# Mycobiota associated with weaning dried foods consumed in Taïz City, Republic of Yemen

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**Abstract:** A total of thirty-eight fungal species and one variety belonging to 16 genera were recovered from local traditional weaning dried food (12 samples: 27 spp., 11 genera, and cereal-legumes ingredients (40 samples: 34 spp., 15 genera). The total number of CFU of fungi, including yeasts, clearly showed that the local weaning food was seriously contaminated with fungi (45263, calculated per gm in each of the 12 samples comparable to 3068 per gm in each of the cereal legumes). On the other hand, the 12 samples of imported commercial weaning food collected from the pharmacies were fungus-free, which means that the manufacture processes of production eliminate all fungi from their ingredients. *Aspergillus*, *Fusarium* and *Penicillium* were regularly the most common genera, and possessed the broadest spectrum of species during the study, of which the most dominant species were *Aspergillus flavus, A. niger*, *Fusarium oxysporum* and *Penicillium chrysogenum* and *P. corylophilum.*

**Key words:** Fungi, weaning foods, cereals, legumes, mycobiota.

## Introduction

The word weaning means the process of gradually replacing mother's milk or milk substitute with usual family diet (WHO 1989 & 2000, IFIS 2009). Weaning foods include imported commercial and traditional weaning foods products. Commercial weaning foods are easy to prepare, hygienic provided it is packaged, but expensive and not available everywhere locally. On the contrary the traditional weaning foods are cheaper, always available locally (Castel and Wijngaart 2005). Weaning foods made from ingredients do not differ from those for adult foods so that the same types and levels of microorganisms would occur on these ingredients naturally (ACMSF 2006). Traditional weaning foods in Yemen are cereals-legumes blending, composed of staple cereals, mostly: wheat, maize, barley, red and white sorghum, millet and rice blending in equal quantities, besides adequate amount of one of these legumes: black or red lentil or both and sometimes fewer quantities of beans. Since the major components of weaning foods are cereals and legumes, moulds that contaminate cereal and legume grains are divided into two groups, field fungi and storage fungi. Field fungi invade grains in the field that includes species of *Alternaria*, *Cladosporium*, *Fusarium*, *Helminthosporium*, *Curvularia*, *Epicoccum*, *Nigrospora*, and *Stemphylium*. Storage fungi invade grain in storage that includes species of *Aspergillus*, *Penicillium*, *Absidia*, *Chaetomium*, *Mucor*, *Paecilomyces*, *Rhizopus*, and *Scopulariopsis* (Meronuck 1987). Soil, water, air, dust, insects, rodents, birds, animals, humans, storage and shipping containers, and handling and processing equipment are the most important sources of the contaminated cereal grains (Bullerman and Bianchini 2009).

Sayed (2004) tested 30 random samples of locally-manufactured dried baby foods with milk base in Assiut City, Egypt; the average count for yeast and mould was 5 CFU/g. Amusa *et al*. (2005) isolated *Aspergillus niger, A. flavus, A. tamarii, Penicillium oxalicum, Macrophomina phaseolina, Fusarium oxysporum* and *Rhizopus* sp. from dried ogi (fermented weaning food in Africa) and soy-ogi. Olorunfemi *et al*. (2006) reported isolation of *Aspergillus flavus, A. niger, Mucor mucedo, Rhizopus stolonifer* and *Saccharomyces* sp. from different dried milled mixtures of weaning foods with maize or sorghum base. Ismail *et al*. (2008) isolated 42 species belonging to 21 genera in addition to some unidentified fungi from baby food products imported into Uganda. The most predominant fungi were *Cladosporium sphaerospermum, Fusarium tricinctum* and *Penicillium oxalicum.* Aydin *et al*. (2009) tested 142 wheat flour samples and found that the mean of mould counts were $7.4 \times 10$ - $1.8 \times 10^4$ CFU/g. Ajima *et al*. (2011) isolated 10 species of fungi belonging to 8 genera from ogi and observed that *A. niger, Penicillium* sp. and *Saccharomyces* sp. were the predominant fungal isolates. Oluwafemi and Ibeh (2011) investigated the fungal population in the locally-made weaning foods (one sample) and commercial weaning foods (seven samples). They noted that the locally-made weaning food had greatly higher fungal count (6500 CFU/g) than the commercial one where the fungal count ranged from 10-50 CFU/g. They isolated *A. niger, A. flavus* and *A. glaucus* from the locally-weaning food; also *Cladosporium* sp., and *Penicillium* sp. from commercial weaning foods. They also pointed out that the low counts in commercial weaning foods are probably due to good food-handling and good manufacture practices. Abanno *et al*. (2012) recorded that the total fungal counts for pap "ogi" and breadfruit flour "seeds of a tree *Treculia africana*" were $1.3 \times 10^1$ CFU/ml and $1.0 \times 10^1$ CFU/ml respectively. *Rhizopus* spp. were recovered from the dried ogi and breadfruit flour in addition to *Candida* that was isolated from the breadfruit flour only. Adebayo-Tayo *et al*. (2012) found that the total counts of fungi ranged from 1.0 - $4.0 \times 10^3$ CFU/g in cereal-based baby foods sold in Nigeria. *A. niger, A. fumigatus, A. terreus, A. flavus, A. glaucus, Rhizopus stolonifer, Penicillium* sp. *F. semithectum, F. proliferatum* and *F. sacchari* were isolated from these samples. Mbakwem-Anitbo and Udemgba (2012) isolated species of *Aspergillus*, *Rhizopus*, *Fusarium* and *Saccharomyces* from ogi. The total fungal counts were $3.5\times10^6$ to $1.35\times10^7$CFU/g. They also observed there was a great decrease in the fungal counts of salt-treated ogi comparable with untreated one. Ismail *et al*. (2012) mentioned that *Aspergillus*, *Penicillium*, *Fusarium* and *Cladosporium* were the most predominant genera in 50 samples of five baby food products mainly made of cereal flour produced in Uganda. Nwogwugwu *et al*. (2012) found that the highest fungal load in wet "Dupap" (novel weaning food composed from pap and African yam bean "Odudu") was $3.2 \times 10^5$ CFU/ml, where they isolated *Aspergillus, Rhizopus, Penicillium* and *Candida.*

The present work was designed to evaluate the mycological status of weaning dried food samples (commercial and traditional) consumed in Taïz city, Yemen.

