Isolation and Identification of Fungi Contaminating Potato Chips Intended for Children’s Consumption and Assessing their Toxins

Hadeel A. AL-Ameri* and Nadeem A. Ramadan
Department of Biology, Faculty of Sciences, Mosul University-Iraq

Received: 3 November 2020/ Accepted: 30 December 2020
© Al-Mukhtar Journal of Sciences 2020
Doi: https://doi.org/10.54172/mjsc.v35i4.332

Abstract: The study aims to investigate the presence of fungi and their toxins in different samples of potato chips imported from different origins. Fifteen chips’ samples were collected from the local markets of Mosul city/Iraq which included various global origins with several flavors of pepper, paprika, hot spices, and cheese. It appears that all potato chips’ samples were contaminated with fungi and mycotoxins. It was evident that Penicillium spp. were the most predominant fungi followed by Aspergillus spp. and Rhodotorella spp. came third, while Geotrichum spp and yeasts came in fourth. Potato chips from the brand Pringles was contaminated with Penicillium spp., and Geotrichum spp. at a percentage of 50, 30% respectively. The Hum Hum brand samples were contaminated with A.terrus and Penicillium spp. at 40, 30% respectively. Dream brand samples were contaminated with A.jamanicum., and Penicillium., at percentages of 30, 60% respectively. Lays1 with tomato ketchup samples were contaminated with four genera: Penicillium spp., Mucor spp., Rhodotorellasp., and yeast with percentages of 40, 20, 10, and 10% respectively. Lays2 with French cheese variety was contaminated with the same fungi of lays2 type but with the addition of Aspergilli (A. versicolor and A. niger), which were 60 and 30% respectively. The Patos brand potato chips were contaminated with two Aspergilli (A.astus and A.jamanicum), at 30 and 40% respectively. Zearalenone was found to be the highest contaminant (13.81ppm) of mycotoxins followed by aflatoxins (0.26ppm). Ochratoxin was the least contaminant (0.16ppm) in the analyzed potato chips. It can be concluded that all tested potato chips’ samples showed the presence of fungi and mycotoxins. However, all mycotoxins (aflatoxin, ochratoxin, and zearalenone) in the food commodities were within the permissible limits intended for human consumption.

Keywords: Contaminated Chips, Mycotoxins, Aflatoxins, Zearalenone, Ochratoxin.

INTRODUCTION

Food contamination is a major problem, and contaminants vary with different food commodities. Fungi are regarded as one of the most persistent food contaminants, having the ability to produce toxins known as mycotoxin under favorable conditions. These toxins may lead to serious diseases called mycotoxicosis (Manjula et al., 2016). More than 300 fungal toxins have been discovered that are produced by different fungal species (Tairo et al., 2008). The most significant fungi agriculturally are Aspergillus, Penicillium, and Fusarium, which can produce toxins such as aflatoxin, ochratoxin, zearalenone, and trichothecces (Martins et al., 2001; Milani et al., 2013). The preservation of processed foods from fungal contamination may be achieved by the incorporation of food additives (Jonathan et al., 2012).

Food additives, such as antifungal agents, are chemicals that are usually added to processed foods in order to preserve them from undesirable changes in their color, flavor, or nutritional values as a result of fungal growth (Manjula et al., 2016).

*Corresponding Author: Hadeel A. Al.-Ameri hadeelahmed.mu@gmail.com Department of Biology, Faculty of Sciences, Mosul University-Iraq.
Antifungal agents are usually prepared from natural sources, plants, or produced chemically (Mmasa et al., 2012). Preferably, they are prepared from natural sources including, spices and flavor materials.

Aflatoxins are secondary metabolites produced by strains of *Aspergillus flavus*, *A. parasiticus*, and *A. nomius*. These metabolites are furcoumarins, including AFB1, AFB2, AFG1, and AFG2 (Amri & Lenoi, 2016). Aflatoxins are fully soluble in solvents such as methanol and chloroform. The presence of a lactone ring in aflatoxin molecules makes them more susceptible to hydrolysis by alkaline solutions (Azizi et al., 2012; Bankole & Adebanjo, 2003).

