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MYCOFLORA AND AFLATOXINS STATUS OF SOME SPICES AND HERBS COMMONLY CONSUMED IN TAIZ GOVERNORATE, REPUBLIC OF YEMEN

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Abstract: The present work was carried out on 105 samples representing 21 kinds of spices (5 samples each) commonly consumed in Taiz city, Yemen. Ajawan, black cumin, coriander, cumin, fenugreek, ginger, laurel and thyme were highly polluted. Whereas black mustard, caraway, cardamom, fennel, garden cress, nutmeg and red pepper moderately contaminated by mould and yeasts. On the other hand, anise, black pepper, cinnamon, linseed and safflower were less contaminated by moulds and yeasts. Clove samples were free from mould and yeasts. The mycological survey of the different spices revealed that they were heavily contaminated with mould and yeasts, where about 91.42 % of the samples examined were contaminated with fungi. Ninety-one species and two varieties appertaining to 25 genera were isolated. *Aspergillus*, *Rhizopus* and *Penicillium* species contributed the broadest spectra of species. *Aspergillus* was the most prevalent genus, it occurred in 90.5 % of the samples constituting 65.1 % of total fungal count. Among fungi recovered in these work, 14 species were new records in Yemen. The results proved the presence of aflatoxin B_1 in seven samples while the rest 14 tested samples were free from any detectable amount of aflatoxins.

Key words: Fungi, spices, aflatoxins.

Introduction

Spices are the various strongly flavored or aromatic substances of vegetable origin; they are commonly used as condiments or employed for other purposes on account of their fragrance and preservation qualities (Oxford English Dictionary, 1989). These are parts of plants such as dried leaves, seeds, fruits, bark, roots, stems, buds and flowers (Sherman and Billing, 1998). Spices have two main components: volatile oils (essential oils), which are responsible for the characteristic aroma of spices and oleoresins (non volatile extracts), which are

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responsible for the typical taste and flavor, these substances also have preserving action, that are toxic to microorganisms (Pruthi 1980). In addition, many of these spices have medicinal properties that alleviate symptoms or prevent diseases because they possess antimicrobial properties. Other spices contain potent phytochemical that provides significant protection against cancer (Aruoma 1998, and Sherman and Flaxman 2001). In fact, the adverse effects of long-term herbal and spices use, adulteration with toxic compounds and contamination by pathogenic microorganisms or natural toxins like mycotoxins have been reported for spices, herbal products and medicinal plants (Aziz *et al.* 1998, Abou-Arab *et al.* 1999, Efuntoye 1999, Freire *et al.* 2000, Tassaneeyakul *et al.* 2004 and Mandeel 2005). Most spices are susceptible to invasion by fungi during some stage of production, processing, transport, harvesting or storage (Salunkhe *et al.* 1980, Thompson *et al.* 1989, Giese 1994, Kneifel and Berger 1994, McKee 1995, Elshafie *et al.* 2002, Abdulkadar *et al.* 2004 and Bircan 2005). Additionally, spices may be attacked by fungi in the field or while in storage. (Julseth and Deibel 1974, Flannigan and Hui 1976, Ayres *et al.* 1980 and Eman 1990). Many fungi are capable of producing toxic substances. If mold growth occurs on the spices, there is possibility of mycotoxin production in the field before harvest and or during transportation, storage and remain in the commodities for several years (Salunkhe *et al.* 1980, Thompson *et al.* 1989, Giese 1994, Kneifel and Berger 1994 and Youssef 1995). Contamination of spices with aflatoxins may takes place in the field, and or during drying, storage and processing stages (Elshafie *et al.* 2002). Several investigations have been carried out on the mycoflora (distribution, composition, density and frequency of occurrence) and aflatoxins production on the herbal and several kinds of spices in many countries , (Abdel-Hafez and El-Maghraby 1992, El-Kady *et al.* 1992 & 1997, Aziz *et al.* 1998, Freire *et al.* 2000, El-Bazza *et al.* 2001, Tassaneeyakul *et al.* 2004, Mandeel 2005, Martin *et al.* 2005, Bugno *et al.* 2006 and Romagnoli *et al.* 2007). They recorded that many spices are heavily contaminated with fungal populations. In addition, there are numerous studies in different countries and regions have established that spices will support fungal growth and subsequent aflatoxins production (Aziz and Youssef 1991, Takahashi 1993, Ragab 1994, Youssef 1995, Akiyama *et al.* 2001, El-Bazza *et al.* 2001, Martins *et al.* 2001, Abdulkadar *et al.* 2004, Bircan 2005, Zinedine *et al.* 2006 and Romagnoli *et al.* 2007).

