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AREVIEW ON AFLATOXIN CONTAMINATION OF MILK AND ITS PUBLIC HEALTH IMPLICATION

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SUMMARY: Aflatoxins are toxic compounds that are produced by certain strains of molds, namely, *Aspergillus flavus* and *Aspergillus parasiticus*. These molds may invade stressed crops in the field or proliferate in improperly stored feed..Animals are exposed to aflatoxin by consumption of feeds that are contaminated by aflatoxin-producing fungal strains during growth, harvest or storage. Dairy cows are one of the many species of animals that may suffer both long-term and short-term adverse effects from consuming aflatoxin contaminated feed. When cows are fed contaminated feed, aflatoxin B1 is converted by hydroxylation to aflatoxin M1, which is subsequently secreted in the milk of lactating cows. Aflatoxin M1 is quite stable towards the normal milk processing methods such as pasteurization and if present in raw milk, it may persist into final products for human consumption. AFM1analysis was conducted by various methods including thin layer chromatography, high-performance liquid chromatography and enzyme-linked immunoassays; but the ELISA method is mostly used because of its rapidity, simplicity and cheapness. Aflatoxins have been implicated in human health disorders including hepatocellular carcinoma, aflatoxicosis, Reye's syndrome and chronic hepatitis. Most controlling government agencies worldwide have regulations regarding the amount of aflatoxins allowable in human and animal foodstuffs. Many countries have declared limits for the presence of aflatoxin M1 in milk and milk products. The European Community and Codex Alimentarius Commission prescribed that the maximum level of aflatoxin M1 in milk and milk products should not exceed 50 ng/kg.Application of Good Agricultural Practices and Good Veterinary Practices by agriculture and also the Hazard Analysis and Critical Control Points (HACCP) system as a draft code of practice for pre harvest and post-harvest control of dairy cow's feed. In milk and dairy products processing is effective.
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Key words: Aflatoxin, Milk, Dairy cow, HACCP

1. INTRODUCTION

Mycotoxins are those secondary metabolites of fungi which are associated with certain disorders in animals and humans. The manifestation of toxicity in animals is as diverse as the fungal species which produce these compounds. In addition to being acutely toxic, some mycotoxins are now linked with the incidence of certain types of cancer and it is this aspect which has evoked global concern over feed and food safety, especially for milk and milk products (Celik *et al.*, 2005).

Aflatoxins are a group of mycotoxins mainlyproduced in animal feed by toxigenic fungi *Aspergillusflavus*, *Aspergillusparasiticus* and *Aspergillusnomius*. These fungi are ubiquitousand can occur in a wide range of agricultural commodities, such as cereals, nuts, and dried fruit and in feedstuffs. *A. flavus*only produces B aflatoxins, while the other two speciesproduce both B and G aflatoxins. AflatoxinsM1 (AFM1) and M2 (AFM2), are the hydroxylated metabolites ofaflatoxinB1 (AFB1) and 2(AFB2), respectively, and found in milk and milk products from livestock thathave ingested contaminated feed (Caloni *et al*., 2006).

Aflatoxin M1 (AFM1) is the hydroxylated metabolite ofaflatoxinB1 (AFB1) and can be found in milk and subsequently in other dairy products when lactating animals are fed with contaminated feedstuffs. Mammals that ingest aflatoxinB1 (AFB1)-contaminated diets excrete amounts of the principal 4-hydroxylated metabolite known as aflatoxin M1into milk (Prandini *et al*., 2009)

Aflatoxin contamination in milk and milkproducts is produced in two ways. Either toxins pass to milk with

ingestion of feeds contaminated with aflatoxin, or it results as subsequent contamination of milk and milk products with fungi (Celik *et al.,* 2005).The main feed sources of aflatoxins are peanut meal, maize and cottonseed meal. Many researchers reported that there was a linear relationship between the amount of aflatoxin M1 in milk and aflatoxin B1 in feed consumed by animals (Kamkar *et al.,* 2011).A recent study of aflatoxin contamination in Addis Ababa milkshed caused a very controversial milk safety issues and got public attentions (Gizachew *et al*., 2016)

Therefore, the objective of this senior seminar is to review existing information on source and occurrence of aflatoxin contamination of milk. With this mini-review to give awareness for the community about aflatoxin contamination of milk and dairy feed.

