

codex alimentarius commission



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**DISCUSSION PAPER ON THE DEVELOPMENT OF A MAXIMUM LEVEL FOR AFLATOXIN IN
DRIED FIGS**

Prepared by Turkey

1. Figs, whose story starts with “Adam and Eve”, are accepted as sacred fruit and mentioned in all holy books. The highest consumption of this product coincides with periods that are important from a religious point of view as the Christmas, Passover celebration or Ramadan. There are traces that figs were cultivated in their motherland Anatolia as early as 3000-2000 B.C. and they were spread through the Mediterranean from Anatolia within the time.

2. With origins in Western Asia and the Mediterranean, the fig (*Ficus carica*) is a member of the Moraceae (mulberry) family. Despite thousands of *Ficus* species spread in tropical and subtropical climates, it is the major one cultivated for fruit production. Today, it is estimated that over 1.0 million metric tons of figs are produced around the world each year, with Turkey, Egypt, Iran, Greece and Algeria leading in production respectively (Table 1). Turkey is the motherland of fig and has a large production potential because of the suitable climate. While 30% of the total production is consumed as fresh in domestic market, 70% of it is consumed as dried in domestic and foreign markets. Turkey grows close to a quarter of the world's production. The top five producers make up over 60 percent of the total crop. The top 10 producers also include Morocco, Syria, the United States, Spain, and Brazil. In the dried figs trade; Turkey, USA and Greece are the first 3 countries in the world (Table 2). Turkey, as the largest producer, supplies more than half of world export volume (Table 3).

Table 1. The total figs production in 2005.

Countries	Production (Mt)
Turkey	280.000
Egypt	170.000
Iran, Islamic Rep of	90.000
Greece	80.000
Algeria	63.000
Morocco	60.000
Syrian Arab Republic	43.400
USA	43.000
Spain	38.000
Brazil	25.000

Source: www.fao.org

Table 2. The total dried figs production in 2000.

Countries	Production (ton)
Turkey	49.001
Greece	12.500
USA	12.500
Italy	7.000
Portugal	4.000
Spain	3.700
Total	90.201

Source : www.tarim.gov.tr

Table 3. Dried Figs Exports and Imports in 2004.

EXPORT			IMPORT		
Countries	Qty (Mt)	Val (1000\$)	Countries	Qty (Mt)	Val (1000\$)
Turkey	49.074	85.597	Germany	9.706	19.294
USA	3.835	9.536	France	9.155	18.543
Spain	3.377	4.394	Italy	5.795	11.318
Syrian Arab Republic	2.898	2.027	China, Hong Kong SAR	4.699	7.756
Greece	2.831	7.105	USA	4.420	6.733
China, Hong Kong SAR	1.894	1.310	Russian Federation	4.112	1.329
Sri Lanka	1.585	1.093	India	3.329	4.737
France	1.410	5.858	Spain	2.709	4.442
Germany	1.344	4.390	United Kingdom	2.709	6.873
Netherlands	785	2.142	Mexico	2.108	3.064

Source: www.fao.org

3. The general drying process applied in major dried fig producer countries is sun-drying however artificial drying may also be applied. The climatic conditions together with the varietal characteristics play a crucial role to obtain a high quality end-product. High dried fruit quality is obtained by drying fruits of varieties that possess high fruit dry matter content and in general low levels of titratable acidity. Final product quality should be in accordance with the standards demanded by the world market. In order to be competitive, suitable varieties and drying conditions leading to high quality should be determined.

4. The fresh fig fruit is highly susceptible therefore mostly marketed in local markets. During the last years as a consequence of the developments in post-harvest handling practices and technology, world fresh fig market is enlarging. Depending on the variety, one or two crops may be harvested within the same year from June to November. The fig fruits that are commercially dried are the second crop fruits that ripen in summer and autumn. Nearly all figs that are intended for drying are allowed to fully ripen on the tree, then partially dry and fall onto the ground. They are picked from the ground and further dried to complete the drying process, either under sun or in artificial driers. In the world trade, dried fig fruits are marketed either as loosely packed or they are packed after certain shapes are given as lerida, layer, pulled, protoben or garland. The dried fig fruits may also be further processed into products such as diced, sliced, and chopped figs, fig paste, and fig concentrate. Besides, the consumption in the fresh-market, a miniscule share of production is also harvested fresh for canning.