This investigation was carried out in an attempt for isolation, identification, frequency, distribution, occurrence and composition of the mycoflora of 21 kinds of spices. Screening for the natural

occurrence of aflatoxins in the different investigated spices was also evaluated.

Materials and Methods

Collection of Spices and Herbs Sample:

One hundred and five samples related to twenty one kinds of spices and herbs, mentioned in Table (1), were gathered from different retail supermarkets at Taiz Governorate (five samples for each kind). Each sample (500 g) was put in a sterile polyethylene bag then transferred immediately to the Laboratory for fungal determination and aflatoxins analysis.

Estimation of Spices and Herbs Borne Fungi:

Direct plate technique, adopted and recommended by Pitt *et al.* 1992, was employed for the enumeration and isolation of fungi associated with spices and herbs sample. Ten segments (0.5 cm^2) or 10 seeds per sample were immersed on the surface of agar plates (3 plates each sample). The plates were incubated at 28° C for 7-10 days and the developing moulds were examined, counted, isolated and identified. The numbers of colonies were calculated per 30 segments or seeds for each sample.

Medium Used for Isolation of Spices or Herbs Borne Fungi:

Modified Czapek's Dox agar medium was used in which the 3% sucrose was substituted with 2% glucose. The composition of the medium (g/L) was (glucose, 20; $NaNO_3$, 3; $KH_2PO_4.7H_2O$, 0.5; $MgSO_4.7H_2O$, 0.5; KCl, 0.5; $FeSO_4.7H_2O$, 0.01; Agar Agar, 15). Ros-bengal (1/15000) combined with Chloramphenicol (0.5 mg/ml) were used as bacteriostatic agents according to Smith and Dawson (1944) and Al-Doory (1980).

Identification of Fungal Genera and Species:

Identification of fungi genera (based on macro and microscopic characteristics) was performed as outlined in following keys: Raper and Thom (1949), Raper and Fennell (1965), Simmons (1967), Rifai (1969), Booth (1971 & 1977), Ellis (1971 & 1976), Christensen and Raper (1978), Pitt (1979 & 1985), Domsch *et al.* (1980), Ramirez (1982), Sivanesan (1984) and Moubasher (1993).

Estimation of Aflatoxins in Spices:

Aflatoxins of species samples were extracted (as crude extracts) according to the method described by Pons *et al.* (1972). The crude extracts were purified by column chromatography according to method modified by Zohri (1990). The thin layer chromatographic technique described by El-Kady and Moubasher (1982) was carried out to qualitative determination of aflatoxins, and the procedure of Ibrahim (1983) was employed for chemical confirmatory tests for aflatoxins.

Table(1): Code No. of samples collected from different retail supermarkets.

Code No.	Latin name	Plant part	English name	Arabic name
1-5	*Trachyspermum ammi*	Seeds	Ajwan	النخوة (الكمون الملوكي)
6-10	*Pimpinella anisum*	Seeds	Anise	ينسون
11-15	*Nigella sativa*	Seeds	Black cumin	الحبة السوداء (حبة البركة)
16-20	*Brassica nigra*	Seeds	Black mustard	خردل اسود
21-25	*Piper nigrum*	Fruits	Black pepper	فلفل أسود
26-30	*Carum carvi*	Fruits	Caraway	كراوية
31-35	*Elettaria cardamomum*	Fruits	Cardamom	هيل (حبهان)
36-40	*Coriandrum sativum*	Flower buds	Coriander	كزبرة
41-45	*Syzygium aromaticum*	Flower buds	Clove	قرنفل
46-50	*Cinnamomum verum*	Bark	Cinnamon	قرفة
51-55	*Cuminum cyminum*	Flower buds	Cumin	كمون
56-60	*Foeniculum vulgare*	Flower buds	Fennel	شمر
61-65	*Trigonella foenum-graecum*	Flower buds	Fenugreek	حلبة
66-70	*Lepidium sativum*	Seeds	Garden cress	الحلف (حب الرشاد)
71-75	*Zingiber officinale*	Rhizomes	Ginger	زنجبيل
76-80	*Laurus nobilis*	Leaves	Laurel	غار
81-85	*Linum usitatissimum*	Seeds	Linseed	كتان
86-90	*Myristica fragrans*	Fruits	Nutmeg	جوز الطيب
91-95	*Capsicum frutescens*	Fruits	Red pepper	الفلفل الأحمر
96-100	*Carthamus tinctorius*	Flowers	Safflower	القرطم
101-105	*Thymus vulgaris*	Leaves	Thyme	الزعتر