## Materials and Methods

A total of 64 random weaning dried food samples (commercial and traditional) were collected from local markets and pharmacies in Taïz city, including 12 commercial weaning food samples, 12 traditional weaning food samples and 40 cereal and legume samples (wheat, barley, corn, rice, millet, red sorghum, white sorghum, black lentil, red lentil and bean) as a total of 4 samples from each kind of cereal and legume. Each sample was put in a sterile polyethylene bag and transferred to the laboratory, where they were prepared for the mycological examination.

**Estimation of fungi**

The mycobiota of samples was determined using the flour dilution-plate method **(**Pitt and Hocking 2009). Rose-Bengal chloramphenicol agar medium (Oxoid 549) according to Harrigan and McCance (1976) was used. The plates were incubated at 28°C for 7-10 days and the developing fungi were counted and identified (based on macro-and microscopic characteristics) according to the following references: Raper and Thom (1949), Raper and Fennell (1965), Booth (1971), Ellis (1971&1976), Pitt (1979), Domsch *et al*. (2007), Ramirez (1982), Sivanesan (1984), Pitt and Hocking (2009), Koz akiewicz (1989), Moubasher (1993), Firsvad and Filtingborg (1995) and Samson *et al*. (1995).

## Results and Discussion

**1. Fungi recovered from weaning food samples**

A total of 38 species and one variety belonging to 16 genera in addition to some other unidentified species were isolated from 24 commercial and traditional weaning food samples and 40 cereal and legume samples (Table 1). It was noticed that the 12 samples of the imported commercial weaning foods were completely free from any fungi (moulds or yeasts), which means that the manufacture processes eliminate all fungi. However, Ismail *et al*. (2008) identified 42 species of 21 genera in addition to some unidentified fungi from baby food products imported into Uganda on dichloran rose bengal chloramphenicol agar (DRBC). Also, Ismail *et al*. (2012) isolated 16 genera and 48 species on Dichloran 18% glycerol agar (DG18) and 36 genera and 65 species DRBC from baby food products mainly made of cereal flour. Oluwafemi and Ibeh (2011) noticed that the total fungal counts ranged from 10 – 50 CFU/g in the commercial weaning foods samples in Nigeria, greatly lower than in the locally-made weaning food (6500 CFU/g). Sayed (2004) found that the manufactured dried baby foods with milk base in Assiut City, Egypt was 5 CFU/g.

There was high incidence of diverse fungal genera and species in the traditional mix weaning foods (TWF). The total count of fungi in TWF samples was 229105 CFU/g in all samples. Twenty-seven species belonging to 11 genera were recorded from 12 TWF samples on rose-bengal chloramphenicol agar at 28°C (Table 1).

The count of fungal propagules in weaning food samples was broadly varied ranging between 1-4 $x10^3$CFU/g in the flours of cereal base in Nigeria (Adebayo-Tayo *et al.* 2012), 3.5 $x10^6$- 1.35 x $10^7$ CFU/g in the ogi (Mbakwem-Anitbo and Udemgba

2012), $3.2x10^5$ CFU/ml in Dupap (Nwogwugwu *et al*. 2012) and $1\text{-}1.3x10^1$ CFU/ml in pap "ogi" and breadfruit flour (Abanno *et al*. 2012).

*Aspergillus*, *Fusarium* and *Penicillium* were the most common fungi (isolated in high frequency of occurrence). *Aspergillus* was the most predominant genus; it was encountered in 75 % of the samples comprising 6.77 % of total filamentous fungi. Our results agreed with those of Ajima *et al*. (2011), who reported that *Aspergillus* (*A. niger*) was the most common (in addition to other fungi) from ogi. Also, Ismail *et al*. (2012) reported that *Aspergillus* was the most frequent genus recovered from locally-made baby food products in Uganda.

*Aspergillus* was represented by 9 species of which *A.niger* and *A. flavus* were the most common occurring in 25% of the samples contributing 47.3 % and 1.3% of total *Aspergillus* and 3.2% and 0.09% of total counts of fungi respectively. *A. fumigatus* and *A. niveus* were isolated in low frequency, emerging in 16.7 % of the samples constituting 23.65% and 2.8% of total *Aspergillus* and 1.6% and 0.19% of total fungi respectively. The remaining *Aspergillus* species were isolated from one sample only. *A. niger* and *A. flavus* were recorded from weaning dried foods in some countries by several workers (Amusa *et al*. 2005, Olorunfemi *et al*. 2006 and Oluwafemi and Ibeh 2011, Ajima *et al*. 2011 and Adebayo-Tayo *et al*. 2012).

Ismail *et al*. (2012) isolated *A. flavus* in high frequency, *A. niger* and *A. ochraceus* in moderate frequencies, *A. fumigatus*, *A. oryzae*, *A. tamarii* and *A. versicolor* in low frequencies and *A. parasiticus*, *A. sydowii* and *A. terreus* in rare frequencies from cereal baby foods locally produced in Uganda.

*Fusarium* and *Penicillium* occupied the second place in the number of cases of isolation in high frequency. *Fusarium* occurred in 66.7% of the samples comprising 3.54% of total fungi. Almost similar results were obtained from locally-prepared cereal-based infant weaning food in Jos, Nigeria (Ikah *et al.* 2001) and from the ogi (Mbakwem-Anitbo and Udemgba 2012). From *Fusarium*, six species were identified of which *F. oxysporum* was recovered in low frequency, occurring in 19% of samples constituting 28.4% of total *Fusarium*. This species was previously recovered from dried ogi and soy-ogi (Amusa *et al*. 2005) and from baby food products imported or produced in Uganda (Ismail *et al*. 2012). *F. avenaceum*, *F. culmorum*, *F. solani*, *F. sporotrichiodes* and *F. verticillioides* were rarely recovered comprising 0.06%, 0.01%, 0.01%, 1.63% and 0.82% of total fungi respectively. Most of these species were previously recovered from baby food products in Uganda (Ismail *et al*. 2008, 2012).