5. Two important goals of human nutrition are attained at the same time with the consumption of dried figs. By consuming 100 grams of dried figs (4-6 figs) about 10 % of the energy requirement, 7 % of protein requirement and 17 % of Calcium, and 30 % of Iron, and 30 % of Magnesium as Recommended Daily Allowances are met. Regarding vitamins, 5.2 % of Vitamin B₁ and 4.5 % of Vitamin B₂, which are necessary for cell reconstruction are taken in by consuming 100 g of dried figs. Dried fig fruits are low in fat and very low in sodium. They contain no saturated fat or cholesterol and are a good source of phenolic and pectic substances and may lower blood cholesterol levels and reduce the risk of cancer and cardiovascular diseases.

6. Today, the most important factor in trade is the presence of aflatoxins, as in other dried fruits and nuts. Research work on aflatoxin formation in dried figs revealed that toxin formation starts with the ripening of the fruit and continues until fully dried where water activity levels are below the critical level. Since fig fruits are very susceptible to aflatoxin formation due its high sugar content and fleshy skin, no standard control measures could be developed till to date.

7. There is no Codex standard for aflatoxin in dried figs. There are many research work carried out on aflatoxin. JECFA re-evaluated aflatoxins in 1996 and 1997. At its June 1997 meeting, the Committee concluded from a quantitative risk assessment on aflatoxins that there is no significant difference in terms of risk to human health between the maximum levels of 10 µg/kg and 20 µg/kg set for aflatoxin B₁ in food (WHO, 1998). The Codex Committee on Food Additives and Contaminants has the responsibility for proposing guideline levels for naturally occurring toxicants in foods and feeds. It will examine the JECFA recommendation, and its proposals will then be reviewed by the Codex Alimentarius Commission for possible adoption as international standards.

8. From a regulatory standpoint, aflatoxins are considered unavoidable contaminants in foods. As in many commodities, they are formed in figs while they are drying on the tree and cannot be prevented or eliminated by the application of current good agricultural practices. National regulations should not jeopardize the availability of food crops at reasonable prices, and the implications for farming, especially subsistence farming in developing countries, must also be considered. Thus, exposure of the population to some level of aflatoxins is tolerated.

9. Beside this, the principle of ALARA (*As Low As Reasonably Achievable*) should be taken into consideration when limits are determined for chemical genotoxic carcinogens. However, factors such as the economic value of the foodstuff, amount of consumption, whether or not the country proposing the limits is a potential producer, protection of producer-consumer interests and methods of sampling/analysis also play important roles.

RECOMMEDATION

10. Taking into consideration the social and economic importance of the dried fig fruits and based upon the above mentioned points, Turkey proposes Codex Alimentarius Commission and Codex Alimentarius Commission Food Additives and Contaminants Committee to start a new work to:

- To determine a maximum level for aflatoxins in dried figs in order to facilitate international trade of this sacred and highly nutritious fruit.
- To elaborate a Code of Practice for the Prevention and Reduction of Aflatoxin Contamination in Dried Figs (see Annex I).

Annex I**CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF AFLATOXIN
CONTAMINATION IN DRIED FIGS****1. INTRODUCTION**

1. The elaboration and acceptance of a Code of Practice for dried figs by Codex will provide uniform guidance for all countries to consider in attempting to control and manage contamination by various mycotoxins, specifically aflatoxins. All dried figs should be prepared and handled in accordance with the Recommended International Code of Practice – General Principles of Food Hygiene¹, which are relevant for all foods being prepared for human consumption. It is important for producers to realize that Good Agricultural Practices (GAP) represent the primary line of defence against contamination of dried figs with aflatoxins, followed by the implementation of Good Manufacturing Practices (GMP) and Good Storage Practices (GSP) during the handling, processing, storage and distribution of dried figs for human consumption. Only by effective control at all stages from the farm through to processing can excellent quality of the final product be assured. However, the complete elimination of mycotoxin contaminated commodities, including dried figs, is not completely achievable up to now.

