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Original Contribution

MICROFUNGI AND MYCOTOXINS OF GRAPES AND GRAPE PRODUCTS

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ABSTRACT

Microfungi may occur on grapes during growth in the vineyards. As a result of the growth of commonly occurring filamentous fungi in grapes mycotoxins are produced. These mycotoxins are the secondary metabolities produced by only a few species of microfungi. Mycotoxins can cause a variety of harmful effects in humans, from allergic responses to immunosuppression and cancer.

Key Words: *mycotoxins, microfungi, vineyards*

INTRODUCTION

Microfungi are ubiquitous microorganisms in the environment. If certain physical conditions, such as moisture level, temperature and the presence of organic and inorganic substrates, are met in fungi, they can easily proliferate[1]. Mycotoxins are substances produced mostly as secondary metabolites by filamentous fungi that grow in food. The growth of filamentous fungi in foods and food products result in waste and is costly as well as sometimes hazardous. Many different fungal species can spoil food products or produce mycotoxin and both [1]. Mycotoxin contamination has been a serious concern for human health [2,3,4]. The major mycotoxin-producing fungi are species of *Aspergillus*, *Fusarium*, and *Penicillium*. These fungi produce the important mycotoxins such as aflatoxins, ochratoxins, fumonisins, patulin.

Grape is a fruit appreciated by consumers as fresh (table grapes), dried (raisins), or as processed products, such as grape juice and wine [5,6]. Grapes that are heavily infected with moulds alter in chemical composition and secondary metabolities such as mycotoxins. These mycotoxins of greatest significance in grapes and grape products produced by *Aspergillus* and *Penicillium* spp., include ochratoxin A., aflatoxins, patulin and citrinin [5,6].

MICROFUNGI IN GRAPE AND GRAPES PRODUCTS

Contamination of grapes by different moulds occurs during preharvesting, harversting and grape processing. The fungal growth begins in grapes if temperature and humidity are suitable. Rotting and spoilage of grape berries before harvest can be caused by a variety of fungal species such as *Alternaria* spp, *Aspergillus* spp, *Botrytis cinerea*, *Cladosporium* spp, *Eurotium* spp, *Penicillium* spp and *Rhizopus* spp. These genus are regarded as the main natural contaminants of grapes [2,5].

Magnoli et al. [5] showed that *Alternaria*, *Aspergillus*, *Cladosporium* and *Penicillium* species were the predominant microfungi in harvested grapes from Argentina. In Spanish wine grapes the most prevalent reported genera were *Alternaria*, yeasts, *Aspergillus*, *Cladosporium*, *Rhizopus*, and *Penicillium* [7]. Also, in some other researches, *Alternaria*, *Aspergillus*, *Botrytis*, *Cladosporium* and *Penicillium* have been isolated as the most frequent fungi genus [3,8]. *Botrytis*, *Cladosporium* and *Penicillium*

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have been reported as the predominant mycobiota by Abrunhosa et al. [9].

Alternaria spp. are important fungal contaminants of vegetable fruits and grain products, including *A. alternata*, a contaminant of various fruits.

Aspergillus species can infect grapes and A. niger is by far the most common *Aspergillus* species responsible for postharvest decay of fresh fruit including grape [5]. On grapes, black *Aspergillus* spp. typically increase from berry set until harvest, perhaps because the surface of immature green berries and exposure to UV light represent a hostile environment for *Aspergillus carbonarius* spores.

In three-year a study, Serra et al. [10] investigated the fungal species present on the surface of grape berries from Portuguese vineyards in four winemaking regions. According to their results, in more humid climates, *Botrytis* seems to be the main pathogen and spoiling agent, and the incidence of black *Aspergillus* is minimal.

MYCOTOXINS IN GRAPE AND GRAPES PRODUCTS:

Ochratoxin A occurs in grapes and dried vine fruits (Fig 1). Ochratoxin A has also been detected in beverages such as grape juices, musts and wines. Ochratoxin A contamination originates in the vineyard, and its detection in wine and grape juice its detection in wine and grape juice has been attracting considerable attention in many countries [11].

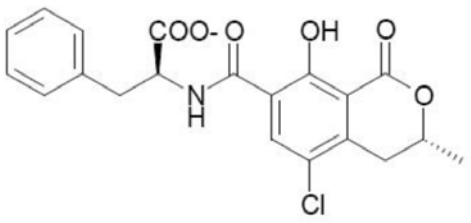

Figure 1. *Structure of ochratoxin A commonly found in grape and grape products.*

According to studies ochratoxin A-producing strains from the group *Aspergillus* section Nigri (*A.carbonarius* and *A. niger* aggregate) are the source of ochratoxin A in wines, grapes and dried vine fruits [2,12]. Ochratoxin A is produced primarily when *A. carbonarius* infects berries before harvest. The relatively few toxigenic strains of the related species, *A. niger*, may also contribute to Ochratoxin A contamination, as *A. niger* is by far the most common species of *Aspergillus* present on grapes [13]. Toxigenic isolates of *A. ochraceus* have only occasionally been isolated from grapes [9]. Magnoli et al. [5], in their study found that from 63 strains of *A.* section Nigri, 41.3% were ochratoxin A producers. Also, Serra et al. [10], found that the most important mycotoxin-producing species was *A. carbonarius*, which is an ochratoxin A producer.