*Penicillium* occurred in 66.7% of samples contributing 2.45 % of total fungi. Several studies reported the isolation of *Penicillium* spp. from baby food samples (Ajima *et al*. 2011, Oluwafemi and Ibeh 2011, Adebayo-Tayo *et al*. 2012 and Nwogwugwu *et al*. 2012). In the present investigation, it was represented by six species of which *P. chrysogenum* and *P. corylophilum* were the most common (16.7% of samples) comprising 4.8% and 6.55% of total *Penicillium* respectively. *P. citrinum*, *P. funiculosum*, *P. glabrum* and *P. nalgiovense* were rarely isolated. Our results agreed with those of Ismail *et al*. (2008) who reported six species of which *P. citrinum* and *P. corylophilum* were recorded from the imported baby foods into Uganda. Also, Ismail *et al*. (2012) identified *P. chrysogenum*, *P. corylophilum* and *P. citrinum* in the studied samples from cereal baby food samples produced in Uganda.

*Cladosporium* (represented by *C. cladosporioides* was isolated in moderate frequency from 33.3% of samples comprising 29.12% of total fungi. *Phoma sorghina* came behind C. *cladosporioides* in 25% of samples (low frequency) contributing 17.5% of total count of fungi. Our results are in harmony with the findings of Ismail *et al*. (2008, 2012), who recorded *Cladosporium cladosporioides* from baby food products imported into Uganda and *C. cladosporioides* and *Phoma* sp. from baby food produced in Uganda. *Cladosporium* sp. was recovered from ogi (Ajima *et al*. 2011) and from commercial weaning foods (Oluwafemi and Ibeh 2011).

*Mucor* spp. were isolated in low frequency of occurrence in 16.7% of samples comprising 0.04% of total fungi. *Curvularia pallescens*, *Epicoccum nigrum*, *Rhizopus stolonifer* and *Ulocladium botrytis* were isolated from one sample (8.3 % of samples) matching collectively 0.01% of total fungi except *Epicoccum nigrum* from 0.15% of total fungi. Some studies recorded the isolation of *Rhizopus* spp. such as those of Ikah *et al.* (2001), Amusa *et al*. (2005), Abanno *et al*. (2012), Mbakwem-Anitbo and Udemgba (2012) and Nwogwugwu *et al*. (2012), while others reported the isolation of *Rhizopus stolonifer* such as those recorded by Olorunfemi *et al*. (2006), Adebayo-Tayo *et al*. (2012) and Ismail *et al*. (2008, 2012). Ajima *et al*. (2011) noticed that *Alternaria* sp., *Curvularia* sp. and *Mucor* sp. were found in ogi. Ismail *et al*. (2008) isolated *Curvularia* (*C. ovoidea* and *C. trifolii*), *Geotrichum candidum*, and *Mucor plumbeus* from food products imported into Uganda. *Mucor* (*M. plumbeus* and *M. racemosus*), *Curvularia* sp,, *Geotrichum candidum* and *Epicoccum nigrum* were also recovered from baby food products produced in Uganda (Ismail *et al.* 2012).

**2. Fungi recovered from cereal and legume samples**

The data in Table (2) show that all samples examined were heavily contaminated with fungi and the highest count (30500 CFU/g) was recorded in red sorghum samples followed by maize (5346 CFU/g), millet (2733 CFU/g), barley samples (293 CFU/g), red lentil (211 CFU/g) and the lowest count was recorded in rice (4 CFU/g).

According to the number of genera, barley was the most contaminated with genera (9 genera) and bean was the least contaminated (3 genera). However, regarding the number of fungal species, white sorghum samples were contaminated with the highest number (12 species) followed by maize, red sorghum and lentil samples (each 10 species) and the lowest number was in rice (4 species).

The gross total count of fungi in all cereal and legume samples was 157771 CFU/g representing 34 species and one variety belonging to 14 genera on rose bengal chloramphenicol agar at 28°C. *Aspergillus*, *Fusarium* and *Penicillium* were the most common (high or moderate frequency of occurrence). These results are in agreement with El-Kady *et al*. (1982) who noticed that the most common genus in some kinds of cereals in Egypt was *Aspergillus* followed by *Fusarium, Penicillium* and *Rhizopus*. Trung *et al.* (2001) found that the most frequent fungi in Vietnamese rice were *Aspergillus* (43.75 %), *Fusarium* (21.8%) and *Penicillium* (10.9 %). Ismail *et al*. (2003) observed that *Aspergillus, Fusarium*, *Penicillium, Khuskia*, *Chaetomium* and *Cladosporium* were the most frequent genera in maize grain in Uganda.

*Aspergillus* was also the most prevalent genus, occurring in 72.5% of the samples constituting 2.7% of total filamentous fungi. Similarly, *Aspergillus* was the main component of the mycobiota of barley (Abdel-Kader *et al*. 1979), millet (Mishra and Daradhiyar 1991), wheat (Berghofer *et al*. 2003) and maize (Ismail *et al*. 2003 and Trung *et al*. 2008). From this genus, 13 species and one variety were identified, of which *A. niger* was the most common, emerging from 35% of the samples comprising 11.74% of total *Aspergillus* and 0.30% of total fungi. The total counts of this species fluctuated between 1-51 CFU/g showing the highest count in millet samples and the lowest in rice samples. Samples of maize and black lentil were free from this species, but the rest of cereals were with different counts. Our results are in similar trend with other reports on barley (Abdel-Kader *et al*. 1979), cereals (El-Kady *et al*. 1982), sorghum (Hussaini *et al*. 2009). *A. niger* was also reported from pearl millet (Badau 2006), wheat flours (Tahani *et al.* 2008), sorghum (Islam *et al.* 2009) and rice (Gopalakrishnan *et al*. 2010).