In humans and animals, aflatoxins affect different cell wall tissues, inhibit RNA function in DNA synthesis, and act as immunosuppressive agents. Aflatoxins are a serious fungal toxin responsible for the contamination of food commodities and the emergence of liver cancer in humans which poses a significant threat to human health (Croft et al., 1986; Wyllie & Morehouse, 1978).

The World Health Organization (1979) has identified the permissible limits of aflatoxin in adult foods to be not more than 20 ppb and 0.5 ppb in milk, whereas it should be 20 ppb in feeds. However for baby food, there are no limits allowed Smith and Moss, 1985 U.S. Ochratoxins are a group of mycotoxins produced by several species of *Aspergillus*, especially *A. ochraceous* and some species of *Penicillium* (Gnonlonfin et al., 2012).

They are colorless, crystalline in texture, with blue fluorescence usually emitted from them when exposed to ultraviolet rays. These toxins dissolve in acidic solutions, with moderate solubility in methanol and chloroform. OTAs have the ability to bind to serum albumin. OTAs could cause intestinal ulcers, affect the liver and reduce its efficiency, and affect kidneys, and cause intestinal disorders. Zaralennon is another mycotoxin and is one of the phenolic compounds with estrogenic characteristics (Savino et al., 2007). It is a crystalline compound, white in color, and glows with blue-green fluorescence usually emitted from this toxin when exposed to wide UV long-waves. Its discovery was in 1916 when symptoms of vomiting and poisoning were described in humans due to the consumption of bread made of wheat infected by *Fusarium*, (especially *F. graminearum*) (Bullerman & Bianchini, 2007).

This study aimed to identify, isolate, and investigate the presence of fungi in different samples of potato chips imported from different origins, then estimate some mycotoxins in these products.

**MATERIALS AND METHODS**

**Sample collection**: Fifteen samples of potato chips were collected from the local markets of Mosul city, which included various global origins with different flavors (pepper, paprika, hot spices, and cheese: Table 1).

**Isolation of fungi**: One gram from every of potato chips’ sample was grounded and transferred to glass bottles containing 9 ml of sterilized distilled water, mixed with a stirrer, and left to settle down. Subsequently, 1 ml of the mixture was streaked on three plates of PDA for each Sample. Plates were incubated at 28°C for one to two weeks. Plates were then examined for the developing fungal colonies and diagnosed according to the approved diagnostic keys (de Hoog & Guarro, 1995; Pitt & Hocking, 2007)

**Diagnosis of Aspergillus species**: Diagnosis was based on the growth on different media and under different temperatures according to (Pitt & Hocking, 2007) by using three types of media for diagnosis, Czapek Yeast-extract Agar (CYA), Malt Extract Agar (MEA), and Glycerol (25%) Nitrate agar (G25N)
Table (1) Types of Potato Chips, Country of origin and flavor additive.

| Sample No. | Flavor additive        | Manufacturing Country | Product name          |
|------------|------------------------|-----------------------|-----------------------|
| 1          | Hot&Spicy              | Belgium               | Pringles              |
| 2          | HotPepper              | Syria                 | HumHum                |
| 3          | Ketchup                | Iran                  | MazMaz                |
| 4          | HotFlavor              | Turkey                | Patos                 |
| 5          | HotPepper              | Saudi Arabia          | Dream                 |
| 6          | HotFlavor              | Turkey                | Cipso                 |
| 7          | Paprika                | Jordan                | SnackMix              |
| 8          | HotPepper              | Turkey                | Doritos               |
| 9          | Cheese And Onion       | Kuwait                | Fico Fresh            |
| 10         | Tomato ketchup         | Saudi Arabia          | Lays1                 |
| 11         | French Cheese          | Saudi Arabia          | Lays2                 |
| 12         | Cheese                 | Turkey                | Patos                 |
| 13         | Ketchup                | Syria                 | Lux                   |
| 14         | Cheese                 | Syria                 | Boshr                 |
| 15         | Garnish                | Syria                 | Mamito                |

