# A Review on Public Health Hazards of Aflatoxin M1, in Milk, and Dairy Products.

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**Abstract.**

Aflatoxin is a potent carcinogen that poses a major risk to both human and animal health. Several molds, particularly Aspergillus flavus and Aspergillus parasiticus, produce a class of mycotoxins that are known to be extremely carcinogenic. It is also difficult to demonstrate carcinogenicity. Aflatoxin exposure is one of the primary etiological variables that contributes to the development of hepatocellular carcinoma. Aflatoxin M1 is one of the main toxins found in milk and dairy products that has been criticized. There must be ongoing research and monitoring to safeguard public health and safety. In the temperate zone, growing temperatures and climate change have led to an increase in the presence of fungus toxins, namely those made by the Aspergillus species, in food products and feeding plants. Research has indicated that in most European nations, AFM1 can be found in both breast milk and cow's milk. As a result, the amount of toxins in milk should be given more attention, and any milk that has more than the permissible amount should not be drunk.

**Key words:** Public Health, Mycotoxins**,** Aflatoxin M1, milk, dairy products.

## Introduction

Aflatoxin M1 has been classified as carcinogenic by the IARC (2002), genotoxic by Lafont et al. (1989), and cytotoxic by Neal et al. (1998). Aflatoxin B1 (AFB1) and aflatoxin M1 (AFM1) have been classified as human carcinogenic class 1 and class 2B, respectively, by the International Agency for Research on Cancer (IARC, 2002). Because of the possible risks and the lack of data available to establish an appropriate exposure level, the World Health Organization recommends using it as little as possible (WHO, 2002).

US standards state that the amount of AFM1 in milk cannot be more than 500 pg ml-1; however, most European nations and the Codex Alimentarius set the limit at 50 pg ml-1 (Van Egmond, 1995). The official action levels for AFM1 in milk in Iran are 50 pg ml-1 (FAO, 2004). Commercial milk and milk products are among the primary sources of Dairy products can put people at risk of aflatoxin M1 exposure when they are ingested. It is a bountiful supply of vital elements like vitamins, calcium, and protein. Dairy goods including cheese, ice cream, yogurt, and butter are all made from milk. People of all ages appreciate these items, which are a mainstay in many diets worldwide. Contaminated animal feed can spread aflatoxin to milk, which can then spread to dairy products. It's critical to make sure animal feed is free of aflatoxin contamination in order to reduce this risk. To guarantee their safety, aflatoxin levels in milk and dairy products must be routinely tested. Furthermore, controlling and storing milk and dairy products properly can help avoid the production, toxicity, and regulation of aflatoxin. The concern over aflatoxins M1 in milk and dairy products is the main topic of this review. to guarantee food safety for humans. All things considered, reducing aflatoxin contamination in the dairy sector calls for a comprehensive strategy. Several analytical methods, such as thin-layer chromatography, high-performance liquid chromatography, and enzyme-linked immunosorbent assay, are used to determine the risk of aflatoxin M1 in milk samples. By identifying and measuring aflatoxins in milk, these techniques aid in confirming the safety of the goods for ingestion. AFM1 excretion in milk as a percentage of AFB1 ranges from 1 to 2% on average, with variations across animals, days, and milking's. AFM1 was first found in milk 12–24 hours after the first AFB1 ingestion, and a few days later, it was at a high level Thus, this article's goals are to Examine the aflatoxin concentration in dairy products and feed. To highlight the problem's significance for public health and the extent of intervention needed to avoid and manage it.

**Mycotoxins.**

Because they are more susceptible than adults, infants and babies should be especially concerned about the presence of this mycotoxin in these items.

Mycotoxins are secondary metabolites of fungus linked to a number of human and animal disorders. Because these chemicals are created by fungi, they are toxic to animals. Apart from their immediate toxicity, several mycotoxins are currently linked to specific types of cancer. Concerns regarding feed and food safety, particularly the safety of milk and milk products, have been brought up globally due to this aspect (Nogaim, 2014).