*A. flavus* was isolated from 27.5% of the samples contributing 21.36% of total *Aspergillus* and 0.55% of total fungi. All kinds of studied cereals were contaminated with this species except wheat and bean samples. This species was previously isolated from different kinds of cereals but with different frequencies and counts such as those reported from barley (Abdel-Kader *et al*. 1979), cereals (El-Kady *et al*. 1982, Lee *et al*. 1986 and Jakić-Dimić *et al*. 2009), millet (Mishra and Daradhiyar 1991), rice (Osman *et al*. 1999, Trung *et al.* 2001 and Gopalakrishnan *et al*. 2010), wheat (Tahani *et al*. 2008), maize (Trung *et al*. 2008 and Makun *et al*. 2010) and sorghum (Hussaini *et al*. 2009 and Islam *et al*. 2009).

*A. ochraceus* was isolated in low frequency of occurrence from 20% of the samples contributing 51.27% of total *Aspergillus* and 1.3% of total fungi. It occurred in samples of maize, millet, red sorghum and bean with counts varied from 5 CFU/g in bean to 467 CFU/g in red sorghum. Mislivec *et al*. (1975) isolated *A. ochraceus* from dried beans, Trung *et al.* (2001) from Vietnamese rice and Trung *et al.* (2008) from maize.

*A. candidus* and *A. fumigatus* were also isolated in low frequency of occurrence from 10 and 12.5 % of samples contributing 2.8 and 3.5 % of total *Aspergillus* and 0.07 and 0.09 of total fungi respectively. Some reports recorded *A. fumigatus* from different kinds of samples, barley (Abdel-Kader *et al.* 1979), cereals (El-Kady *et al*. 1982), millet (Badau 2006), wheat (Tahani *et al.* 2008) and maize (Makun *et al*. 2010). Trung *et al*. (2008) examined twenty-five samples of maize and isolated *A. flavus, A. niger, A. wentii, A. glaucus, A. ochraceus*, *A. restrictus*, *A. ornatus and A. candidus*. The species recorded in the current investigation were infrequently recovered from grains in many parts of the world (Abdel-Kader *et al.* 1979, El-Kady *et al.* 1982, Badau 2006, Tahani *et al*. 2008, Makun *et al*. 2010 and Trung *et al*. 2008). The remaining *Aspergillus* species were isolated from one sample only and these were *A. oryzae A. parasiticus*, *A. sydowii*, *A. terreus*, *A. ustus*, *A. versicolor* and *A. wentii*. They comprised collectively 1.04% of total *Aspergillus* and 0.03% of total fungi. Most of these species were recovered from some types of cereals as reported by many workers as follows: *A. parasiticus* from millet (Mishra and Daradhiyar 1991) and from rice (Osman *et al.* 1999), *A. sydowii* from barley (Kader *et al*. 1979), *A. wentii* from maize (Trung *et al*. 2008), and *A. versicolor* from bean (Mislivec *et al*. 1975) and from Korean cereals (Lee *et al*. 1986).

*Fusarium* was the second most common genus and was recovered in moderate frequency (50 % of the samples) comprising 18.7% of total fungi. The average total counts of *Fusarium* widely fluctuated between 1 - 5052 CFU/g. The highest count was recorded in maize and the lowest in beans. The dominance of *Fusarium* in maize was also reported from Egypt (El-Kady *et al*.

1982, Moubasher *et al.* 1982), Uganda (Ismail *et al.* 2003) and in rice from Vietnam (Trung *et al.* 2001). Samples of maize, red sorghum and millet were heavily contaminated by *Fusarium*, while bean and wheat were less contaminated. On the other side, samples of rice and black lentil were free from *Fusarium* species. Eight species of the genus were identified of which *F. oxysporum* was the most common, occurring in 30% of the samples constituting 29.1% of total *Fusarium* and 5.4% of total fungi. *F. solani* was isolated in low frequency (15% of the samples) constituting 12.8% of total *Fusarium* and 2.4% of total fungi. Abdel-Kader *et al.* (1979) isolated *F. oxysporum* and *F. solani* from barley. El-Kady *et al.* (1982), Lee *et al.* (1986) and Aran and Eke (1987) recorded *F. oxysporum* from different cereal samples in Egypt, Korea and Turkey respectively. Gopalakrishnan *et al.* (2010) isolated *F. solani* from rice in India. The rest of *Fusarium* species were isolated in rare frequency and these were *F. avenaceum*, *F. graminearum*, *F. culmorum*, *F. semitectum*, *F. sporotrichiodes*, contributing collectively 58.1% of total *Fusarium* and 10.85% of total fungi. Lee *et al.* (1986) identified *F. germinearum* from cereal samples. Abdel-Kader *et al.* (1979), Trung *et al.* (2008), Islam *et al.* (2009) and Gopalakrishnan *et al.* (2010) isolated *F. verticillioides* (*F. moniliforme*) from barley, maize, sorghum, and rice respectively.

*Penicillium* came behind *Fusarium* and was encountered in 32.5% of the samples comprising 0.96% of total fungi. The counts of this genus widely varied from 1-175 CFU/g and the highest count was recorded in maize, while the lowest was in bean and rice. Samples of maize and millet were the most contaminated and bean and rice were the less contaminated, whereas red sorghum and black lentil were free from this genus. Some reports recorded the isolation of *Penicillium* in the first and/or second order of frequencies of occurrence such as Abdel-Kader *et al.* (1979), Aran and Eke (1987), Mishra and Daradhiyar (1991), and Berghofer *et al.* (2003). Four species of *Penicillium* were identified and these were *P. citrinum*, *P. funiculosum*, *P. glabrum* and *P. corylophilum*. They occurred in 2.5-5% of the samples constituting 46.4%, 26.5 %, 2.19 % and 0.7% of total *Penicillium* and 0.44%, 0.25 %, 0.13% and 0.006% of total fungi respectively. *P. citrinum* was isolated from bean (Mislivec *et al.* 1975), barley (Abdel-Kader *et al.* 1979), and rice (Trung *et al.* 2001), whereas *P. corylophilum* was isolated from cereals (El-Kady *et al.*1982).