2. CHEMISTRY AND METABOLISM OF AFLATOXIN

Chemically, aflatoxins are difurocoumarolactones (difurocoumarin derivatives). Their structure consists of a bifuran ring fused to a coumarin nucleus with a pentenone ring (in B and M aflatoxins) or a six-membered lactone ring in G aflatoxins. The four compounds are separated by the color of their fluorescence under long wave. Ultraviolet illumination (B=blue,G= green). Two other aflatoxins M1 and M2 were isolated from urine and milk and identified as mammalian metabolites of AFB1 and AFB2 (Dhanasekaran, 2011).

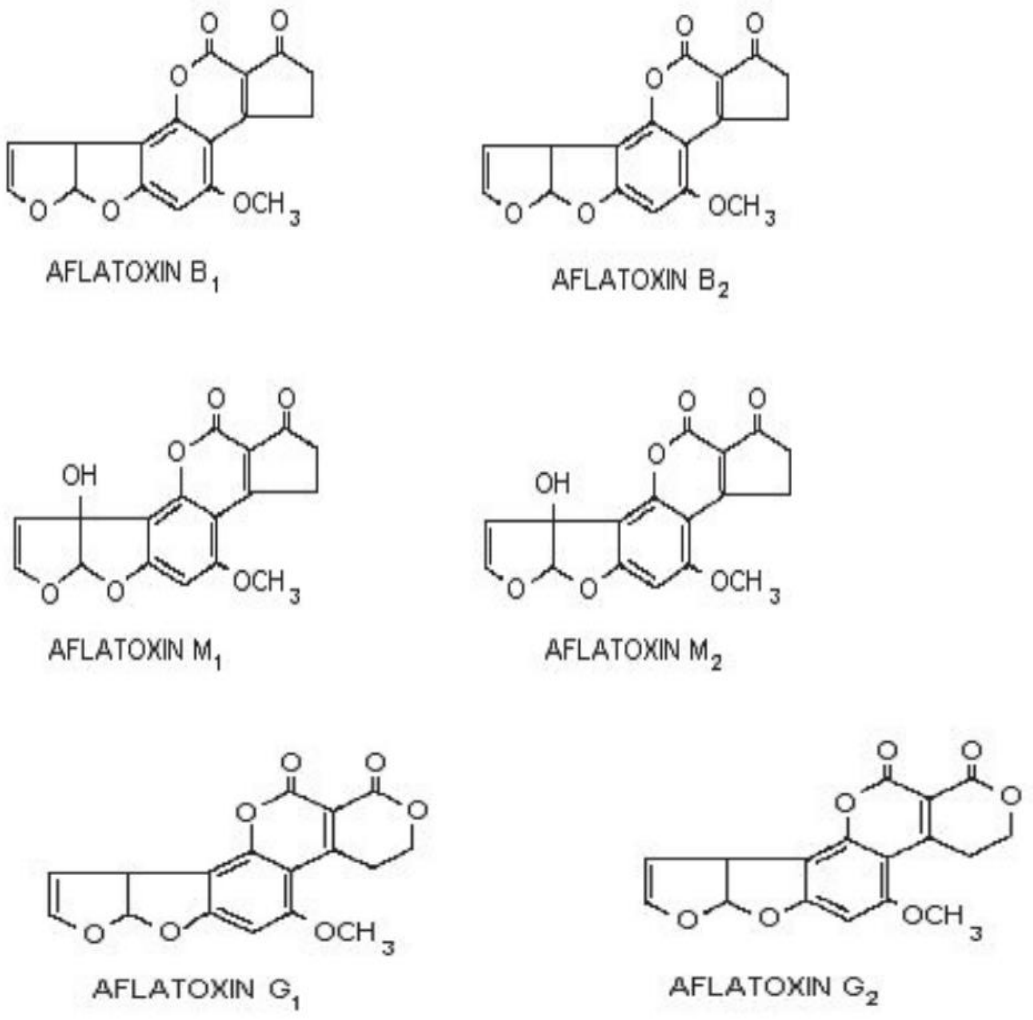

Fig.1. Structure of aflatoxin (Ayciceket al., (2005)