Isolates of the *Aspergillus* species were diagnosed depending on the morphological cultural characteristics and its image under the microscope by platting them on PDA and incubating at 28 °C for seven days. Culturing was done by using a sharp cork borer to transfer part of the edge of the colony under septic conditions and placing them in the center of three agars mentioned above, with three replicates of each fungal isolate. Agars were incubated in an inverted state under three temperatures, 5 °C, 25 °C, and 37 °C for seven days. Species of the *Aspergillus* genus were diagnosed through their form of growth, colony colour, and colony diameter depending on the taxonomic key of the *Aspergillus* species (Pitt & Hocking, 2007).

**Mycotoxins analyses of potato chips:** Before opening potato chip packages, sterilization of outer covering was done with 70% alcohol. Twenty grams of potato chips samples were grounded, placed in plastic bags, and subjected to extraction for mycotoxins analyses. Aflatoxin, ochratoxin, and zearalenone, were analysed using enzyme-linked immunosorbent assay (ELISA) at the veterinary laboratory in the province of Erbil.

**Method of mycotoxins extraction:**

Five grams of grounded potato chips samples were transferred to conical flasks. To these samples, 25 ml of 70% methanol was added when aflatoxin and zearalenone were extracted, and 50% was used when ochratoxin was extracted. Samples were shaken for three minutes then filtered using Whatman No.1 filter papers. 5 ml of the filtrate was transferred to a test tube. However, in the case of zearalenone, 1 ml of the filtrate was diluted four times with sterile distilled water (1:4). All samples were placed in the refrigerator until analysis.

ELISA technique was used for samples analyses using Neogene Kits and as follows: 100 µl of samples and control were pipetted in the red plate wells followed by 100 µl of Enzyme conjugate, mixed two to three times for homogenization. Mixtures were transferred to white wells in another plate and left for 10-20 seconds at room temperature. A plate was washed with distilled water five times. Then 100 µl of the substrate were added and mixed for 10-20 seconds and left for 3 minutes at room temperature. 100µl of stop solution was finally added. Results were obtained using Neogen Vertex software Vera tax ELISA Reader.
RESULTS

As illustrated in Table 2, it appears that all potato chips’ samples were contaminated with fungi and mycotoxins. Pringles potato chips brand was contaminated with the following fungi; *A. niger, A. astus, Penicillium* spp., *Geotrichum* spp., and *Chaetomium* spp., at a percentage of 20, 30, 50, 30, and 10% respectively. Hum Hum potato chips were contaminated with three fungi; *A. terrus, A. niger*, and *Penicillium* spp. at 40, 20, and 30% respectively. Three fungi contaminated the MazMaz brand samples and included *Penicillium* spp., *Geotrichum* spp., and *Rhodotorella* spp. in descending percentages of 30, 20, and 10% respectively. Potato chips were also contaminated with three fungi; *Penicillium* spp., *Geotrichum* spp. and *Mucor* spp., at 40, 20, and 10% respectively. The Dream brand of potato chips was contaminated with *A. jamanicum, Penicillium, Geotrichum* spp., and *Chaetomium* spp. at percentages of 30, 60, 30, and 10% respectively. The same fungi were isolated from the Dream and Cipso brands except for *Aspergillus*, which was *A. flavus*, and these fungi were in the following percentages 50, 70, 40, and 10% in the same order respectively. Two species of Aspergilli, *A. flavus* and *A. parasiticus* were isolated from Snack Mix potato chips at a percentage of 80 and 60%, in addition to *Penicillium* spp. and *Geotrichum* spp. at a rate of 60 and 10% respectively. The same *Aspergillus* spp. of Snack Mix was also contaminating samples from Doritos potato chips in addition to *A. niger* at a rate of 70, 70, and 30%. *Penicillium* was also isolated from the chips brand at a percentage of 20%. Five fungi were isolated from Fico Fresh potato chips brand including *A. niger, A. astus, Penicillium* spp., *Rhizopus* spp., and *Trichoderma* spp., at a rate of 30, 40, 40, 10, and 20% respectively. Lays with tomato ketchup was contaminated with three fungi namely *Penicillium* spp., *Mucor* spp., *Rhodotorella* spp., and yeast with percentages of 40, 20, 10, and 10% respectively (Table 2).