**Toxicity of Aflatoxins and Acute Aflatoxicosis**

AFB1 is the most prevalent aflatoxin, classified as a group 1 carcinogen, and a potent hepatocarcinogen in humans and other animals (Ali, 2019). Most studies on mycotoxins have focused on aflatoxin B1, because of its strong carcinogenic effects on humans. The metabolism of AFB1 varies throughout different animal species (Wu et al., 2009). Aflatoxin exposure in humans is also impacted by hepatitis. Hepatitis B virus (HBV) and AFB1 have been shown to work together as synergistic causal agents of hepatocellular carcinoma. Hepatocytes are made more susceptible to the cancer-causing properties of AFB1 through direct or indirect HBV infection (Ali, 2019). According to an epidemiological investigation, persistently infected Gambian children and adolescents with HBV had greater concentrations of AFB1 adducts than did uninfected people (Turner, et al., 2000). Information regarding acute aflatoxin toxicity in humans is scarce. Human cases of acute poisoning have been documented in developing nations. For instance, in 1974, a hepatitis outbreak caused by eating maize contaminated with aflatoxin in India claimed 100 lives. Similarly, in 2004 a severe acute aflatoxicosis outbreak in Kenya resulted in a 39.4% fatality rate (Lewis, et al., 2005; Probst, et al., 2007). Common symptoms of acute poisoning in humans include vomiting, necrosis, fatty liver, and abdominal pain. According to Marin et al. (2013), there are other symptoms include sadness, anorexia, diarrhea, jaundice, and photosensitivity.

**Metabolism**

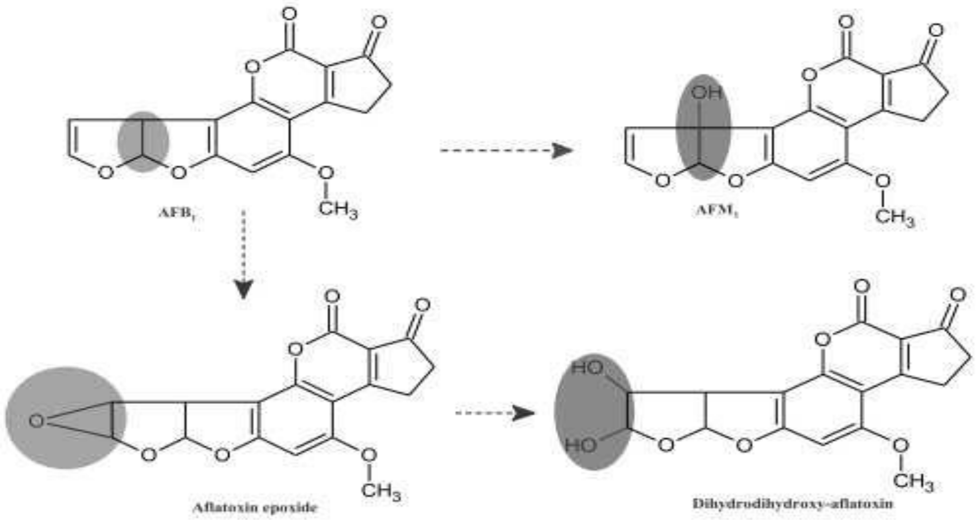


**Fig. 1: Aflatoxin B1 metabolism in the liver (Iqbal, *et.al,* 2015).**

It is crucial to take into account the metabolites of aflatoxin that cause both acute and long-term damage. According to Concon J. M. (1988), there are four distinct fractions of aflatoxins: B1, B2, G1, and G2. (Van Egmond, 1989). The hepatic mixed function oxidase system breaks down the B1 and B2 fractions to produce the M1 and M2 fractions, which are eliminated in milk AFB1 toxin, which hydroxylates to aflatoxin M1 in the bodies of dairy animals and humans and excretes in milk, is the most toxic form of aflatoxin. Toxins at concentrations of ng/kg can now be found by researchers thanks to the advancement of analytical techniques Aflatoxin M1 is a serious health hazard that is released into milk by dairy animals' livers after they consume contaminated feed crops such peanuts, tree nuts, and maize. Aflatoxin exposure can cause immune system suppression, liver damage, elevated risk of liver cancer, weakened immune system, and stunted growth in children.

**Public Health Significance of Aflatoxin.**

Aflatoxin toxicity and carcinogenicity have been associated with both human and animal populations (Murray, 2009). Acute aflatoxicosis results in death, however chronic aflatoxicosis leads to pathologic alterations that take longer to manifest, like immunosuppression and cancer. Acute aflatoxicosis has been known to cause acute hepatitis in humans (Murray, 2009). Aflatoxin B1 was found in large amounts in the livers of the deceased (Magnussen and Parsi, 2013).