Aflatoxin B1 (AFB1) present in feed of lactating animals gets transformed to 4-hydroxylated metabolite in liver and is excreted in milk as aflatoxin M1 (AFM1). The AFM1 could be detected in milk 12-24 h after the first AFB1 ingestion, reaching a high level after a few days. When the intake of AFB1 is finished, the AFM1 concentration in the milk decreases to an undetectable level after 72 h.About 1-3% ingested AFB1 is converted into AFM1,but it varies from animal to animal, from day to day and from one milking to the other(Yitbarek *et al.*,2014).

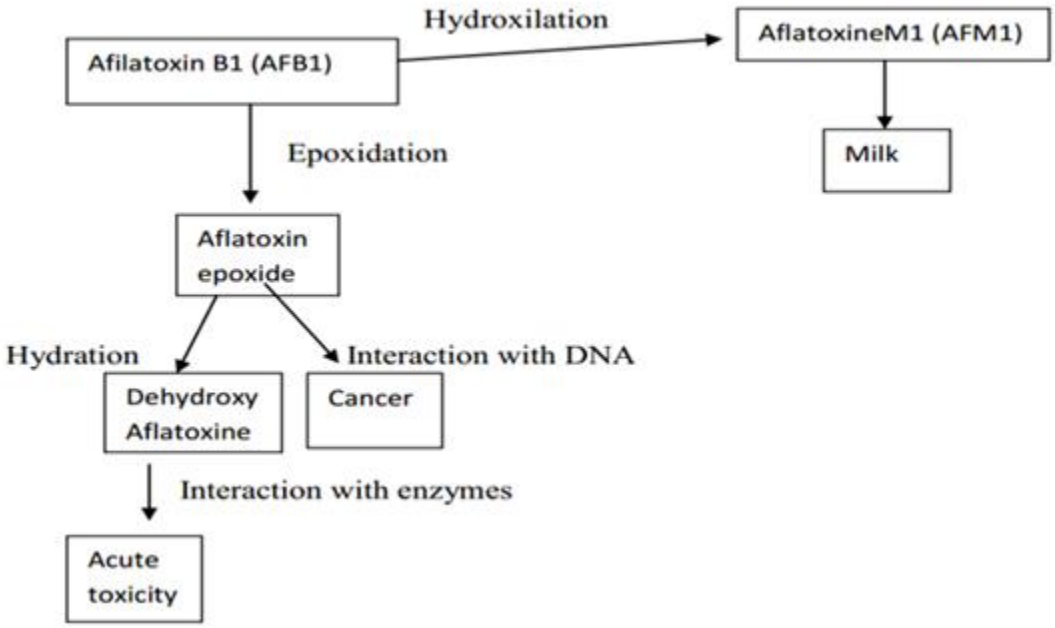

Fig 2. Some metabolic products from AFB1 (Markaki et al., 1997)

3. SOURCE AND OCCURRENCE OF OF AFLATOXINS IN MILK AND MILK PRODUCTS

Prior to AF contamination, the food material must be infected with fungi that have the genetic capacity to synthesize and deposit the toxins on the foods and feeds before or after harvest. Only species of the genus Aspergillus are responsible for synthesis of AF. Members belonging to this genus are most abundant in the tropics and are major food spoilage agents in warmer climates. The genus is metabolically versatile producing over twenty mycotoxins. Of the over 180 species of Aspergillus, only a few are aflatoxigenic (Anthony *et al*., 2012).