Results and Discussions

The mycological analysis of the 21 kinds of spices revealed that most of them were heavily contaminated with mould and yeasts. From the 105 samples tested, 96 samples (91.4 %) were polluted with fungi. Ajawan, black cumin, coriander, cumin, fenugreek, ginger, laurel and thyme were highly polluted, containing 150 - 197 colonies/150 seeds or segments. Whereas, black mustard, caraway, cardamom, fennel, garden cress, nutmeg and red pepper were moderate contaminated having 126-148 colonies/150 seeds or segments. On the other hands, anise, black pepper, cinnamon, linseed and safflower were less contaminated having 8-120 colonies/150 seeds or segments.

Only clove samples were free from mould and yeasts and that was agreement with the results of Garrido *et al.* (1988 & 1992), El-Kady *et al.* (1992), Youssef (1995), EL-Bazza *et al.* (2001), Elshafie *et al.* (2002), El-Shanawany *et al.* (2002), Hemida (2004) and Mandeel (2005).

Tabulated data presented in Table (2) revealed that 2720 colonies representing ninety-one fungal species and two varieties appertaining to 25 genera were identified from the tested samples on Czapek's agar at 28° C. *Aspergillus*, *Rhizopus* and *Penicillium* were the most common fungi, isolated in high or moderate frequency of occurrence. Our results were greatly harmony with those obtained by numerous researchers all over the world. They reported that, these genera were quite common on crude and herbal drugs, spices and umbelliferous seeds (Shrivastava and Jain 1992, Banerjee *et al.* 1993, Halt 1998, Freire *et al.* 2000, Omafuvbe and Kolawole 2004 and Rizzo *et al.* 2004).

Aspergillus was the most prevalent genus. It was occurred in 90.5 % of the samples constituting 65.1 % of total count. The mean total counts of *Aspergillus* widely varied from 21 - 162 colonies/150 seeds or segments of spice, showing the maximum in samples of laurel leaves and the minimum in linseed seeds. Most of spices sample were highly contaminated with *Aspergillus* but clove and cinnamon bark were free from *Aspergillus*. In addition, *Aspergillus* was the first predominant genus among fungi isolated from herbs, spices or medicinal plants. In agreement, *Aspergillus* agreed the main component of the mycoflora of spices (Martinez-Magana *et al.* 1989, Ismail 2000, El-Shanawany *et al.* 2002, Mandeel 2005 and Bugno *et al.* 2006).

In addition, five species and one variety could produce sexual spores (Teleomorphs) which related to two genera namely: *Emericella* (tree species + one variety) and *Eurotium* (two species). From this genus, 38 species and one variety were identified of which *A. flavus* and *A. niger* were the most common species. They were isolated in high frequency of occurrence emerging in 56.2 % and 63.8 % of the samples comprising 17.0 % and 33.5 % of total *Aspergillus* and 11.1 % and 21.8 % of total fungi, respectively. It was noticed that samples of cumin and laurel were highly polluted with the above two species where as, linseed samples was less contaminated with them. Several studies reported that *A. niger* or *A. flavus* was the most frequently encountered and widely distributed fungus in herbal drugs and spices (Vardavakis 1988, Abdel-Gawad and Saber 1989, Moharram *et al.* 1989, Shrivastava and Jain 1992, Zohri *et al.* 1992, Youssef 1995, Freire *et al.* 2000 and Omafuvbe and kolawole 2004). Eight species and one variety from

Aspergillus, were isolated and identified in moderate or low frequency of occurrence and these were: *A. foetidus*, *A.* oryzae, A. *flavo furcatis*, *A. flavus* var. *columnaris*, *A. ochraceus*, *A. parasiticus*, *A. pulverulentus*, *A. tamarii* and *A. unguis*. These *Aspergillus* species were previously isolated in moderate, low or rare frequency from different kinds of spices and medicinal plants (Abdel-Gawad and Saber 1989, Moharram *et al.* 1989, El-Kady *et al.* 1992, Shrivastava and Jain 1992, Youssef 1995, Aziz *et al.* 1998, Freire *et al.* 2000, El-Shanawany *et al.* 2002, Mandeel 2005 and Bugno *et al.* 2006). The remaining *Aspergillus* species were isolated in rare frequency of occurrence matching collectively about 12.1 % of total *Aspergillus* and 7.9 % of total fungi. These species were previously isolated in different densities from several kinds of spices and medicinal plant (Moharram *et al.* 1989, Eman 1990, Youssef 1995, Abdel-Hafez and El-Maghraby 1992, El-Kady *et al.* 1997, Ismail 2000, El-Shanawany *et al.* 2002 and Hemida 2004).