2. This Code of Practice applies to dried figs (*Ficus carica* L.) of commercial and international concern. It contains general principles for the reduction of aflatoxins in dried figs that should be sanctioned by national authorities. National authorities should educate producers, transporters, storage keepers and other operators of the production chain regarding the practical measures and environmental factors that promote infection and growth of fungi in dried figs resulting in the production of aflatoxin in orchards. Emphasis should be placed on the fact that the planting, pre-harvest and post-harvest strategies for a particular fig crop depends on the climatic conditions of a particular year, traditional production, harvesting and processing practices followed in a particular country or region.

2. DEFINITION

3. Caprification is a process applied in case female fig fruits of a certain variety need for fruit set. The “profichi” (ilek) fruits of male figs possessing fig wasps (*Blastophaga psenes* L.) and pollen grains are either hung or placed on female fig trees to pollinate and fertilize the main and second crop (iyilop) fruits. The pollen shedding period of the male flowers in male fig fruits should coincide with the ripening of the female flowers in female fig fruits.

4. Ostiole or eye is the opening at the distant side of the fruit.

3. SCOPE

5. This document is a guideline for manufacturers of dry figs whose products are the matter of international trade for human consumption. All dry figs must be prepared in compliance with the general hygiene rules and food hygiene principles.

6. Fig differs from other fruits, which have potential risk of aflatoxin contamination, with its fruit formation and properties, such as its juicy and pulpy skin. Thus, toxigenic fungi may grow and form aflatoxins even if no damage occurs on the skin.

7. Besides the high sugar content, the skin of figs are not protective and firm, therefore it is exposed to aflatoxin formation. The critical periods for aflatoxin formation in dried fig fruits starts with ripening of figs on the tree, continues during the over-ripe period when they loose water and shrivel and fall down onto the ground and until they are fully dried on drying trays. Contamination can occur at both on the skin and/or inner cavity of fruit.

8. The main requirement is to obtain a healthy plant and good quality product by applying necessary cultural techniques for prevention/reduction of aflatoxin formation.

¹ Recommended International Code of Practice - General Principles of Food Hygiene (CAC/RCP 1- 1969, Rev. 4-2003)