*Cladosporium cladosporioides* and *Mucor* spp. were recovered in low frequencies (each 22.5% of the samples contributing of 8.6% and 1.4% of total fungi respectively) in samples of barley, white and red sorghum, black and red lentil. Jakić-Dimić *et al.* (2009) identified *Mucor* spp. in samples of corn, wheat, bran, silage, barley, soybean, and sorghum in Serbia. The count of this genus fluctuated between 7- 442 CFU/g, showing the highest number in red sorghum and the lowest in black lentil (Table 2). Count of *C. cladosporioides* greatly varied from 1- 3333 CFU/g and the highest count was recorded in red sorghum and the lowest in millet and red lentil, while rice, black lentil and bean samples were completely uncontaminated with this fungus (Table 2). Several studies reported the isolation of *Cladosporium* spp. from cereals (Lee *et al*., 1986 and Aran and Eke 1987), wheat (Berghofer *et al*. 2003) and maize (Ismail *et al*. 2003).

*Rhizopus stolonifer* was isolated in low frequency from 12.5% of the samples (wheat, barley, red sorghum, and black lentil). Its count fluctuated between 1-10 CFU/g showing the highest in wheat and the lowest in barley and black lentil samples (Table 2). This fungus was isolated from different cereals, namely barley (Abdel-Kader *et al.* 1979), cereals (El-Kady *et al*. 1982 and Aran and Eke 1987), millet (Mishra and Daradhiyar 1991 and Badau 2006) and wheat (Tahani *et al*. 2008).

*Alternaria alternata*, *Curvularia pallescens* and *Emericella nidulans* were recovered in rare frequency (each 7.5% of samples) contributing 0.09%, 0.02% and 0.05% of total fungi respectively. *A. alternata* occurred in wheat and black lentil samples, *C. pallescens* in barley, millet, and rice. Whereas, *E. nidulans* was isolated from wheat, red and black lentil. *Drechslera* sp. was isolated from 5% of the samples of wheat and sorghum only comprising 0.004% of total fungi. It was isolated from wheat and white sorghum (Table 1). Abdel-Kader *et al.* (1979) isolated *Drechslera* and *Alternaria* from barley grain samples in Egypt. Lee *et al*. (1986) observed presence of *Alternaria* spp., *Drechslera* spp. and *Emericella nidulans* in cereal samples in Korea. *A. alternata* was also isolated by Zur *et al.* (2002) from cereal grains. *E. nidulans* was also recorded by Badau (2006) and Tahani *et al*. (2008) from millet and wheat respectively. *Curvularia* was isolated from millet (Mishra and Daradhiyar 1991) and rice (Gopalakrishnan *et al*. 2010). Also, Islam *et al*. (2009) identified *Curvularia lunata* in 17.4% of sorghum grains.

*Epicoccum nigrum*, *Geotrichum candidum*, *Moniliella suaveolens* and *Phoma sorghina* were isolated from one sample only (each 2.5% of the samples) contributing 0.002%, 0.002%, 0.06% and 0.002% of total fungi respectively. Lee *et al*. (1986) isolated *Epicoccum* sp. from Korean cereal. Tahani *et al*. (2008) isolated *Geotrichum* from wheat.

Table 1: Total counts (TC, CFU/g in all samples) and percentage frequencies (%F) of fungal genera and species recovered from 12 traditional weaning food and 40 cereals and legumes samples on Rose Bengal chloramphenicol (Oxoid CM 549) agar at 28°C.

| Genera and Species | Traditional weaning food | | Cereals and legumes | |
|---|---|---|---|---|
| | TC | %F | TC | %F |
| *Alternaria alternata* (Fries) Keissler | | | 140 | 7.5 |
| *Aspergillus* | 15498 | 75 | 4055 | 72.5 |
| *A. awamori* Nakazawa | 133 | 8.33 | 203 | 5 |
| *A. candidus* Link | 333 | 8.33 | 114 | 10 |
| *A. flavus* Link | 200 | 25 | 866 | 27.5 |
| *A. flavus* var. *columnaris* Raper & Fennell | | | 133 | 5 |
| *A. fumigatus* Fresenius | 3666 | 16.67 | 142 | 12.5 |
| *A. niger* van Tieghem | 7334 | 25 | 476 | 35 |
| *A. niveus* Blochwitz | 433 | 16.67 | | |
| *A. ochraceus* Wilhelm | 3333 | 8.33 | 2079 | 20 |
| *A. oryzae* (Ahlburg) Cohn | | | 20 | 2.5 |
| *A. parasiticus* Speare | | | 7 | 2.5 |
| *A. sydowii* (Bain. & Sart.) Thom & Church | | | 3 | 2.5 |
| *A. terreus* Thom | 33 | 8.33 | 3 | 2.5 |
| *A. ustus* (Bainier) Thom & Church | | | 3 | 2.5 |
| *A. versicolor* (Vuillemin) Tiraboschi | 33 | 8.33 | 3 | 2.5 |
| *A. wentii* Wehmer | | | 3 | 2.5 |
| *Cladosporium cladosporioides* (Fresenius) de Vries | 66710 | 41.67 | 13615 | 22.5 |
| *Curvularia pallescens* (Tsuda & Ueyama) Sivanesan | 33 | 8.33 | 39 | 7.5 |
| *Drechslera* sp. | | | 6 | 5 |
| *Emericella nidulans* (Eidam) Vuill. | | | 73 | 7.5 |
| *Epicoccum nigrum* Link | 333 | 8.33 | 3 | 2.5 |
| *Fusarium* | 8099 | 66.67 | 29469 | 50 |
| *F. avenaceum* (Corda: Fr.) Saccardo | 133 | 8.33 | 4034 | 5 |
| *F. culmorum* (Smith) Saccardo | 33 | 8.33 | 1567 | 2.5 |
| *F. graminearum* Schwabe | | | 6510 | 5 |
| *F. oxysporum* Schlechtendal | 2300 | 25 | 8562 | 30 |
| *F. semitectum* Berkeley & Ravenel | | | 733 | 2.5 |
| *F. solani* (Martius) Sacchardo | 33 | 8.33 | 3780 | 15 |
| *F. sporotrichiodes* Sherb. | 3733 | 8.33 | 4267 | 2.5 |
| *F. verticillioides* (Sacchardo) Nirenberg | 1867 | 8.33 | 13 | 2.5 |
| *Geotrichum candidum* Link | | | 3 | 2.5 |
| *Moniliella suaveolens* (Lind. & Lind.) V.Arx | | | 100 | 2.5 |
| *Mucor* spp. | 100 | 16.67 | 2222 | 22.5 |
| *Penicillium* | 5603 | 66.67 | 1509 | 32.5 |
| *P. chrysogenum* Thom | 266 | 16.67 | | |
| *P. citrinum* Thom | 133 | 8.33 | 700 | 5 |
| *P. corylophilum* Dierckx | 367 | 16.67 | 10 | 2.5 |
| *P. funiculosum* Thom | 67 | 8.33 | 400 | 5 |
| *P. glabrum* (Wehmer) Westling | 367 | 8.33 | 33 | 5 |
| *P. nalgiovense* Laxa | 67 | 8.33 | | 0 |
| *Penicillium* spp. | 4336 | 25 | 196 | 12.5 |
| *Phoma sorghina* (Sacchardo) Boerema *et al.* | 40073 | 25 | 3 | 2.5 |
| *Rhizopus stolonifer* (Ehrenberg) Vuillemin | 33 | 8.33 | 79 | 12.5 |
| Sterile mycelia | 39252 | 50 | 106455 | 32.5 |
| *Ulocladium botrytis* Preuss | 33 | 8.33 | | |
| Total count of fungi | 229105 | 100 | 157771 | 100 |
| Number of genera (16 genera) | 11 | | 15 | |
| Number of species (38 + 1 variety) | 27 | | 34+1 variety | |