Rhizopus (*R. stolonifer*) was the second common genus came behind *Aspergillus* in the number of cases of isolation and total counts. It was recovered from 61.9 % of the samples comprising 13.8 % of total counts. The mean total counts of *Rhizopus* were varied from 2 - 44 colonies/150 seeds or segments. Samples of coriander, red pepper, cumin, anise and ajowan were the most contaminated, whereas thyme, ginger, black cumin and laurel were less contaminated with *Rhizopus stolonifer*. On the other side, the clove and cinnamon samples were free from *Rhizopus stolonifer*. In general these results were in agreement with those of El-Kady *et al.* (1992), Shrivastava and Jain (1992), Youssef (1995), Ismail (2000), El-Bazza *et al.* (2001), Elshafie *et al.* (2002), Martin *et al.* (2005) and Bugno *et al.* (2006).

According to the number of isolates, *Penicillium* occupied the third order. It was recovered from 30.5 % of the samples contributing 5.0 % of total fungi. The mean total counts of this genus varied from 1 – 23 colonies/150 seeds or segments. Spices sample of thyme, fenugreek, garden cress, linseed were heavily polluted, while red pepper, caraway, ajowan, cumin, black pepper, black cumin, ginger, laurel and cardamom were less polluted with *Penicillium* species. On contrast, samples of clove, fennel, coriander and cinnamon were free from *Penicillium* species. Fifteen species of *Penicillium* were identified belonging to three sections and three subsections described by Raper and Thom (1949) as follows: Monoverticillata (two species) namely, *P. decumbens* Thom, and *P. waksmanii* Zaleski. Biverticillata Symmetrica (three species) namely, *P. funiculosum* Thom *P. islandicum* Sopp *P. variabile* Sopp. Asymmetrica Velutina subsection (seven species) namely, *P.*

brevicompactum Dierckx *P. chrysogenum* Thom *P. citrinum* Thom *P. corylophilum* Dierckx *P. oxalicum* Currie and Thom *P. roquefortii* Thom *P. steckii* Zaleski. Asymmetrica Lanata subsection (one species) *P. lanosum* Westling. Finally, Asymmetrica Fasciculata subsection (two species) namely, *P. expansum* Link ex Gray *P. griseofulvum* Dierckx. From those isolate *P. brevicompactum*, *P. chrysogenum* and *P. citrinum* were the most prevalent. These three species were isolated from 10.5 %, 7.6 % and 6.7 % of the samples constituting 13.3 %, 11.8 % and 12.4 % of total *Penicillium* and 0.6 %, 0.8 % and 0.7 % of total fungi, respectively. The remaining *Penicillium* species were isolated in rare frequency of occurrence (from 1 - 4 samples) representing collectively about 55.5 % of total Penicillium and 2.8 % of total fungi. Penicillia were recorded as the main components of mold counts in spices sample and medicinal plants (Hashmi and Ghaffar 1991, Shrivastava and Jain 1992, Banerjee *et al.* 1993, Abdel-Hafez and El-Said 1997, Ismail 2000 and Martin *et al.* 2005).

Ulocladium was isolated from spices sample in low frequency of occurrence. It was recovered from 22.9 % of the samples contributing 1.2 % of total fungi. From the genus, 3 species were identified of which *U. alternaria* was the commonest species. *U. atrum* and *U. chlamydosporum* were recovered in rare frequency of occurrence. This genus was also isolated from different substrates including spices and herbs in low and rare frequencies of occurrence. In this respect, El-Kady *et al.*(1992) isolated *U. botrytis* in rare occurrence from 120 samples belonging to 24 kinds of spices. Youssef (1995) isolated two species from the genus namely *U. atrum* and *U. botrytis* from 165 samples of medicinal plants. In addition, El-Kady *et al.* (1997) could isolate *U. atrum* and *U. microsporium* from phyllosphere of some herbal plants. However, El-Shanawany *et al.* (2002) could isolate *U. atrum* in low frequency of occurrence from 48 samples of 12 types of spices.