Lays2 with French cheese potato chips were found to be contaminated with the same fungi of the previous Lays type, but with the addition of Aspergilli (*A. versicolor* and *A. niger*), which were 60 and 30% respectively. The Patos brand chips were contaminated with two Aspergilli (*A. astus* and *A. jamanicum*), at 30 and 40% respectively, and 20% for *Penicillium, Rhodotorella* spp. and yeasts.

The Lux type of potato chips was also contaminated with two Aspergilli (*A. astus* and *A. niger*) at 20 and 10%, with *Penicillium* 10%, and Yeasts 10% (Table 2).
| Product No. | Product name  | Fungi                              | % of Isolation |
|-------------|--------------|------------------------------------|----------------|
| 1           | Pringles     | *Aspergillusniger*                 | 20             |
|             |              | *A. astus*                         | 30             |
|             |              | *Penicillium spp.*                | 50             |
|             |              | *Geotrichum spp.*                 | 30             |
|             |              | *Chaetomium spp.*                 | 10             |
| 2           | Hum Hum      | *Aspergillusniger*                | 20             |
|             |              | *Penicillium spp.*               | 30             |
| 3           | MazMaz       | *Penicillium spp.*                | 30             |
|             |              | *Geotrichum spp.*                | 20             |
|             |              | *Rhodotorella spp.*               | 10             |
| 4           | Patos        | *Penicillium spp.*                | 40             |
|             |              | *Geotrichum spp.*                | 20             |
|             |              | *Mucor spp.*                      | 10             |
| 5           | Dream        | *A. Jamanicum*                    | 30             |
|             |              | *Penicillium spp.*                | 60             |
|             |              | *Geotrichum spp.*                | 30             |
|             |              | *Chaetomium spp.*                | 10             |
| 6           | Cipso        | *A. flavus*                       | 50             |
|             |              | *Penicillium spp.*                | 70             |
|             |              | *Geotrichum spp.*                | 40             |
|             |              | *Chaetomium spp.*                | 10             |
| 7           | Snack Mix    | *A. flavus*                       | 80             |
|             |              | *A. parasiticus*                  | 60             |
|             |              | *Penicillium spp.*                | 60             |
|             |              | *Geotrichum spp.*                | 10             |
| 8           | Doritos      | *A. flavus*                       | 70             |
|             |              | *A. parasiticus*                  | 70             |
|             |              | *Aspergillusniger*                | 30             |
|             |              | *Penicillium spp.*                | 20             |
| 9           | Fico Fresh   | *A. astus*                        | 30             |
|             |              | *Aspergillusniger*                | 40             |
|             |              | *Penicillium spp.*                | 40             |
|             |              | *Rhizopus spp.*                   | 10             |
|             |              | *Trichoderma spp.*                | 20             |
| 10          | Lays 1       | *Penicillium spp.*                | 40             |
|             |              | *Mucor spp.*                      | 20             |
|             |              | *Rhodotorella spp.*               | 10             |
|             |              | *Yeasts*                          | 10             |
| 11          | Lays 2       | *A. versicolor*                   | 60             |
|             |              | *A. niger*                        | 30             |
|             |              | *Mucor spp.*                      | 20             |
|             |              | *Penicillium spp.*                | 30             |
|             |              | *Rhodotorella spp.*               | 20             |
|             |              | *Yeasts*                          | 20             |
| 12          | Patos        | *A. astus*                        | 40             |
|             |              | *A. Jamanicum*                    | 30             |
|             |              | *Penicillium spp.*                | 20             |
|             |              | *Rhodotorella spp.*               | 20             |
|             |              | *Yeasts*                          | 20             |
| 13          | Lux          | *A. astus*                        | 20             |
|             |              | *A. niger*                        | 10             |
|             |              | *Penicillium spp.*                | 10             |
|             |              | *Yeasts*                          | 10             |
| 14          | Boshar       | *A. candidus*                     | 20             |
Five species of molds and yeasts were contaminating Bushar potato chips brand; *A. candidus* (20%), *A. niger* (10%), *Penicillium* (20%), *Mucor* spp. (20%), *Rhodotor ella* spp. (30%), and yeast (40%). The Mamito chips were contaminated with four species of fungi and yeast which were, *A. parasiticus* (20%), *Penicillium* spp. (30%), *Geotrichum* spp. (10%), *Rhodotor ella* spp. (20%), and yeasts (30%). From figure (1) it is evident that *Penicillium* spp. was the most predominant fungi which contaminated different potato chips’ brands (27.45%), followed by *Aspergillus* spp. (23.52%). In third place was *Rhodotor ella* spp. (13.72%), while in fourth place was *Geotrichum* spp. and yeasts (9.8%). *Chaetomium* spp and *Trichoderma* spp were the least isolated contaminant of different chips’ types which accounted for 7.84 and 1.96% respectively.