**How to prevent toxins from entering the milk?**

It is very important that milk does not contain AFM1 at all or only to an acceptable degree because otherwise this important food material can become a source of toxic materials (Iqbal et al., 2015). As the toxin is introduced through the feed into the bloodstream through the cattle's digestive tract and then into the milk, it is crucial to treat cattle with feeding materials that have the lowest possible contamination and low toxin content. For basic feed materials, the maximum permissible limit for aflatoxin B1 is 20 ng/kg; however, this is lower, at 5 ng/kg, for feed mixtures used by dairy cows. The maximum toxin content for milk is 50 ng/kg, and any more than that cannot be distributed (Szeitzne Szabo & Frecskane Csaki, 2013).The animal's physiological condition may also have an impact on the amount of toxins in milk because rumen acidosis, a low pH in the rumen, can cause the toxin to be absorbed more effectively.

**The potential decrease in milk and milk products and the stability of AFM1.**

Mycotoxins can contaminate milk, cheeses and all dairy products both directly and indirectly. Eating feed contaminated with tiny fungus is the simplest way to indirectly contaminate an area. The primary metabolite of AFB1, AFM1, is the most significant. AFM1 and AFB1 have nearly identical effects on the human body. For instance, when molds, which can produce toxins, grow inside or on the surface of cheeses, this is known as direct contamination. These may even be part of the starting cultures that are used to produce various cheeses. Even milk and dairy products can become infected by Aspergillus strains, which then release the toxin AFB1, which is often considerably less concentrated than AFM1 (Fisher et al.,2011).

**Techniques for identifying aflatoxin M1 in dairy products and milk.**

The extraction of AFM1 from milk and dairy products using a combination of polar organic solvents, such as acetonitrile, methanol, or acetone, is the initial step in most procedures. For environmental concerns, less chlorinated hydrocarbons are used during extraction (Shephard, 2008) Most first do sample preparation and extraction, cleaning, and maybe derivatization before separating AFM1 from other components using chromatographic techniques. To do this, we need to take out of the sample everything that could interact with the component we are searching for throughout the weaning process Column chromatography, solid-phase extraction columns, fluid-fluid extraction, immunoaffinity columns, and multifunctional columns employed in a single step are some of the cleaning techniques (Krska et al., 2005).

There are quite sensitive techniques for figuring out how much AFM1 is in milk. The majority of researchers employ the HPLC-MS and ELISA techniques, which allow for the detection of even up to 10 nanograms of toxins after correct preparation and concentration. Apart from the extremely low detection threshold One benefit of HPLC techniques is their ability to identify several poisons from a single sample. The popularity of ELISA stems from the fact that, in addition to being exceedingly precise, it is also quite fast. With correct preparations made even on site, several samples can be classified with ELISA very quickly.

**Detection of Aflatoxin in milk and dairy products.**

Aflatoxin can be detected using a variety of techniques, such as chromatographic methods, molecular approaches, and immunoassays. The analysis of aflatoxin in milk and dairy products, both quantitative and qualitative, is made possible by these techniques. Aflatoxin levels may be regularly tested for and monitored, which can aid in identifying tainted products and stopping their distribution. Furthermore, technological developments have resulted in the creation of quick and sensitive detection techniques that can help in the prompt identification of aflatoxin and guarantee the safety of milk and dairy products that may be contaminated by it through tainted animal feed, processing, handling, and proper storage of milk, cheese, yogurt, and butter, all of which carry a serious risk to the health of consumers. We can shield customers from aflatoxin's damaging effects and preserve public health in the dairy industry by guaranteeing the safety of milk and dairy products. Because aflatoxin has the potential to cause cancer and has negative health impacts, its presence in milk and dairy products is a severe concern. Implementing strategies to stop the transfer of aflatoxin from animal feed to milk is crucial. This can be accomplished by preventing aflatoxin production, testing frequently, and storing food properly. To reduce aflatoxin contamination in the dairy business and safeguard the health of people and animals, a comprehensive strategy is required.

**Cheese containing aflatoxin M1**.

Aflatoxins are a group of naturally occurring toxins produced by Aspergillus flavus and Aspergillus. parasiticus. The four mains naturally produced aflatoxins are B1, B2, G1, and G2; with B1 usually being the aflatoxin found at the highest concentration in contaminated food and feed (Sweeney and Dobson, 1998). Aflatoxin M1 (AFM1) and Aflatoxin M1 (AFM1) are Mon hydroxylated derivatives of AFB1 and AFB2, which are formed and excreted in the milk of lactating animals including humans that have consumed AFB1 or AFB2 contaminated material (Lopez, 2001). AFB1 in dairy rations is metabolized to AFM1 in milk in a ratio of approximately 100:1, and AFM1 is relatively stable in raw and processed milk products; therefore, if raw milk contains AFM1, cheese made from such milk will also contain AFM1 (Lopez, 2001; Galvano et al., 1996). During the cottage cheese and cheese making process, most of the toxin is transferred to the curd, and only a smaller part is left in the whey. As a result, the AFM1 concentration of soft cheeses is approximately three times and of hard cheeses five times higher than the toxin concentration of the milk used as a raw material (Szeitzne Szabo & Frecskane Csaki, 2013). According to Van (Egmond et al. 1977), cheese has an AFM1 content that is almost four times higher than that of cheese milk. The affinity of AFM1 for casein has been proposed as the reason for the increase in AFM1 concentration in cheese (Applebaum et al., 1982). Nonetheless, several writers have noted that during processing and storage, the AFM1 concentration in milk is not consistent and steady.