In addition, the data presented in Table (2) showed that the non-filamentous fungi (yeasts) were isolated in moderate frequency of occurrence. It emerged in 24.8 % of the samples contributing 4.9 % of total fungi. Their total counts varied from 2 - 30 colonies/150 seeds or segments. The samples of cardamom, red pepper, caraway, garden cress, linseed and ajowan were highly polluted with yeasts but, ginger, thyme, anise and black mustard were less contaminated with non filamentous or pseudohypha fungi. On contrast, fenugreek, nutmeg, cinnamon, cumin, black pepper, clove, fennel, coriander and laurel were free from yeasts. Several reports revealed that yeast were present in crude herbal and spices sample (Beuchat *et al* 1991, Omafuvbe and kolawole

2004, Martin *et al.* 2005 and Mandeel 2005).

Non-sporing filamentous fungi (sterile mycelia) were isolated in low frequency of occurrence represented in 14.3 % of the samples constituting 2.4 % of total fungi. The mean total counts of these filamentous fungi widely varied from 1 – 24 colonies /150 seeds or segments. Sterile mycelia were isolated but with different incidence from numerous substances including spices and herbs as reported by some researchers (Eman 1990, El-Kady *et al.* 1992 & 1997 and Youssef 1995)

Thirty-four and one variety belonging to twenty-one genera were isolated in rare frequency of occurrence. They were occurred in 0.9 – 9.5 % of the samples matching collectively about 7.6 % of total fungi. Most of these fungi were previously isolated from herbal drugs and spices in variable numbers and frequencies (Moharram *et al.* 1989, Abdel-Hafez and El-Maghraby 1992, El-Kady *et al.*1992, Youssef 1995, Ismail 2000, Freire *et al.* 2000, Hemida 2004, Mandeel 2005, Bugno *et al.* 2006 and several others).

Fourteen species were new records in Yemen and these are *Alternaria dianthi*, *Aspergillus ambiguus*, *A. caespitosus*, *A. ellipticus*, *A. multicolor*, *A. ostianus*, *A. pulverulentus*, *A. pulvinus*, *A. puniceus*, *A. recurvatus*, *A. speluneus*, *A. tubingensis*, *A. viridi-nutans*, and *Paecilomyces farinosus*. Numerous of these fungal genera and species isolated previously, but in different counts and frequencies from some spices sample in many parts of the world (Garrido *et al.* 1988, Moharram *et al.*1989, Abdel-Hafez and El-Maghraby 1992, El-Kady *et al.* 1992, Chourasia 1995, Youssef 1995, Aziz *et al.* 1998 and others).

The analysis of extracts of samples of the twenty-one kind of spices proved the presence of aflatoxin B1 in five spices named anise (*Pimpinella anisum*), caraway (*Carum carvi*), fennel (*Foeniculum vulgare*), laurel (*Laurus nobilis*) and safflower (*Carthamys tinctorius*). In addition, traces of aflatoxin B1 were detected in another two kinds named ajawan (*Trachyspermum ammi*) and cumin (*Cuminum cyminum*). In contrast, the tested samples of other 14 spices were free from aflatoxins. Findings similar to the results obtained in the present study, have been reported by several workers (Takahashi, 1993; Ragab, 1994; Youssef, 1995; Aziz *et al.*, 1998; Akiyama *et al.*, 2001; El-Bazza *et al.*, 2001; Martins *et al.*, 2001; Abdulkadar *et al.*, 2004; Bircan, 2005; Zinedine *et al.*, 2006 and Romagnoli *et al.*, 2007).

Table (2): Total counts (TC, calculated /3150 seeds or segments in all samples), Number of cases of isolation (NCI, out of 105 samples) and occurrence remarks (OR) of fungal genera and species recovered from 105 spice samples on Czapek's agar at 28°C.