Results of the 12 samples of imported weaning food are omitted because they were, all nil.
%F= Percentage frequency for traditional weaning food, H = High occurrence >50% of total samples, M = Moderate occurrence, >25 – 50%, L = Low occurrence, 16.67 – 25%, R = Rare occurrence < 16.67.

Table 2 : Total counts (TC, calculated CFU/g), and percent frequency (F %) of fungal genera and Species recovered from tested cereals, legumes and weaning foods samples on rose Bengal chloramphenicol agar at 28 $^{o}$C.

| | Wheat | | Maize | | Barley | | Millet | | White sorghum | | Red sorghum | | Rice | | Red lentil | | Black lentil | | Bean | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genera and species | TC | F% | TC | F% | TC | F% | TC | F% | TC | F% | TC | F% | TC | F% | TC | F% | TC | F% | TC | F% |
| *Alternaria alternata* | 2 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 33 | 50 | 0 | 0 |
| *Aspergillus* | 37 | 50 | 36 | 50 | 98 | 100 | 122 | 75 | 43 | 100 | 633 | 75 | 1 | 25 | 20 | 100 | 68 | 75 | 12 | 75 |
| *A. awamori* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 25 | 0 | 0 | 1 | 25 | 0 | 0 | 0 | 0 |
| *A. candidus* | 2 | 25 | 0 | 0 | 2 | 25 | 0 | 0 | 8 | 25 | 17 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *A. flavus* | 0 | 0 | 17 | 25 | 86 | 50 | 42 | 50 | 18 | 25 | 42 | 25 | 1 | 25 | 11 | 50 | 2 | 25 | 0 | 0 |
| *A. flavus* var. *columnaris* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *A. fumigatus* | 10 | 25 | 0 | 0 | 8 | 25 | 0 | 0 | 8 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 50 | 0 | 0 |
| *A. niger* | 25 | 25 | 0 | 0 | 3 | 25 | 51 | 50 | 2 | 25 | 25 | 25 | 1 | 25 | 8 | 50 | 0 | 0 | 6 | 50 |
| *A. niveus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *A. ochraceus* | 0 | 0 | 19 | 50 | 0 | 0 | 29 | 50 | 0 | 0 | 467 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 50 |
| *A. oryzea* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *A. parasticus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 25 | 0 | 0 |
| *A. sydwii* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 25 | 0 | 0 | 0 | 0 |
| *A. terreus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *A. ustus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 25 | 0 | 0 |
| *A. versicolor* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 25 |
| *A. wentii* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cladosporium cladosporioides* | 3 | 50 | 8 | 25 | 42 | 25 | 1 | 25 | 17 | 50 | 3333 | 25 | 0 | 0 | 1 | 25 | 0 | 0 | 0 | 0 |
| *Curvularia pallescens* | 0 | 0 | 0 | 0 | 1 | 25 | 8 | 25 | 0 | 0 | 0 | 0 | 1 | 25 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Drechslera* sp. | 1 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Emericella nidulans* | 17 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 25 | 1 | 25 | 0 | 0 |
| *Epicoccum nigrum* | 0 | 0 | 0 | 0 | 1 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Fusarium* | 11 | 50 | 5052 | 100 | 62 | 50 | 953 | 100 | 55 | 75 | 1150 | 50 | 0 | 0 | 84 | 50 | 0 | 0 | 1 | 25 |
| *F. avnaceum* | 0 | 0 | 42 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 967 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *F. culmorum* | 0 | 0 | 392 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *F. graminearum* | 3 | 25 | 1625 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *F. oxysporum* | 8 | 25 | 1558 | 50 | 62 | 50 | 444 | 75 | 52 | 50 | 0 | 0 | 0 | 0 | 17 | 25 | 0 | 0 | 1 | 25 |
| *F. semitectum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 183 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *F. solani* | 0 | 0 | 369 | 50 | 0 | 0 | 508 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 68 | 50 | 0 | 0 | 0 | 0 |
| *F. sporotrichiodes* | 0 | 0 | 1067 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *F. verticillioides* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Geotrichum candidum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Moniliella suaveolens* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 25 | 0 | 0 |
| *Mucor* spp. | 0 | 0 | 0 | 0 | 8 | 25 | 0 | 0 | 13 | 50 | 442 | 25 | 0 | 0 | 86 | 75 | 7 | 25 | 0 | 0 |