The amount of mycotoxins in chips’ samples was determined in this study. Table (3) shows that all of the chips’ types were contaminated with aflatoxin with a percentage ranging from 0.1 to 2.5 ppm. While Patos, Dream, Cips, Snack Mix, Doritos, Fico Fresh, in addition to Mamito, had no aflatoxin contamination. Percentages of ochratoxin were between 0.1 and 0.5 ppm. While Pringles, Maz Maz, Patos, Doritos, Fico Fresh, and Lay's 2 had no ochratoxin contamination. Potato chips’ types contaminated with zearalenone had percentages ranging from 4.5 to 46.4 ppm. However, MazMaz, Fico Fresh, and Lay's 1 showed no zearalenone contamination. Finally, Boshar potato chips were the most contaminated samples with three mycotoxins: aflatoxin, ochratoxin, and zearalenone, with percentages of 2.6, 0.5, and 33.2 ppm respectively.

It appears that zearalenone was the most abundant contaminant (13.81 ppm) among the three examined mycotoxins (Fig, 2), followed by aflatoxin (0.26ppm), whereas ochratoxin, was the least contaminant (0.16ppm) in the tested potato chips.

![Figure 1](image_url)
Table (3) Occurrences of mycotoxins in potato chips’ samples.

| Sample No. | Product name | Mycotoxins |
|------------|--------------|------------|
|            |              | Aflatoxin ppm | Ochratoxin ppm | Zearalenone ppm |
| 1          | Pringles     | 0.3         | 0.0            | 6.5            |
| 2          | Hum Hum      | 0.3         | 0.4            | 4.5            |
| 3          | Maz-Maz      | 0.2         | 0.0            | 0.0            |
| 4          | Patos        | 0.0         | 0.0            | 14.7           |
| 5          | Dream        | 0.0         | 0.4            | 7.9            |
| 6          | Cipso        | 0.0         | 0.1            | 10.2           |
| 7          | Snack Mix    | 0.0         | 0.5            | 11.2           |
| 8          | Doritos      | 0.0         | 0.0            | 19.9           |
| 9          | Fico Fresh   | 0.0         | 0.0            | 0.0            |
| 10         | Lays1        | 0.1         | 0.2            | 0.0            |
| 11         | Lays2        | 0.1         | 0.0            | 12.1           |
| 12         | Patos        | 0.0         | 0.1            | 26.4           |
| 13         | Lux          | 0.3         | 0.1            | 13.2           |
| 14         | Boshar       | 2.6         | 0.5            | 33.2           |
| 15         | Mamito       | 0.0         | 0.4            | 46.4           |

Figure (2): Mycotoxins in analyzed potato chips.

DISCUSSION

When different foods are contaminated by various fungi, producing and non-producing mycotoxins depends on the fungi itself, the type of food product, and the surrounding environment (Milani et al., 2013). Despite the difficulty of the final elimination of pollution, molds, and the presence of mycotoxins, hard work is needed to minimize the adverse effects of these toxins by using the best way possible, whether physical or chemical (Do & Choi, 2007).