Genera and species	TC	NCI and OR	Keys of samples contained that isolates
Alternaria	26	10 R	6, 13, 14,15, 16, 17, 20, 21
A. alternata	5	3 R	17, 20, 21
A. chlamydospora	3	1 R	21
A. dianthi	7	3 R	13, 21
A. tenuissima	11	7 R	6, 13, 14,15, 16, 17, 21
Aspergillus	1771	90 H	All samples except (9, 10)
A. aculeatus	7	4 R	4, 7, 14, 17
A. alliaceus	8	3 R	15, 16
A. ambignus	2	1 R	13
A. aureolatus	4	1 R	4
A. awamori	41	8 R	2, 4, 6, 15, 20, 21
A. caespitosus	2	2 R	17, 20
A. candidus	1	1 R	14
A. ellipticus	8	1 R	2
A. ficuum	21	6 R	5, 6, 7, 19
A. flavipes	3	2 R	11, 14
A. flavo-furcatis	42	15 L	1, 3, 4, 5, 7, 8, 14 15, 16, 18, 19, 20
A. flavus	301	59 H	All samples except (9, 10, 17)
A. flavus var. *columnaris*	23	12 L	1,2, 3, 4, 6, 13, 14, 17, 18, 19
A. foetidus	134	26 M	1, 2, 4, 8, 13, 14, 15, 16, 18, 19, 21
A. fumigatus	5	4 R	2, 4, 6
A. janus	2	2 R	17, 19
A. japonicus	21	6 R	1, 7, 19
A. multicolor	1	1 R	20
A. niger	594	67 H	All samples except (9, 10)
A. ochraceus	51	12 L	8, 11, 12,13, 14, 15, 17, 18, 20
A. oryzae	103	28 M	1, 2, 4, 6, 11, 13, 14, 16, 17, 18, 20, 21

Table (2): continue

Genera and species	TC	NCI and OR	Keys of samples contained that isolates
A. ostianus	2	2 R	4, 7
A. parasiticus	73	24 L	1, 3, 4, 5, 6, 7, 11, 12, 13, 18, 19
A. petrakii	19	8 R	3, 4, 7, 11, 13, 15
A. pulverulentus	153	18 L	1, 3, 6, 7, 12, 13, 15, 16, 18, 19
A. pulvinuis	6	1 R	19
A. recurvatus	2	2 R	13
A. speluneus	2	1 R	14
A. subolivaceus	2	1 R	11
A. subsessilis	10	6 R	4, 12, 13, 20, 21
A. sydowi	14	4 R	4, 11, 17
A. tamarii	41	13 L	1, 4, 5, 8, 15, 18, 20, 21
A. terreus	6	5 R	4, 5, 11, 16
A. tubingensis	13	4 R	4, 14, 15, 21
A. unguis	28	16 L	1, 4, 5, 11, 12, 13, 14, 16, 18, 21
A. ustus	2	2 R	21
A. versicolor	8	2 R	8, 12, 13, 15, 21
A. viridi-nutans	3	2 R	12, 14
A. wentii	13	6 R	3, 5, 8, 12
Botryotrichum piluliferum	2	2 R	2, 6
Cladosporium cladosporioides	28	4 R	13, 17, 20
Cochliobolus	17	8 R	2, 4, 21
C. lunatus	2	2 R	21
C. ovoidea	5	3 R	21
C. spicifer	10	3 R	2, 4
Curvularia tuberculata	1	1 R	4
Emericella	9	3 R	4, 8
E. nidulans	5	2 R	4, 8
E. nidulans var. *dentata*	1	1 R	4
E. quadrilineata	2	1 R	4

Table (2): continue

Genera and species	TC	NCI and OR	Keys of samples contained that isolates
E. rugulosa	1	1 R	4
Eurotium	7	6 R	4, 17 18
E. amstelodami	5	5 R	4, 17
E. chevalieri	2	1 R	18
Fusarium	9	4 R	7, 17, 21
F. dimerum	1	1 R	17, 21
F. oxysporum	8	3 R	7, 17, 21
Gibberella pulicaris	10	3 R	21
Humicola	3	3 R	3, 4
H. fuscoatra	2	2 R	3
H. grisea	1	1 R	4
Memnoniella echinata	1	1 R	21
Monodictys paradoxa	1	1 R	21
Mucor	13	4 R	6, 10, 14
M. circinelloides	4	1 R	10
M. hiemalis	9	3 R	6, 14
Nectria haematococca	9	2 R	21
Paecilomyces farinosus	6	2 R	2, 20
Penicillium	135	32 M	All samples except (8, 9, 10, 12)
P. brevicompactum	18	11 R	1, 2, 6, 7, 13, 16, 17, 18, 21
P. chrysogenum	23	8 R	2, 14, 16, 17, 19, 20
P. citrinum	19	7 R	1, 2, 4, 13, 14, 17
P. corylophilum	1	1 R	17
P. decumbens	2	1 R	3
P. expansum	1	1 R	13
P. funiculosum	10	4 R	4, 15, 17
P. griseofulvum	1	1 R	2
P. islandicum	19	3 R	13, 21
P. lanosum	2	2 R	17, 18
P. oxalicum	5	2 R	5, 14

