AFLATOXIN CONTAMINATION IN SUNFLOWER OIL

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ABSTRACT

Sunflower (*Helianthus annuus* L.) is an annual ornamental herb grown as an oil seed crop. Because of their chemical composition and nutritional value sunflower seeds are considered to be a great source of lipids and proteins and are largely used in the production of edible oils and animal feed. The protein content of the seeds is approximately 50%–60%. Sunflower oil is the preferred oil in most of Europe, East Europe, Russia, Mexico, countries along with Mediterranean and several South American countries. Mycotoxins are poisonous organic compounds produced by several species of fungi. In studies have shown that isolates of different mold species were able to produce aflatoxins B_1,B_2,G_1 and G_2, sterigmatocystin, ochratoxin A, patulin, citrinin, penicillic acid, zearalenone and griseofulvin in sunflower. Aflatoxins are a major group of mycotoxins, which have toxic, carcinogenic and mutagenic activity, causes important health problems and economic losses. The production of oils from oilseeds requires the following steps: storage of grains, preparation, extraction of crude oil and refine (degumming, deacidification, bleaching, deodorization). Some of these steps may be harsh and lead to inactivation or elimination of important compounds, such as vitamins, antioxidants and enzymes, although the effect on undesirable compounds like aflatoxins varies markedly among methods. The high contamination of oilseeds by aflatoxins generates a concern on a global scale due to the high consumption of these products. Several reports have shown high incidences of aflatoxin contamination in plant-derived oils in regions of China, Sudan, India and Sri Lanka. Experimental studies have shown that aflatoxins present in the oleaginous material can be transferred to the final oil product. However, depending on the type processing (extraction and purification) of the crude oil, the levels of these contaminants can be reduced.

Key words: Sunflower oil, mycotoxins, aflatoxins, oil processing

INTRODUCTION

Mycotoxins are secondary metabolites mainly produced by different fungal species when they contaminate food and feed. Various fungal species like such as *Aspergillus, Penicillium* and *Fusarium* under different climatic conditions of temperature and humidity can contaminate cereals. Mycotoxin contamination occurs frequently in various food commodities globally, leading to animal and human health risks. More than 400 mycotoxins have been identified and reported and the key important mycotoxins that are highly prevalent in the contaminated agro-food products are aflatoxins, ochratoxin A (OTA), deoxynivalenol (DON), fumonisins (FBs), zearalenone (ZEN), citrinin (CIT) and patulin. Among the types of aflatoxins are aflatoxin B_1, B_2, G_1 and G_2, which are a group of closely related mycotoxins (Selveraj et al., 2015).

Aflatoxin B_1, produced by *Aspergillus flavus* and *Aspergillus parasiticus*, is one of the most toxic and common contaminants in food and feed. Ingestion of aflatoxin-contaminated food leads to acute and chronic toxic effects, which may be hepatocarcinogenic, mutagenic, teratogenic or genotoxic (Samuel et al., 2014).

Aflatoxins are commonly found in nuts, peanuts, corn, cottonseed and other oil seeds which affect not only the health of humans and animals but also the economics of agriculture and food. Aflatoxins are produced under optimum temperature and moisture conditions and cannot be completely avoided, so aflatoxins have become a threat worldwide. In order to protect human safety, limits on aflatoxins have been set in many countries. In the European Commission, the current maximum levels are 2 µg/kg for AFB_1 and 4 µg/kg for total aflatoxins for groundnuts, nuts, dried fruits and cereal (Fan et al., 2013).

Sunflower (*Helianthus annuus* L.) is an annual ornamental herb grown as an oil seed crop (Nahar et al., 2005). Because of their chemical composition and nutritional value sunflower seeds are considered to be a great source of lipids and proteins and are largely used in the production of edible oils and animal feed. The protein content of the seeds is approximately 50%–60%. (Beheshti and Asadi, 2013). Sunflower oil is the preferred oil in most of Europe, East Europe, Russia, Mexico, countries along with Mediterranean and several South American countries.

Sunflower seed contain 25-32 % edible oil which is a rich source of polyunsaturated fatty acids used for human consumption. Sunflower seeds also provide a nutritious food for cattle, poultry hogs and cage birds. The seeds are also consumed roasted, salted and a coffee substitute is prepared from roasted seeds. Of the different fungi isolated from sunflower seed, *Aspergillus flavus* Link. was found to be most predominant (Dawar and Ghaffar, 1991).

The high contamination of oilseeds by aflatoxins generates a concern on a global scale due to the high consumption of these products. Several reports have shown high incidences of aflatoxin contamination in plant-derived oils in regions of China, Sudan, India and Sri Lanka. Experimental studies have shown that aflatoxins present in the oleaginous material can be transferred to the final oil product. However, depending on the type processing (extraction and purification) of the crude oil, the levels of these contaminants can be reduced (Bordin et al., 2014).