| | Wheat | | Maize | | Barley | | Millet | | White sorghum | | Red sorghum | | Rice | | Red lentil | | Black lentil | | Bean | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genera and species | TC | F% | TC | F% | TC | F% | TC | F% | TC | F% | TC | F% | TC | F% | TC | F% | TC | F% | TC | F% |
| *Penicillium* | 4 | 25 | 175 | 25 | 36 | 50 | 100 | 50 | 42 | 25 | 0 | 0 | 1 | 25 | 19 | 75 | 0 | 0 | 1 | 25 |
| *P. chrysogenum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *P. citrinum* | 0 | 0 | 175 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 25 |
| *P. corylophilum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 25 | 0 | 0 | 0 | 0 |
| *P. funiculosum* | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *P. glabrum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 | 25 | 0 | 0 | 0 | 0 | 8 | 25 | 0 | 0 | 0 | 0 |
| *P. nalgiovense* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Penicillium* spp. | 4 | 25 | 0 | 0 | 36 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 25 | 8 | 25 | 0 | 0 | 0 | 0 |
| *Phoma sorghina* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 25 | 0 | 0 |
| *Rhizopus stolonifer* | 10 | 50 | 0 | 0 | 1 | 25 | 0 | 0 | 0 | 0 | 8 | 25 | 0 | 0 | 0 | 0 | 1 | 25 | 0 | 0 |
| *Ulocladium botrytis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sterile mycelia | 0 | 0 | 75 | 25 | 45 | 75 | 1549 | 75 | 10 | 25 | 24933 | 75 | 1 | 25 | 0 | 0 | 8 | 25 | 0 | 0 |
| Total count of fungi | 83 | 100 | 5346 | 100 | 293 | 100 | 2733 | 100 | 181 | 100 | 30500 | 100 | 4 | 50 | 211 | 100 | 110 | 100 | 13 | 75 |
| Number of genera = 16 | 8 | | 5 | | 9 | | 6 | | 8 | | 6 | | 4 | | 6 | | 8 | | 3 | |
| Number of species =38+1 var. | 9 | | 10 | | 9 | | 8 | | 12 | | 9+1 | | 3 | | 10 | | 9 | | 5 | |

## References

Abanno NU, Ogbulie JN and Egbuhuzor N (2012): Microbiological, biochemical and sensory properties of "PABruit" (Weaning food: Fermented maize meal fortified with processed breadfruit). Journal of Research in Microbes 1: 51-56.

Abdel-Kader MIA, Moubasher AH and Abdel-Hafez SII (1979): Survey of the mycoflora of barley grains in Egypt. Mycopathologia 69: 143-147.

ACMSF (2006): AD HOC GROUP on infant botulisms, Rreport on minimally processed infant weaning foods and risk of infant botulism. Advisory committee on the microbiological safety of food. Food Standards Agency, London, UK.

Adebayo-Tayo BC, Oscar F and Igboekwe A (2012):Microbiological and mycotoxins evaluation of cereals - based baby food samples sold in Nigeria market. Academia Arena 4:18-26.

Ajima U, Ogbonna AI, Olotu PN and Asuke AU (2011): Evaluation of fungal species associated with dried ogi. Continental Journal of Food Science and Technology 5: 17- 25.

Amusa NA, Ashaye OA and Oladapo MO (2005): Microbiological quality of ogi and soy-ogi (a Nigerian fermented cereal porridge) widely consumed and notable weaning food in southern Nigeria. Journal of Food, Agriculture and Environment 3: 81- 83.

Aran N and Eke D (1987): Mould mycoflora of some Turkish cereals and cereal products. World Journal of Microbiology and Biotechnology 3: 281-287.

Aydin A, Paulsen P and Smulders FJM (2009): The physico-chemical and microbiological properties of wheat flour in Thrace. Turkish Journal of Agriculture and Forestry 33: 445-454.

Badau MH (2006): Microorganisms associated with pearl millet cultivars at various malting stages. International Journal of Food Safety 8: 66-72.

Berghofer LK, Hocking AD, Miskelly D and Jansson E (2003): Microbiology of wheat and flour milling in Australia. International Journal of Food Microbiology 15: 137-149.

Booth C (1971): The Genus *Fusarium*. Commonwealth Mycological Institute, Kew, Surrey, UK, 257 pp.

Bullerman LB and Bianchini A (2009): Food safety issues and the microbiology of cereals and cereal products. In Microbiologically Safe Food. Heredia, N.; Wesley, I. and Garćia, S. (Eds.). John Wiley and Sons, Inc., Publication. New Jersey, USA.

Castel S and Wijngaart A (2005): Small-scale production of weaning foods, 2$^{ed}$ ed. (de Zylva. N. Translator). Agromisa Foundation, Wageningen, The Netherlands.

Domsch KH, Gams W and Anderson TH (2007): Compendium of Soil Fungi. 2$^{nd}$ ed., IHC-Verlag, Eching, 672 pp.

El-Kady IA, Abdel-Hafez SII and El-Maraghy SS (1982): Contribution to the fungal flora of cereal grains in Egypt. Mycopathologia 77: 103-109.

Ellis MB (1971): Dematiaceus Hyphomycetes. Commonwealth Mycological institute, Kew, Surrey, England, 608 pp.

Ellis MB (1976): More Dematiaceus Hyphomycetes, Commonwealth Mycological institute, Kew, Surrey, England, 507 pp.

Firsvad JC and Filtingborg O (1995): Introduction to food-borne fungi. (ed. by Robert A, Samson E and Ellen S Hoekstra), The Netherlands, 322 pp.

Gopalakrishnan C, Kamalakannan A and Valluvaparidasan V (2010): Survey of seed-borne fungi associated with rice seeds in Tamil Nadu, India. Libyan Agriculture Research Center Journal International 1(5): 307-309.

Harrigan WF and McCance ME (1976): Laboratory methods in food and dairy microbiology. Academic Press, USA.

Hussaini AM, Timothy GA, Olufunmilayo HA, Ezekiel AS and Godwin HO (2009): Fungi and some mycotoxins found in mouldy sorghum in Niger State, Nigeria. World Journal of Agricultural Sciences 5: 5-17.

IFIS (2009): Dictionary of food science and technology, International Food Information Service (IFIS), John Wiley and Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, United Kingdom.

Islam SMM, Masum MMI and Fakir MGSA (2009): Prevalence of seed-borne fungi in sorghum of different locations of Bangladesh. Scientific Research and Essay 4: 175-179.