Table (2): continue

Genera and species	TC	NCI and OR	Keys of samples contained that isolates
P. roquefortii	8	4 R	2, 13, 17, 18
P. steckii	7	4 R	3, 11, 13, 21
P. variabile	7	3 R	5, 18, 21
P. waksmani	12	2 R	13, 20
Rhizopus stolonifer	376	65 H	All samples except (9, 10)
Scopulariopsis brevicaulis	15	1 R	8
Stemphylium vesicarium	4	1 R	2
Syncephalastrum racemosum	23	6 R	6, 10, 14
Teteracoccosporium paxianum	1	1 R	11
Trichoderma	12	4 R	2, 21
T. hamatum	3	3 R	2, 21
T. koningii	9	3 R	2, 21
Trimmutostroma	10	6 R	2, 6, 7, 20, 21
T. betulinum	8	5 R	2, 7, 20, 21
T. salicis	2	1 R	6
Ulocladium	33	24 L	1, 2, 5, 6, 7, 8, 11, 12, 16, 21
U. alternaria	17	13 L	1, 5, 6, 7, 8, 11, 12, 16, 21
U. atrum	6	6 R	2, 6, 7, 8, 11, 21
U. chlamydosporum	10	8 R	1, 2, 6, 8, 11, 12, 16, 21
Sterile mycelia	64	15 L	3, 4, 5, 7, 8, 12, 14,15, 17,20
Yeast	134	26 M	1, 2, 4, 6, 7, 14, 15, 17, 19, 20, 21
Total count	2720		
Number of genera	25		
Number of species	91 + 2 var		

Occurrence remarks (OR) H = High occurrence > 51 samples; M = Moderate occurrence, 25 – 50 samples; L = Low occurrence, 12 – 24 samples; R = rare occurrence < 11 samples.

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الحالة الفطرية وسموم الافلاتوكسينات لبعض البهارات والأعشاب شائعة الاستخدام في محافظة تعز، الجمهورية اليمنية

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أجريت الدراسة على ١٠٥ عينة تنتمي إلى ٢١ نوع من البهارات والأعشاب شائعة الاستخدام في محافظة تعز، الجمهورية اليمنية. كانت أكثر البهارات تلوثاً هي النخوة (الكمون الملوكي), الحبة السوداء (حبة البركة), الكزبرة, الكمون, الحلبة, الزنجبيل, الغار والزعتر. في حين كانت بهارات الخردل الأسود, الكراوية, الهيل, الشمر, الحلف (حب الرشاد), جوز الطيب والفلفل الأحمر متوسطة التلوث بالأعفان والخمائر. على الجانب الأخر كان كل من اليانسون, الفلفل الأسود, القرفة, الكتان والقرطم أقل تلوثا بالأعفان والخمائر. بينما كانت عينات القرنفل خالية تماماً من الأعفان والخمائر. دراسة الفلورا الفطرية المتواجدة في البهارات المختلفة أظهرت أن معظمها عالية التلوث باللأعفان والخمائر, حيث وجد أن ما نسبته 91,42 % من العينات المختبرة ملوثة بالفطريات. تم عزل إحدى وتسعون نوعاً بالإضافة إلى صنفين ينتمون إلى 25 جنساً من الفطريات. كانت أجناس الأسبرجلس, الريزوبس والبنيسليوم هي الأكثر شيوعاً حيث مثلت العدد الأكبر من الفطريات المعزولة. كان جنس الأسبرجلس هو الأكثر سيادة وكانت نسبة تواجده في العينات 90,5 % بنسبة 65,1 % من العدد الكلي للفطريات المعزولة. من بين الفطريات المعزولة في هذه الدراسة كان هنالك 14 نوعاً تم عزلها وتعريفها لأول مرة في اليمن. وقد أظهرت النتائج وجود سم الافلاتوكيسن B_1 في سبعة أنواع من البهارات المدروسة في حين خلت البقية من أي كميات محسوسة من سموم الافلاتوكسينات.