3.1 SITE SELECTION and ORCHARD ESTABLISHMENT:

9. Some criteria must be taken into account for choosing of orchards, these are mentioned below;
 - Fig trees grow in subtropical and mild temperate climates and have a short dormancy period. One of the most important climatic factor, which restricts the fig growing, is the low temperatures rather than high temperatures in summer. Also high temperatures and arid conditions in summer can increase sun-scald and cause some important problems in quality and trigger aflatoxin formation.
 - Low temperatures right after bud-break in the spring and during October – November before shoots are hardened can damage the tree. Freezing temperatures in winter may affect the fig wasps overwintering in male fruits and may create problems in fruit set.
 - The fig varieties may vary regarding their tendency for crack/split however high relative humidity and rainfall during the ripening and drying period must be taking into account before establishing the orchard. High humidity and rainfall can increase of ostiole-end cracking, development of fungi and decrease of quality.
 - Fig can be grown in a wide range of soils such as sandy, clayey, or loamy. A soil depth of at least 1-2 m accelerates the growing of fig tree which has fibrous and shallow roots. The optimum pH range is 6 – 7.8. The chemical (such as pH) and physical properties of the orchard soil influence the intake of plant nutrient and so dried fig quality and resistances, thus it should analysis before establishment.
10. During establishment of fig orchards, the following items are important;
 - Soil and climate properties of the region must be suitable for fig growing
 - The level of the underground water table must not be limiting
 - Irrigation possibilities must be adequate.
 - The orchards should be established with healthy nursery trees that are free from any insects and diseases.
 - Adequate space should be given between the rows and the trees to allow the use of necessary machinery and equipments.
 - Before planting the way the fruits will be utilized (fresh, dried or both) need to be considered. it should be considered which products are grown in that orchard and a good soil preparation should be done. Materials remaining from the previous crops and foreign materials should be cleaned and if it is needed the field can be fallowed in following few years.
 - Products which cause aflatoxin formation such as maize should not be produced around the fig orchards.
 - Practices such as pruning, tillage, fertilization, irrigation, and plant protection should be applied on time and with a preventive approach in the framework of “Good Agricultural Practices” and “Good Manufacturing Practices”.
 - The devices and equipments should not damage fig trees or cause cross contamination with pests and/or diseases.
 - Dust formation during tillage should be prevented because toxigenic fungi can be spread onto the surfaces and increase the potential risk of aflatoxin contamination.
 - An integrated pest management programme must be applied and fruits or vegetables that promote infestation with dried fruit beetles or vinegar flies should be removed from the fig orchards since these pests act as vectors for the transmission of fungi especially into the fruit cavity.
11. As a summary, some procedures used to reduce and prevent aflatoxin production include:

- I. Selection of resistant varieties, if practicable,
- II. Minimize the presence of insects and other pests in the orchard during the growing phase,
- III. Minimize physical damage to dried figs during harvesting and transportation,
- IV. Ensure that figs are properly cleaned, dried and labelled when placed in a storage facility equipped with temperature and moisture controls.

3.2 CAPRIFICATIONS:

12. Caprifigs are important for fig varieties, which require for fruit set. Caprifigs should be healthy, free from fungi and should have plenty and live pollen grains and wasps (*Blastophaga psenes* L.). During pollination of female fig fruits by fig wasps, that pass their life cycle in caprifig fruits, *Fusarium*, *Aspergillus spp* and other fungi can be transported to the female fig fruits from the male fruits through these wasps. The fungi may cause mould formation especially during ripening, result in aflatoxins, smut or endosepsis (internal rot) and decrease quality and yield. Since male trees are the major sources of these fungi, male trees are generally not allowed to grow in female fig orchards. It is important to use clean caprifigs, rotten and soft caprifigs should be removed prior to caprification. Because caprifigs, which are allowed to stay on the tree and/or in the orchard, can host to other fungal diseases and/or pests therefore after caprification they must be collected and destroyed by burning. To make the removal of caprifigs easier, it is recommended to place caprifigs in nets or bags.

3.3 HARVEST:

13. Harvesting of dried figs is different from harvest of figs for fresh consumption. The figs to be dried are not harvested when they mature but kept on the trees for over-ripening. After they loose water, partially dry and shrivel, an abscission layer forms and the fig fruits naturally fall from the trees onto the ground. The most critical aflatoxin formation period begins with ripening and continues when shrivelled until fully dried. The fig fruits need to be collected from the ground daily to reduce losses, caused by diseases or pests. On the other hand, the collecting containers should be suitable, preventing any mechanical damage and should be free of any fungal sources.

14. Dried fig harvest should be done regularly at short intervals to minimize the contacts with soil and thus contamination risks. Frequent harvest also reduces insect infestation especially of dried fruit beetles (*Carpophilus spp.*) and fig moths (*Ephestia cautella* Walk. and *Plodia interpunctella* Hübner).

15. In case of a significant difference exists between day and night temperatures, dew formation that may trigger aflatoxin formation may occur. This is important since wet surfaces favouring the growth of fungi may be formed even after complete drying of the fruit.

3.4 DRYING:

16. Drying area and time are very important issues in the aflatoxin formation. The moisture content of the partially dried and shriveled fig, which fallen down from the trees, is approximately 30-50 % and these fruits are more susceptible than the fully dried fig fruits that have approximately 20-22 % moisture content. Good soil management before harvest is therefore necessary to reduce the risk of damaging.