SUNFLOWER OIL PROCESSING

Oil processing involves three major conventional processes which include continuous neutralizing, bleaching and deodorisation. Neutralisation of crude oil with caustic soda is still an essential feature for a refinery required to produce a consistently high quality product and to handle a number of different oil types. A bleaching step is necessary to remove soap, trace metals, sulphurous compounds and part of the more stable pigments and pigment breakdown products which have resulted from raw materials damage or oxidation. The deodorization process involves steam distillation under vacuum. Its purpose is to remove so far as possible residual free fatty acids, aldehydes and ketones which are responsible for unacceptable oil odours and flavors and, more recently to decolourise the oil by heat decomposition (270ºC) of the pigments and distillation of the decomposition products (Banu and Muthumary, 2010).

The sunflower oil process flow diagram is shown in Fig. 1 (Pal et al., 2015).

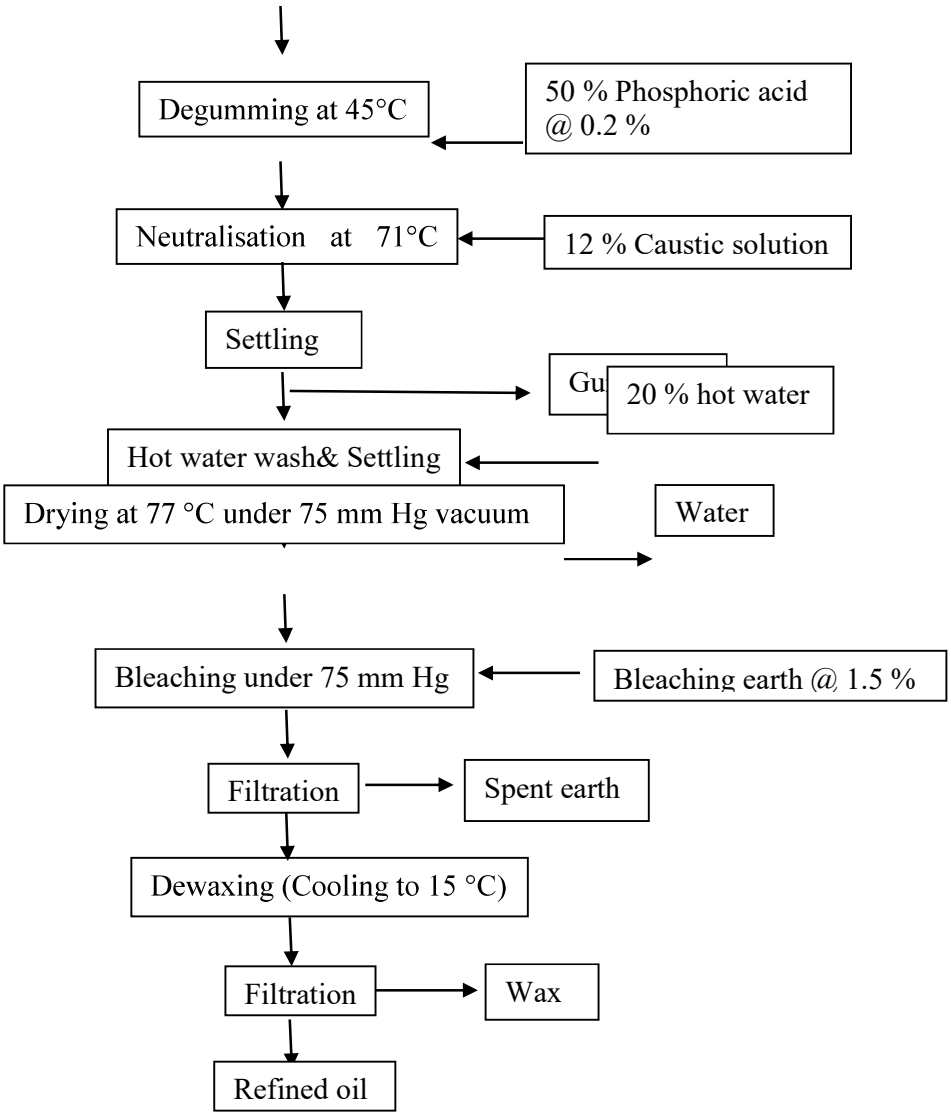

Fig. 1 Process flow diagramme for refining of sunflower oil

SUNFLOWER OIL AND AFLATOXIN

The seeds of sunflower (*Helianthus annuus),* may first have been cultivated by Indian tribes in North America, about 3000 B. C. The seeds were used as a food, medicine and as a religious symbol. The plant was brought by Spanish travelers to Europe sometime around 1500 AD. The sunflower thrives in temperate climate and is today cultivated in USA, Europe, Russia and Canada among others. For the food industry the seeds are largely cultivated for oil production, but the seeds are also used for food or bird feed (National Sunflower Association 2013). Sunflower seeds can contain up to 45% oil (Eklöf, 2013). Sunflower seeds are a good substrate for aflatoxin production. Lipids may play, an important role in the biosynthesis of aflatoxin (Chulze et al., 1990).