A. flavus and *A. parasiticus* are ubiquitous fungi, showing particular affinity for oily seeds as a growth source. *A. flavus* and *A. parasiticus* colonize plants in the field, with the most risky geographical areas being those with tropical or subtropical climate, but they can also colonize products in post-harvest if not adequately dehydrated. The temperature growth range of these fungi is 12–48 °C and can survive in soil, in crop residues, and when conditions are suitable they begin to produce spores which are spread by wind and so they can reach ears. *A. parasiticus* prefers a soil environment and is more common on pea-nuts while *A. flavus* is better adapted to an aerial environment (Prandini *et al*., 2009).

In general aflatoxin productiondetermined: presence of fungal spores; warm environment (range of 20–40oC); high moisture and oxygen (hydration of feedstuff above 20% dry matter and above 70% equilibrium relative humidity; poor air circulation; physical feed damage (i.e. by pests; plant stress such as drought, low soil fertility or insect infestation; presence of suitable organic substrate and suitable pH,range of 4–8 (Lanyasunya and Mutunga, 2012).

Aflatoxins can contaminate corn, cereals, sorghum, peanuts, and other oil-seed crops. Thus, food contamination by this group of mycotoxins has been implicated in both animal and human aflatoxicosis. Aflatoxins often occur in crops in the field prior to harvest. Postharvest contamination can occur if crop

drying is delayed and during storage of the crop if water is allowed to exceed critical values for the mold growth. Insect or rodent infestations facilitate mold invasion of some stored commodities (Hedayati *et al.,* 2007).The main feed sources of aflatoxins are peanut meal, maize and cottonseed meal. Many researchers reported that there was a linear relationship between the amount of aflatoxin M1 in milk and aflatoxin B1 in feed consumed by animals (Kamkar *et al.,* 2011).Groundnuts and groundnut meal are by far the two agricultural commodities that seem to have the highest risk of aflatoxin contamination. Although these commodities are important as substrates, fungal growth and aflatoxin contamination are the consequence of interactions among the fungus, the host and the environment. The appropriate combination of these factors determines the infestation and colonization of the substrate and the type and amount of aflatoxin produced (Dhanasekaran, 2011).

Aflatoxin-contaminated crop in dairy rations have resulted in aflatoxin M1 contaminated milk and milk products, including non-fat dry milk, cheese, and yogurt. Many other milk products such as cream, butter, ice cream may contain AFM1. The presence of AFM1in these products has rarely been investigated (Arapcheska, 2015).

3.1. Carry-over of AF in milk

The term carry-over indicates the passage of undesired compounds from contaminated feed into food of animal origin. Evidence of carry-over due to AFs has been found in milk, porcine tissue, and eggs, representing an additional risk of human exposure to AFs, a potential cause of secondary aflatoxicosis. In this perspective, the most threatening aspect of AF contamination of feed is related to carry-over of AFs in milk of dairy animals (Giovati *et al*., 2015). The major AF metabolite excreted in milk in all species is M1 (AFM1). This product of mammalian bioconversion of part of the ingested AFB1 is formed by oxidative reactions catalyzed by hepatic CYP enzyme system, which lead to hydroxylation in the terminal furan ring of the parental molecule (Roebuck and Wogan, 1977).

AFM1 is normally detected in milk within 12 h of administration of AFB1-contaminated feed. As a result of continuous daily exposure to constant levels of AFB1, the concentration of AFM1 in milk increases linearly for several days before finally achieving a steady-state, when an equilibrium between intake and excretion is established, and has been shown to decline as contaminated feed is withdrawn, reaching an undetectable level after 4–5 days (Masoero *et al*.,2007). The extent of carry-over in dairy cows is influenced by numerous nutritional and endogenous host factors, including breed, health of the animal, hepatic biotransformation capacity, lactation stage, and actual milk production (Volke *et al.,* 2011). Consequently, the excretion of AFM1 in milk may vary greatly between individual animals, from day to day, and from one milking to the next. From data obtained in different studies, the rate of AFB1 carry-over as AFM1 in milk of dairy cows was established to range from 0.3% to 6.2% .Higher carry-over percentages are recorded in high-yielding cows, because of the significantly higher consumption of concentrated feeds (Giovati *et al*., 2015).