**Aflatoxin in cheese may arise from four different sources:**

1.Raw milk contains AFM1 due to the transfer of AFB1 from tainted animal feed to milk.

2.Fungal growth on surfaces that produces aflatoxin (B1, B2, G1, and G2).

3.cheese, despite its low carbohydrate content, which makes it an unsuitable substrate.

4. The use of AFM1-contaminated powdered milk to make cheese.

There have been conflicting reports regarding how cheese preparation affects AFM1 recovery. Early research reveals that AFM1 losses during cheese production can range from 65% to 47%, <20% to <15%, as reported by Purchase et al. (1972), McKinney et al. (1973), Grant and Carlson (1971), and Stubblefield and Shannon (1974). However, subsequent studies by a number of authors (Brackett and Marth, 1982b; Brackett and Marth, 1982c; Munksgaard et al., 1987; Van Egmond and Paulsch, 1986; Bakirci, 2001, Govaris et al. 2001; Deveci, 2007) revealed that the type of cheese, processing methods, and the volume of water removed during the process all increased the concentration of AFM1 in cheese. For instance, Mohammadi et al. (2008) looked at a few variables that are present during the production of Iranian white brine cheese. The amount of water removed and, consequently, the amount of AFM1 in the cheese curds were found to be influenced by a number of parameters, including press time, temperature during renneting, and pH of the saturated brine Research has been done on a variety of cheese types regarding the general stability of AFM1 throughout ripening and storage. According to studies by Fremy et al. (1990) and Dragacci et al. (1995), Camembert cheese had higher AFM1 concentrations early in the ripening process than it did later. These outcomes concurred with research conducted by Govaris et al (2001).

## Conclusion.

Aspergillus species, which under certain conditions are capable of producing mutagenic, teratogenic, and carcinogenic toxins like AFB1, AFB2, AFG1, and AFG2, have found that the temperate zone is the ideal habitat for their spread. AFB1 is integrated into the body of the mother or other dairy animals, where it undergoes hydroxylation in a procedure known as the detoxication stage. Following this, it is eliminated from the body and enters the bodies of newborns and people through the milk. The most crucial step in preventing milk's AFM1 content from rising above 50 ng/kg, which is already too high for human consumption, is to prevent it altogether. To do these dairy cows must be fed premium feed that is ideally free of mycotoxins. Numerous writers have demonstrated how the season affects aflatoxin M1 concentration. In comparison to hot seasons, they found that AFM1 concentrations were higher during cold seasons. According to several studies (Applebaum et al., 1982; Blanco et al., 1988b; Hussain and Anwar, 2008; Tajkarimi et al., 2008; Falla, 2010, Bilandzic et al., 2010), this is because milking animals are typically fed compound feeds during the winter, which causes the concentration of AFB1 to rise and, in turn, increases the concentration of AFM1 in milk. Furthermore, the presence of aflatoxin B1 in feeds is influenced by temperature and moisture content. In addition to being able to produce toxins, Aspergillus flavus and Aspergillus parasiticus may grow well in feeds with moisture levels between 13% and 18% and in environments with moisture levels between 50% and 60% (Jay, 1992).

The World Health Organization (WHO) suggests reducing AFM1 consumption to a minimum in order to minimize AFM1 potential risks, and it believes that there is not enough information to establish a reasonable exposure level. This suggests that out-pasturing of milking cattle may be another reason for low AFM1 levels in the summer. There is minimal scientific support for the regulation restrictions, which are highly erratic. In addition to standardizing the currently in place regulatory limitations for aflatoxins, efforts should be made to disseminate more comprehensive and detailed scientific information on the health risks to humans associated with long-term exposure to low levels of aflatoxin. AFM1 is commonly found in cow's milk and milk products. Therefore, it is necessary to regularly check milk and milk products for the presence of AFM1 contamination using precise and trustworthy analytical procedures. Maintaining minimal levels of AFM1 in dairy animals' diets is also crucial.

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