In the presence of such fungal mycotoxins in different imported brands of potato chips, there is evidence that Iraqi authorities have failed to conduct an inspection and standardization and quality control measures. Fortunately, the contamination of various brands is located within the limits of 20 ppb, based on the rates approved by AOAC. The presence of this low percentage could be due to the physical separation of the good potatoes from those contaminated before the preparation of potato chips. This may remove 40-80% of the aflatoxin that is considered to be the most toxic and potent carcinogen which has been directly correlated to adverse health effects, such as liver cancer. Aflatoxins have acute and chronic toxicity produced mainly by *Aspergillus parasiticus* and *Aspergillus flavus* in tropical and subtropical regions (Milani et al., 2013). This may be due simply to the contamination of food additives and pepper, which is often contaminated with *Aspergillus*, or because of the composition of potato chips, consisting of a mixture of corn, rice, flour, and potatoes, as there may be a source of pollution or fungal toxins within these components. Also, heat treatment and autoclave treatment do not completely remove aflatoxin from foods (Thieu et al., 2008), despite the fact that some studies have shown that roasting is a good way to reduce levels of aflatoxin in peanuts.

The significance of *Aspergillus* fungi in food comes from its toxic, mutagenic, and carcinogenic effects. It has been ranked by the International Agency for Research on Cancer as one of the first-class carcinogens, and there are studies on liver poisoning in Kenya and India, that showed that viral hepatitis could increase the likelihood of cancer due to the presence of ochratoxin residues in samples of potato chips that have been studied and produced by fungi Asperdillus and Penicillium. Fortunately, the level of ochratoxin
was within the limits allowed in food (20 ppb) and not more than 5 ppb per kg of body weight per day.

According to data provided by the European Commission, the daily consumption of ochratoxin ranges from 0.02-1.9 ppb /kg body weight /day (Christensen et al., 1977).

It is interesting to note that some types of potato chips contained moderate levels of zearalenonem despite that no Fusarium spp. were isolated from the tested chips. Such results may appear confusing, but it could be said that Fusarium spp. are the most fungal species present in the processing methods for chips’ preparation, while the other species of fungi like Aspergillus and Penicillium spp. were present during the storage of these food products. The presence of zearalenone residues in potato chips may be due to its high stability against different processing methods. Different concentrations of zearalenone were found in all tested potato chips (both in temperate areas like Belgium, or subtropical areas such as Saudi Arabia), the worldwide incidences of Fusariumgraminearum and zearalenone produced by this fungus have been well documented (Bahrami-Samani et al., 2017).

As potato chips are considered as a light snack the current study’s results were near to the average zearalenone level of 20 ppb of breakfast cereals, snack foods, popcorn, and cornmeal, in the U.S.A. (warner). The hypothesis stated that potato chips may be made of a mixture of rice, wheat, corn, and other ingredients, which may explain here the presence of zearalenone, which is frequently found in all major cereal grains worldwide, also, ubiquity of Fusarium spores (Nelson et al., 1983).

F.graminearum (the producer of zearalenone) a soil inhabiter, it is also considered as a storage fungus, since growth and toxin production may occur under various storage condition. Corn and wheat are most suscepti-

ble to invasion by this fungus (Bahrami-Samani et al., 2017).

Efforts have been made to reduce the level of zearalenone by various chemical, physical, and biological processing methods. In this study, potatoes were subjected to physical methods of heat treatment. The fate of zearalenone depends on its distribution in the food matrix and its chemical properties, such as heat stability (Krnjaja et al., 2013).

Although all the tested residual mycotoxins (aflatoxin, ochratoxin, and zearalenone) were within the permissible limits of these toxins in the food commodities intended for human consumption, however the new legislation indicates that products intended for human consumption, or as an ingredient in food must comply with a limit of 4 ppb for total aflatoxin, ochratoxin and zearalenone.(Park & Stoloff, 1989).