Table1,Correlation between high-level AFM1 in milk and level of AB1 in feed collected from the corresponding dairy farms (Gizachew *et al*., 2016)

Town	Feed sample used by milk producers	AFB1(μg/kg)	AM1
Debrezeit	Wheat bran and noug seed cake mix	405	4.98
Sululta	Wheat bran,Maizegrain and noug seed cake mix	300	4.79
Sendafa	Wheat bran,Sweet pea hull mix	14	2.92
Addis Abeba	Wheat bran,Sweet pea hull and noug seedcake mix	72	2.92

4. DETECTION METHODS OF AFLATOXIN IN MILK

Several methods of extraction and detection have been used or developed for detection of AFM1in milk dairy products during the past decade. It is however important that to consider the type of matrix (fresh, stored, pasteurized milk, liquid or powder milk, cheese) as this can affect the final results. In addition, most of commercial kits or rapid tests are designed for specific

matrix. This makes the extraction of mycotoxins and AFM1from different matrices a challenge and costly (Chen and Peng, 2005).These are extremely important for determining the aflatoxin levels in various commodities. Simple and cost-effective methods are absolutely essential especially for developing countries. In the absence of reliable methods of analysis, it would be difficult to establish relevant tolerance limits. It is worth mentioning that tolerance limits cannot be lower than the actual limits of detection of the method employed for analysis (Waliyarand Reddy, 2009).

Therefore there is a need of sensitive methods for extraction and detection. Among screening methods, the enzyme-linked immune sorbent assay (ELISA) has been the most used as a screening method for AFM1 (Huwig *et al*., 2001).
The Aflatoxin M1 ELISA Kit represents a highly sensitive, a quick and economical which is designed to detect aflatoxin M1 in milk and milk products (Alex *et al*., 2014).Aflatoxin M1quantitative test is based on the principle of the enzyme linked immunosorbent assay. An aflatoxin conjugate is bound on the surface of a micro titer plate. Aflatoxin M1containing samples or standards and an antibody directed against aflatoxin M1are given into the wells of the micro titer plate. Immobilized and free aflatoxin M1competefor the antibody binding sites. After one hour incubation at room temperature, the wells are washed with diluted washing solution to remove unbound material. A peroxidase conjugate against the antibody is given into the wells and after hour incubation, the plate is washed again. Then substrate solution is added and incubated for 20 minutes, resulting in the development of blue colour. The colour development is inhibited by the addition of a stop solution, and the colour turns yellow. The yellow colour is measured photometrically at 450 nm (Pacheco, 2011).
The concentration of aflatoxin M1is indirectly proportional to the colour intensity of the test sample (Markaki *et al.*, 1997). Immediately after aflatoxin is detected in m ilk, the ration should be reformulated with ingredients that contain less than 20 ppb aflatoxin. If the level of milk contamination exceeds 0.5 ppb on a second test, a special dietary chemisorbent should be added to the diet at recommended levels. These compounds include clays (bentonites) at 1 percent of the diet, activated carbon at 1 percent of the diet and glucomannan (Mycosorb®) at 0.05 percent of the diet on a dry matter basis (Stark, 2010).

However, in one study, about 1/4 pound of hydrated sodium calcium aluminum silicate was shown to reduce aflatoxinM1 in milk about 50 percent when cattle consumed feed containing 200ppb aflatoxin. Silky clay loan soil and bentonite have a similar effect but have not been well studied. Many commercially available products also theoretically will bind aflatoxinM1 and should result in lower aflatoxin in milk. Generally, the cost of using the commercially available products is greater than the cost of using bentonite to bind aflatoxin (Jodie, 2012).