17. Fig fruits can be dried artificially in driers or under sun with the help of the solar energy. In artificial driers, the fig fruits are dried in a shorter period and more hygienic products with less pest damage can be obtained. The aflatoxin levels can be also reduced. In sun-drying, drying trays that are 10-15 cm above the ground should be preferred to eliminate the contamination of fruits by foreign materials such as soil particles or plant parts. Since fruits can benefit from the heat at the soil surface and are well aerated, they can dry quickly and thus, losses caused by diseases and pests are reduced.

18. During drying of dried figs, the following items should be considered;

- Fruits should not be placed directly on the soil surface or on some vegetation.
- Drying beds should be arranged as single layers in a sunny parts of the orchard where air currents are present. The drying trays should be covered with a material to protect the figs from rain fall in case there is a risk or to prevent infestation of fig moths that lay eggs in the evening.
- Figs that are fully dried should be picked from the trays.

- The fully dried fruits should be collected from the trays preferably in the morning before the temperature of the fruits increase and soften but after the dew goes away.
- The trays should be re-visited at short intervals to collect the fully dried figs, if this interval is too long then fig fruits further dry and harden.
- Dried figs taken from drying trays must be subjected to fumigation as soon as possible to control storage pests. Fumigation process can be performed by deep-freezing, phosphine or CO₂ (atmospheric and high pressure) treatment or any other registered method.
- Holding these processes by light in nights is undesirable because *Ephestia (Cadra) cautella Walk* which appears in night and leave eggs, cause the damage. This time interval should not last too long not to harden the figs.
- Low quality figs, separated as cull and have the risk of contamination, should be dried and stored separately to prevent cross contamination.
- Staff who does the harvesting or work in storage rooms should be trained in this respect and controlled to obey these criteria.

3.5 TRANSPORTATION:

19. During the transportation of dried figs from farm to processor, the quality of figs should not effect adversely and the following items should be considered;

- Dried figs should not be transported with products having the risk of extraordinary smell and pest contamination.
- In all stages of transportation boxes should be used instead of bags.
- During transportation and holding before entry of processor, increase of moisture and temperature must be prevented.
- The dried figs should be moved in suitable containers to a suitable storage or directly to the processing plant as soon as possible after harvesting or drying.
- Containers used in transportation should be clean, dry, and free of visible fungal growth, insects or any other source of contamination.
- The containers should be strong enough to withstand all handling without breaking or puncturing, and tightly sealed to prevent any access of dust, fungal spores, insects or other foreign material.
- Vehcles (e.g. wagons, trucks) to be used for collecting and transporting the harvested dried figs from the farm to drying facilities or to storage facilities after drying, should be clean, dry, and free of insects and visible fungal growth before use and re-use and be suitable for the intended cargo.
- The use of registered fumigants or insecticides may be useful.
- At unloading, the transport container should be emptied of all cargo and cleaned as appropriate.

3.6 STORAGE:

20. The shelf life of dried figs could be prolonged, if they are dried to a water activity value at which molds, yeasts and bacteria can not grow. In case further hot spots are formed where temperature and moisture increases, secondary aflatoxin formation may occur. Because of this reason, direct contact of dried fig containers with the floor or with wall is not recommended. In storage rooms to prevent direct contact, a palette can be placed under the boxes.

21. During transportation of dried figs, the following items should be considered;

- The storage rooms should be disinfected with proper disinfectants.
- The areas like cleavage and cavity should be repaired, the windows should be netted.
- The precautions should be taken to avoid insect, bird and similar problems.

- The walls should be white-washed every year.
- Cull figs should be stored separate from the others.
- The storage rooms should be dark and cool.
- The storage rooms should be far from the animal shelters if any present at the farm, and fruits must not be stored with materials that have peculiar smell.
- Dried figs must be stored at temperatures of 5-10°C and relative humidity less than 65%.