FAC 00/20-Add. 1 will not be issued.

INTRODUCTION

3. Zearalenone is a secondary metabolite produced by several species in the fungus genus *Fusarium*, contaminating maize, wheat, rye and other cereals. Zearalenone shows oesterogenic and growth promoter activities in domestic and laboratory animals.

4. Zearalenone has recently been evaluated by JECFA, but its final report is not yet available. According to the draft summary, the Committee established a provisional maximum tolerable daily intake (PMTDI) for zearalenone of 0.5 μg/kg body weight.. The Committee also took into account the previously established ADI of 0-0.5 μg/kg body weight for the metabolite α–zearalanol, evaluated as a veterinary drug and recommended that the total intake of zearalenone and its metabolites (including α–zearalanol) should not exceed this value. Risk assessments were earlier performed in 1987 by a Canadian group (2) who considered both the hormonal and carcinogenic effects to be critical effects, and in 1998 a Nordic Working Group (1) considered the temporary TDI of 0 - 0.1 μg/kg body weight proposed by Kuiper-Goodman et al. still to be appropiate for zearalenone.

5. *Fusarium* infection has the potential to destroy the quality and reduce yield of a potentially good cereal crop within a few weeks of harvest. The kernels may be discoloured, shrivelled and may contain zearalenone, frequently combined with other *Fusarium* mycotoxins (3). Also, symptomless grain may be infected by less pathogenic *Fusarium* species which produce zearalenone and other mycotoxins. Fungal growth and mycotoxin production may continue after harvest if the grain is not sufficiently dried. When the water content of small grain is reduced to 16-17 %, growth of *Fusarium* species will stop.

6. The cereal plants are most susceptible to *Fusarium*-infection at anthesis (flowering). Frequent rainfall, high humidity and heavy dew during the flowering and early kern-fill periods favours infection and disease development. Timing, rather than the amount of rain is a most critical factor when sufficient inoculum is available (4).

7. Individual *Fusarium* species are known to produce several mycotoxins. Among the zearalenone producing species are *F. cerealis*, *F. culmorum*, *F. graminearum* and *F. sambucinum*. There is variation in zearalenone producing ability between strains within the same species.

8. Most surveys indicate that zearalenone occurs primarily in maize, and some of the highest contamination levels have been reported in maize and maize silage (5, 6). Also, cereals like wheat, barley, oats and rye are susceptible to infection by zearalenone producing *Fusarium* species (3). Pasture leaves have been reported to contain zearalenone (7).

9. To reduce erosion of topsoil and to save energy in soil tillage, various reduced soil tillage methods have been introduced in cereal farming. Ploughing will cover crop residues with a layer of soil and greatly reduce inoculum from infected straw from the previous crop. Reduced tillage may mean soil preparation and seeding in one operation, leaving straw on top of the soil (8, 9).

10. Practices that will reduce *Fusarium* infection and growth and zearalenone contamination in the field and after harvest may differ between climate regions and different crops. However, general measures to reduce fungal infection of the crop, such as those described in ALINORM 97/12A, appendix IX, are also applicable to reduce zearalenone contamination of maize and small grain.

11. The recommendations for reducing zearalenone contamination of maize and other cereals in the present document are divided into two parts:

(a) Recommended practices based on Good Agricultural Practice (GAP).
(b) Suggestions for future management systems based on Hazard Analysis Critical Control Points (HACCP).

RECOMMENDED PRACTICES BASED ON GOOD AGRICULTURAL PRACTICE (GAP)

12. Good Agricultural Practice includes methods to reduce *Fusarium* infection and contamination of the cereals in the field and during harvest, storage, transport and processing.

PREHARVEST

13. Growth rotation of susceptible cereals with potato, vegetables, clover, alfalfa and othercrops that are not host to zearalenone producing *Fusarium* spp. are important in reducing inoculum in the field (10, 11).

14. Ploughing will cover crop residues with a layer of soil and greatly reduce *Fusarium* inoculum of fungal infected straw in the field. If reduced tillage methods are used for soil preparation, it is important to cover crop residues as far as possible.

15. Most cereal varieties have been developed for high yield and quality. Recently, resistance to *Fusarium* have been emphasised in most maize and cereal breeding programmes. If available, varieties resistant or tolerant to *Fusarium spp.* should be selected (3).

16. Fertilisation should be based on soil analysis to avoid excessive nutrient supply for the plants. Optimal nutrition, and irrigation according to need, will produce robust plants without lodging, which are less exposed to *Fusarium* infection.