From the berry skin softens and sugar content increases until harvest, berries are most susceptible to infection by *A. carbonarius* and also are capable of supporting ochratoxin A production, particularly when damaged. Delayed harvest of mature berries also increases the risk of ochratoxin A contamination [12]. Also, Hocking et al. reported that temperature and water activity are likely to affect the rate of growth and ochratoxin A production by black *Aspergillus* species in berries.

Ochratoxin contamination of grape and grape derived products such as grape juice, vinegar, pekmez (boiled and concentrated grape juice is called “pekmez” in Turkey) wine, and potential sources of ochratoxin contamination has also been discussed by Varga and Kozakiewicz [14]. According to researches, ochratoxin A contamination of dried vine fruits is usually much higher than that of wines or grape juice. When ochratoxin A contamined grape juices were used for pekmez production, 5-6 times higher ochratoxin A levels is found in the final product.

Mycotoxins such as patulin, aflatoxin and citrinin are less common than ochratoxin A in grape and grape products (Fig 2).

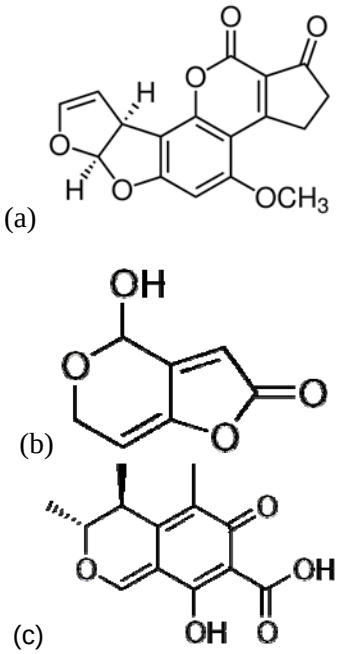

Figure 2. *Structure of aflatoxin B1 (a), patulin (b) and citrinin (c).*

Penicillium verrucosum is the only species of *Penicillium* capable of ochratoxin A production [15]. The strains of *Penicillium expansum* isolated from grapes may produce patulin.

Citrinin has been also detected in grapes before storage. It is produced by different species of *Penicillium*, *Aspergillus* and *Monascus*

The aflatoxigenic species, *A. flavus* and *A. parasiticus*, have also occasionally been isolated from grapes. *Trichothecium roseum* growing on grapes affected by 'grey rot' (*B. cinerea*) is the likely source of mycotoxins such as trichothecin. However, mycotoxins such as these are seldom detected in wine and other grape products and are currently of little concern for the grape and wine industries [9]. In a study [11], was showed that *Aspergillus* and *Penicillium* species commonly isolated from grapes are not a source of the mycotoxins, patulin and citrinin.

Patulin has been detected in juice naturally produced from mouldy grapes, and grape juices [11].

HARMFUL EFFECTS OF MYCOTOXINS

Ochratoxin A is a mycotoxin with nephrotoxic, nephrocarcinogenic, teratogenic and immunosuppressive properties, which has received growing interest from the scientific community and food committees in the last few years [14,15]. Ochratoxin A is a kidney toxin and probable carcinogen. It is produced by P*enicillium verrucosum* in cereal grains in cold climates, by *A. carbonarius* in grapes, wines and vine fruits, and by *A. ochraceus* sometimes in coffee beans [4].

Aflatoxins are potent carcinogens, produced by *Aspergillus flavus* and *A. parasiticus* [4].

Patulin causes gastrointestinal problems, skin rashes, and is known to be mutagenic [9]. This mycotoxin has been shown to be neurotoxic, immunotoxic, immunosuppressive, genotoxic, teratogenic and carcinogenic [11].

Citrinin has been shown to be hepato-nephrotoxic in a wide range of species.

CONCLUSION

Mycotoxins contamination (primarily ochratoxin) of grape and grapes products are caused primarily by black aspergilli.

Management practices to minimise the risk of ochratoxin A contamination of grapes in vineyards centre on reducing *A. carbonarius* in soil and preventing damage to grapes. Grapes from such vineyards must be harvested as soon as mature and processing should commence rapidly [12]. Further studies are necessary to find suitable practices for lowering fungal contamination and ochratoxin A levels in grapes and grape derived products.

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