Prevention of mycotoxins formation is believed to be the best means of managing hazards associated with mycotoxins contamination. In addition, an effective food safety management program must include prevention, setting regulatory limits, the establishment of monitoring programs, control through good agricultural practices, control through processing, decontamination through specific treatments, and consumer and producer education (Park & Stoloff, 1989).

**CONCLUSION**

Based on the results, it appears that all potato chips’ samples were contaminated with fungi and mycotoxins, especially Penicillium spp. and Aspergillus spp. in addition to some other fungi. The study also concluded that zearalenone was the highest contaminant (13.81 ppm) among the three examined mycotoxins, followed by aflatoxin (0.26ppm). Whereas ochratoxin was the least contaminant (0.16ppm) in the analyzed potato chips.
REFERENCES

Amri, E., & Lenoi, S. o. (2016). Aflatoxin and fumonisin contamination of sun-dried sweet potato (Ipomoea batatas L.) Chips in Kahoma District, Tanzania.

Azizi, I., Ghadi, H., & Azarmi, M. (2012). Determination of aflatoxin B1 levels of the feedstuffs in traditional and semi-industrial cattle farms in Amol, northern Iran. Asian Journal of Animal and Veterinary Advances, 7(6), 528-534.

Bahrami-Samani, O., Rahimi, E., & Nili-Ahmadabadi, A. (2017). Assessment of zearalenone contamination in processed cereal-based foods in Shahrekord, Iran. Toxin Reviews, 36(3), 257-260.

Bankole, S., & Adebanjo, A. (2003). Mycotoxins in food in West Africa: current situation and possibilities of controlling it. African Journal of Biotechnology, 2(9), 254-263.

Bullerman, L. B., & Bianchini, A. (2007). Stability of mycotoxins during food processing. International journal of food microbiology, 119(1-2), 140-146.

Christensen, C. M., Mirocha, C. J., & Meronuck, R. A. (1977). Molds, mycotoxins, and mycotoxicoses [produced by Fusarium, Aspergillus, contaminated feeds]. Cereal Foods World.

Croft, W. A., Jarvis, B. B., & Yatawara, C. (1986). Airborne outbreak of trichothecene toxicosis. Atmospheric Environment (1967), 20(3), 549-552.

de Hoog, G. S., & Guarro, J. (1995). Atlas of clinical fungi (Spain, Ed.). Universal Roviralvirgili, Reus.

Do, J. H., & Choi, D.-K. (2007). Aflatoxins: detection, toxicity, and biosynthesis. Biotechnology and Bioprocess Engineering, 12(6), 585-593.

Gnonlonfin, G., Adjovi, C., Katerere, D. S., Shephard, G., Sanni, A., & Brimer, L. (2012). Mycoflora and absence of aflatoxin contamination of commercialized cassava chips in Benin, West Africa. Food Control, 23(2), 333-337.

Jonathan, S., Abdul-Lateef, M., Olawuyi, O., & Oyelakin, A. (2012). Studies on biodeterioration, aflatoxin contamination and food values of fermented, dried and stored Ipomoea batatas chips. Nature and Science, 10(11), 123-128.

Krnjaja, V., Lević, J., Stanković, S. Ž., Petrović, T. S., Tomić, Z., Mandić, V., & Bijelić, Z . (2013) .Moulds and mycotoxins in stored maize grains. Biotechnology in Animal Husbandry, 29(3), 527-536.

Manjula, K., Hell, K., Fandohan, P., Abass, A., & Bandyopadhyay, R. (2016). Aflatoxin and fumonisin contamination of cassava products and maize grain from markets in Tanzania and republic of the Congo. Journal of Applied & Environmental Microbiology, 4(34), 55-62.

Martins, M. L., Martins, H. M., & Bernardo, F. (2001). Aflatoxins in spices marketed in Portugal. Food Additives & Contaminants, 18(4) .319-315 .

Milani, C., Hevia, A., Foroni, E., Duranti, S., Turroni, F., Lugli, G. A., Sanchez, B., Martin, R., Guemonde, M., & van Sinderen, D. (2013). Assessing the fecal microbiota: an optimized ion torrent
16S rRNA gene-based analysis protocol. *PloS one*, 8(7), e68739.