17. Irrigation should be according to the need of the plants. Precipitation during anthesis (flowering) makes conditions favourable for dissemination and infection by *Fusarium* spp. Thus, irrigation during anthesis and during the ripening of the crop should be avoided.

18. Crop protection chemicals, applied to control foliar diseases, may augment the risk for *Fusarium* infection. The effect of fungicide seed treatment on the emergence is known, but the link between seed treatment and ear infection is not well documented. There are several examples of increased *Fusarium* infection following fungicide spray at the heading stage (12).

19. The establishment of *Fusarium* infection in cereal heads during flowering may be monitored before harvest by sampling and determination of infection by standard microbiological methods. Also, mycotoxin content in representative preharvest samples may be determined. Utilisation of the crop may be based on prevalence of infection and mycotoxin content in the grain.

HARVEST

20. Maize and other cereals should be harvested at maturity, when the water content is satisfactory for a long term storage. If the cereal crop has to be harvested with a higher water content, rapid hot air drying is necessary.

STORAGE

21. The storage facilities should be dry, well ventilated, and with structures that provide protection from rain and ground water.

22. Bagged commodities should be stored under dry, well ventilated conditions, protected from rain and ground water.

23. During storage of small grain and maize the mosture content of the grain should be monitored regularly. It is necessary to measure the moisture content at several spots in each lot or silo. For long term storage the moisture content should be 15 % or less.

24. Records of humidity measurements should be kept during the entire storage period. The data can be of value if fungal infection and mycotoxin production should occur in the silo.

25. Insect and rodent infestation should be avoided. If necessary disinfect with appropriate approved fumigants or pesticides.

TRANSPORT

26. Conditions causing water condensation during transport should be avoided. Temperature fluctuations should be as small as possible. The transport structures should protect shipments of grain from rain and moisture.

27. Insect and rodent infestation during transport should be avoided by using insect-proof containers. If needed disinfect with appropriate approved fumigants or pesticides.

PROCESSING

28. Small, shrivelled grain may contain more zearalenone than healthy normal grain. Winnowing grain at harvest or later will remove shrivelled grain.

ZEARALENONE MANAGEMENT SYSTEM BASED ON HAZARD ANALYSIS CRITICAL CONTROL POINT SYSTEM (HACCP)

29. At the Third International Conference on Mycotoxins in Tunisia, March 1999, it was recommended that mycotoxin control programmes should incorporate HACCP principles in the control of risks associated with mycotoxin contamination of foods and feeds (15).

30. HACCP is a food safety management system that is used to identify and control hazards within the production and processing system. The general principles of HACCP have been described in several documents (16, 17), and FAO/IAEA will publish a HACCP manual for mycotoxin control in the near future. A zearalenone management system based on HACCP would include the following basic principles:

1. Identification of hazards and control measures
The hazard (in this case zearalenone) and risk associated with the hazard are identified and assessed at each step in the agricultural and transport and processing system. Possible control measures are described.

2. Identification of the Critical Control Points (CCP) for zearalenone formation during cereal production
A zearalenone management system based on the HACCP approach must consider hazards at all stages of the production, handling and processing (preharvest, harvest and postharvest). In addition, a prerequisite to the development of a HACCP program is the observance of Good Agricultural Practice (GAP) and Good Manufacturing Practice (GMP). In an integrated mycotoxin management system incorporating the HACCP concept, each identified and appropriately managed phase will help prevent the risk of exposure to zearalenone.

3. Establishment of critical limits for all Critical Control Points
A CCP may be a raw material, a location, a practice, a procedure or a process stage, but it must be specefic. The critical limit (for example temperature or water activity) is the value that separates acceptability from unacceptability for each CCP.

4. Establishment of monitoring systems
A monitoring system, which gathers information about each raw material and process stage, must be established to ensure that the process operates under control, that is that the criteria is met. Monitoring methods should be rapid to be effective.

5. Establishment of corrective action in the event of deviation of a critical limit.
There are three types of corrective actions. The first action is to regain control, the second action may be physical methods to ensure that zearalenone contaminated grain does not enter the food chain, and the third type of corrective action is to ensure that the deviation does not occur again.

6. Verification of the system
The verification provide additional information to reassure that the application of HACCP results in the production of safe food and includes

A. Verification of the HACCP plan.
B. Verification of the implementation of the HACCP plan.

7. Record keeping
Record keeping is an essential part of the HACCP. This ensures that all information, which has been gathered during installation and operation of the system, will be readily accessible.

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