Ismail MA, Taligoola HK and Ssebukyu EK (2003): Mycobiota associated with maize grains in Uganda with special reference to aflatoxigenic aspergilli. Journal of Tropical Microbiology 2: 17-26.

Ismail MA, Taligoola HK and Nakamya R (2008): Mycobiota associated with baby food products imported into Uganda with special reference to aflatoxigenic aspergilli and aflatoxins. Czech Mycology 60: 75–89.

Ismail MA, Taligoola HK and Nakamya R (2012): Xerophiles and other fungi associated with cereal baby foods locally produced in Uganda. Acta Mycologica 47: 75-89.

Jakić-Dimić D, Nešić K and Petrović M (2009): Contamination of cereals with aflatoxins, metabolites of fungus *Aspergillus flavus*. Biotechnology in Animal Husbandry 25: 1203-1208.

Johnson LF and Curl EA (1972): Methods for research on ecology of soil borne pathogens. Minneapolis. Burgess Public Company.

Kozakiewicz Z (1989): *Aspergillus* species on stored products (Mycological Papers, No.161). C.A.B. International Mycological Institute, Kew, U K.

Lee US, Jang HS, Tanaka T, Toyasaki N, Sugiura Y, Oh YJ, Cho C M. and UenoY (1986): Mycological survey of Korean cereals and production of mycotoxins by *Fusarium* isolates. Applied and Enviromental Microbiology 52: 1258-1260.

Makun HA, Anjorin ST, Moronfoye B, Adejo FO, Afolabi OA, Fagbayibo G, Balogun BO and Surajudeen AA (2010): Fungal and aflatoxin contamination of some human food commodities in Nigeria. African Journal of Food Science 4: 127-135.

Mbakwem-Anitbo C and Udemgba G (2012): Microbiological quality of untreated and salt-treated Ogi (akamu) kept at room temperature. Nature and Science 10: 26-29.

Meronuck RA (1987): The significance of fungi in cereal grains. University of Minnesota. Plant Disease 71: 187-219.

Mishra NK and Daradhiyar SK (1991): Mold flora and aflatoxin contamination of stored and cooked samples of pearl millet in the Paharia Tribal Belt of Santhal Pargana, Bihar, India. Applied and Environmental Microbiology 57: 1223-1226

Mislivec PB, Dieter CT and Bruce VR (1975): Mycotoxin-producing potential of mold flora of dried beans. Applied and Environmental Microbiology 29: 522-526.

Moubasher AH, El-Kady IA and EL-Maraghy SSM (1982): Toxigenic *Fusarium* isolated from cereal grains in Egypt. Proceedings of the International Symposium on mycotoxins, Cairo, Egypt, 6-9 September 1981, pp. 337-343.

Moubasher AH (1993): Soil Fungi in Qatar and Other Arab Countries. Pulblished by Center for Scientific and Applied Research, University of Qatar, Doha, Qatar, 566 pp.

Nwogwugwu NU, Ogbulie JN, Chinakwe EC, Nwachukwu IN and Onyemekara NN (2012): The microbiology and proximate assay of a novel weaning food-'DUPAP'. Journal of Microbiology and Biotechnology Research 2: 298-304.

Olorunfemi FA, Akinyosoye FA and Adetuyi FC (2006): Microbial and nutritional evaluation of infant weaning food from mixture of fermented food substrates. Research Journal of Biological Sciences 1: 20-23.

Oluwafemi F and Ibeh IN (2011): Microbial contamination of seven major weaning foods in Nigeria. Journal of Health, Population and Nutrition 29: 415-419.

Osman NA, Abdelgadir AM, Moss MO and Bener A (1999): Aflatoxin contamination of rice in the United Arab Emirates. Mycotoxin Research 15: 39-44.

Pitt JI (1979): The genus *Penicillium* and its teleomorphic states *Eupenicillium* and *Talaromyces*. Academic Press, London, 634 pp.

Pitt, JI and Hocking AD (2009): Fungi and food spoilage. 3rd ed., Springer, Science and Business Media, 519 pp.

Ramirez C (1982): Manual and atlas of penicillia. Elsevier Biomedical Press, Amsterdam, the Netherlands, 874 pp.

Raper KB and Fennell DI (1965): The genus *Aspergillus*. The Williams & Wilkins, Baltimore, USA, 686 pp.

Raper KB and Thom C (1949): A manual of *Penicillium*. Williams & Wilkins, Baltimore, USA, 875 pp.

Samson RA, Hoekstra ES, Frisvad JC and Filtenborg O (1995): Introduction to food-borne fungi. 4th ed., Centraalbureau voor Schimmelcultures, Wageningen, Netherlands.

Sayed M (2004): Microbiological quality of baby foods. Assiut Veterinary Medical Journal 50:72-79.

Sivanesan A (1984): The bitunicate Ascomycetes and their anamorphs. Strauss and Cramer Gmbh, Hirschberg ISBN, Germany, 701 pp.

Tahani N, Serghini-Caid H and Elamrani MOA (2008): Mycologie du blé tendre : qualité technologique du grain et conséquences sur les produits finis (Abstract in English). Reviews in Biology and Biotechnology 7: 27-32.

Trung TS, Tabuc C, Bailly S, Querin A, Guerre P and Bailly JD (2008): Fungal mycoflora and contamination of maize from Vietnam with aflatoxin $B_1$ and fumonisin $B_1$. World Mycotoxin Journal 1: 87-94.

Trung TSY, Bailly JD, Querin A, Bars LE and Guerre P (2001): Fungal contamination of rice from South Vietnam, mycotoxinogenesis of selected strains and residues in rice. Revue Veterinary Medical 152: 555-560.

WHO (1989): Infant feeding: The physiological basis. Bulletin of the World Health Organization 67: 1-107.

WHO (2000): Complementary feeding: Family foods for breast feeding children. World Health Organization, Geneva, Switzerland.

Zur G, Shimoni E, Hallerman, E and Kashi Y (2002): Detection of *Alternaria* fungal contamination in cereal grains by a Polymerase Chain Reaction-Based Assay. Journal of Food Protection 65: 1433-1440.