Mmasa, J., Msuya, E., & Mlambiti, M. (2012). Socio-economic factors affecting consumption of sweet potato Products: An empirical approach.

Nelson, P. E., Toussoun, T. A., & Marasas, W. (1983). Fusarium species: an illustrated manual for identification.

Park, D. L., & Stoloff, L. (1989). Aflatoxin control—How a regulatory agency managed risk from an unavoidable natural toxicant in food and feed. *Regulatory Toxicology and Pharmacology*, 9(2), 109-130.

Pitt, J. I., & Hocking, A. D. (2007) *Fungi and food spoilage* (Vol. 519). Springer.

Savino, M., Limosani, P., & Garcia-Moruno, E. (2007). Reduction of ochratoxin A contamination in red wines by oak wood fragments. *American journal of enology and viticulture*, 58(1), 97-101.

Tairo, F., Mneney, E., & Kullaya, A. (2008). Morphological and agronomical characterization of sweet potato [Ipomoea batatas (L.) Lam.] germplasm collection from Tanzania. *African Journal of Plant Science*, 2(8), 077-085.

Thieu, N. Q., Ogle, B., & Pettersson, H. (2008). Screening of Aflatoxins and Zearalenone in feedstuffs and complete feeds for pigs in Southern Vietnam. *Tropical Animal Health and Production*, 40(1), 77-83.

Wyllie, T. D., & Morehouse, L. G. (1978). Mycotoxic fungi, mycotoxins, mycotoxicoses.
المستخلص:
تهدف الدراسة الحالية إلى التحري عن وجود الفطريات في عينات مختلفة من رقائق البطاطس المخصصة للأطفال وتقدير السموم الفطرية الموجودة فيها.

هديل احمد العامري ونديم احمد رمضان
قسم علوم الحياة، كلية العلوم، جامعة الموصل، العراق

تاريخ الاستلام: 3 نوفمبر 2020 / تاريخ القبول: 30 ديسمبر 2020

https://doi.org/10.54172/mjsc.v35i4.332

من المهم تحديد وجود السموم الفطرية المختلفة في المنتجات الغذائية الطازجة والتي قد تؤدي إلى التلوثات المحتملة. تهدف الدراسة الحالية إلى تحري عن وجود الفطريات في عينات مختلفة من رقائق البطاطس المخصصة للأطفال من مصادر عالمية مختلفة بنكهات مختلفة من الفلفل والأبستك وتوابل الحارة والجبنة.

كانت ملوثة بالفطريات والسموم الفطرية، وبينت الدراسة أن أنواع الفطريات Penicillium spp. وAspergillus spp. كانا أكثر شيوعًا. عدد أنواع Geotrichum spp. في رقائق البطاطس Pringles كانا بنسبة 50% على التوالي. عدد أنواع Rhodotorella spp. وأكثر أنواع Aspergillus spp. بنسبة 30% على التوالي. وتوجد سموم زيرالينون في عينات رقائق البطاطس Pringles بنسبة 60%. وتوجد سموم الأفلاتين B وC1 في عينات رقائق البطاطس Lays1 بنسبة 30% على التوالي. وتوجد سموم الأفلاتين B وC2 في عينات رقائق البطاطس Lays2 بنسبة 30% على التوالي. وتوجد سموم الأفلاتين A وC3 في عينات رقائق البطاطس Pringles بنسبة 30% على التوالي. وتوجد سموم الأفلاتين A وC2 في عينات رقائق البطاطس Dream بنسبة 30% على التوالي. وتوجد سموم الأفلاتين A وC2 في عينات رقائق البطاطس Pringles بنسبة 30% على التوالي. وتوجد سموم الأفلاتين A وC2 في عينات رقائق البطاطس Dream بنسبة 30% على التوالي.

الكلمات المفتاحية:
تلوث رقائق البطاطس، السموم الفطرية، الفلاتوكسين، زيرالينون، الأفلاتين B وC1 وC2.