The mycoflora of sunflower seeds appeared to be diverse, with many toxin producing species as common contributors. The analysis of toxins did however not detect any toxins, and since

the commodity was storage stable (the highest aw detected was 0.63), there did not seem to be any risk involved with consuming these products. However, if the commodity would be exposed to moisture there would be a risk of toxin production. Abdullah et al. (2010) found common genera in sunflower seeds to be *Aspergillus, Alternaria, Fusarium,* and *Penicillum. A. niger* and *A. flavus* were the most common species, but also *Penicillium expansum* were common. Jimenez et al. (1991) found highest counts of *A. niger* and *Penicillium spp*. and Shahnaz et al. (1991) found high incidence of *A.flavus* and *A. niger.* Sharfun-Nahar et al. (2005) also found along with high incidence of *Penicillium* spp. The study also revealed *A. ochraceus* as a contributor to the mycoflora of sunflower seeds, and both studies found species of *Alternaria* and *Fusarium* (Eklöf, 2013).

The oil extraction step, both by pressing and solvent, is not capable to eliminate the aflatoxins. In fact, the toxin is shared between the phases, remaining in both the oil and defatted meal. The oil extraction with non-traditional solvents has been shown viable, and studies performed with ethanol, and isopropanol have also shown the ability to partially remove aflatoxins from oil seeds. However, a point to be elucidated is the appropriate treatment given to the solvent leading to the elimination of toxins, so that it allows its reuse in the process (Bordin et al., 2014).

There are no studies in the literature that relate the degumming with the presence of aflatoxins. However, it is known that the toxins are soluble in polar organic solvents. Thus, it is assumed that the procedures used in this step may reduce contamination of the vegetable oil (Bordin et al., 2014). Aflatoxins decompose at high temperatures ranging from 237 to 306°C. Thus, the conditions adopted in deodorizing process can be essential for complete removal of aflatoxins from vegetable oils (Bordin et al., 2014).

Parker and Melnick (1966) were the first researchers to assert that the refining process is effective in removing aflatoxins. The authors evaluated the effect of chemical refining on peanut crude oil initially infected with 812 µg/kg aflatoxin, being possible after the bleaching stage, obtaining an oil containing traces of aflatoxins in a concentration lower than 1 µg/kg.

Banu and Muthumary (2010) reported that among the 23 different crude sunflower oil samples were tested, 10 of them showed positive results to AFB_1 and the remaining 13 showed negative results to AFB_1. All the refined oil samples were free from AFB_1 contamination. This was supported by the absence of fungi in the refined oil samples. This may be due to oil processing which includes continuous neutralization, bleaching and deodorizations. During these processes, fungal propagules are probably removed from the oils. The toxic AFB_1 have been found to be heat stable up to their melting points of around 250°C. Therefore, AFB_1 was not completely destroyed by such processes and was carried along the way from seeds to oil samples. The complete conventional processes remove these compounds from the crude oil. But the quantity of contamination is very least ranging from 0.1 to 0.4 ppm. This low level was due to extraction of oil using food grade hexane. The extraction plays a role of partially removing aflatoxin from the oil samples.

CONCLUSION

Knowledge of contaminating sunflower mycoflora is important because undetectability of a mycotoxin at the time of analysis does not mean that this metabolite could not be found later if the toxigenic species is present in the sunflower, and if favorable conditions allow for fungal development and mycotoxin formation. Control of moisture and temperature levels of these commodities is necessary to prevent mould growth and mycotoxin production.

Mycotoxins are partially destroyed in refined oils by the conditions employed in the refining stages. Regardless the process for obtaining oil by pressing or solvent from a feedstock contaminated with aflatoxins, studies have showed that the toxins are partitioned between the oil and meal, requiring the application of physical, chemical or biological products for the reduction or elimination of these contaminants. There is limited evidence indicating that the process of refining crude oil was efficient for removing not only the aflatoxins, but also other mycotoxins produced by *Fusarium* spp., such as trichothecenes and zearalenone. Thus, it is possible to ensure safe edible oil for human provided it is properly processed. (Bordin et al., 2014).

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