5. TOXICITY AND PUBLICHEALTH IMPLICATION OF AFLATOXIN

Aflatoxins are both acutely and chronically toxic. AFB1is one of the most potent hepato-carcinogens known, and hence the long-term chronic exposure to extremely low levels of aflatoxins in the diet is important for human health.AFM1is cytotoxic, as demonstrated in human hepatocytes and its acute toxicity in several species is similar to that of AFB1. AFM1 can also cause DNA damage, gene mutation, chromosomal anomalies and cell transformation in mammalians cells, in insects, lower eukaryotes and bacteria (Prandini *et al.,* 2009).It is important to realize that acute toxicity due to aflatoxins for any given species of animal is influenced by such factors as age, size, breed, condition of animal and composition of diet. Young animals tend to be more sensitive than mature animals. The presence of AFM1 and its by-products in milk represents a worldwide concern as even small amounts of these metabolites may be of importance for consumers of large quantities of milk, like children, who are, moreover, more susceptible to the adverse effects of mycotoxins. Consumption of milk contaminated with AFM1 may reduce the development of their immune competence making them more susceptible to other diseases. (Giovati *et al*., 2015). The susceptibility of animals to aflatoxins varies from species to species. Primary liver cancer is one of the most prevalent human cancers in the developing countries. Epidemiological studies support the association between the incidence of hepatocellular carcinoma and consumption of foods contaminated with aflatoxin. It is currently known that there are synergistic effects between aflatoxin and hepatitis B virus (which causes jaundice) infection causing primary liver cancer (Waliyarand Reddy, 2009).Calves also are more susceptible to aflatoxin and have died as a result of aflatoxin contamination in feed (Jodie, 2012).

6. EFFECT OF PROCESSING

Several studies showed that AFM1 is relatively stable toheat treatments such as pasteurization, sterilization and autoclaving, and other processes likefreezing, fermentation and cold storage (Chun *et al.,* 2009).Cultured dairy products are manufactured by heating milk and adding a starter culture to initiate the fermentation. Studies have not shown that there was a

significant decrease in the AFM1 content of cultured dairy products, such as kefir and yoghurt (Jodie, 2012).Concentration and drying of milk evaporated results of a partial or complete removal of water from milk, with or without heating, that leads to a concentration of milk solids and contaminants such as AFM1.This may make the toxin more susceptible to oxygen, light or other destabilizing factors. Large losses of AFM1 were reported in some studies, whereas in other works milk concentration did not affect the AFM1 content (Yousef and Marth, 1989).During manufacture of cream and butter,AFM1 is mainly soluble in the aqueous phase of milk or adsorbed to casein particles data of several studies show that a small proportion of AFM1 in milk is carried-over to cream, and yet a smaller proportion to butter. Theremainder of AFM1in milk, however, remains in skim milk and buttermilk (Roebuck and Wogan, 1977).

Inmanufacture of cheese AFM1 seems to be predominantly associated with casein, so that cheese curd contains a higher concentration than whey. Association of AFM1 with casein can be expressed as an enrichment factor (EF) for AFM1during cheese-making. Studies showed that the concentration ofAFM1is about 3 fold higher in many soft cheeses and about 5 fold higher in hard cheeses than in milk. Some studies demonstrated that cheese ripening and proteolysis of casein increases the recovery of AFM1 from naturally-contaminated milk; proteolysis may affect hydrophobic regions on casein associated molecules releasing AFM1(Yousef and Marth, 1989).

7. LEGISLATION WITH REGAR TO CONTROL AND PREVENTION OF AFLATOXIN CONTAMINATION

AFs are considered as ubiquitous and unavoidable contaminants of foods and feeds. Although it is difficult to remove AFs from human and animal diets, it is possible to decrease the risk of exposure through the establishment of regulatory limits and official monitoring plans to control the compliance of commodities with regulations through standardized analytical methods (Giovatiet al., 2015).Considering the health risks associated with AFM1, many countries have established legal limits for maximum residue level (MRL) of AFM1 inmilk. These limits are not universal to all countries (FAO, 2004).

To avoid carry-over for AFB1 in feed of lactating cows have also been set, ranging from 5 µg AFB1/kg of feed (European Community) to 10 µg/kg (China) and 20 µg/kg (USA) (FAO, 2004). However this tolerance level is difficult to observe because the average daily individual intake in a herd should be limited to 40 g AFB1 per cow, in order to produce milk with less than 50 ng AFM1per kg (Prandini et al., 2009).In developing countries of Asia and Africa, lenient standard limits for AFM1 (and AFs in general) and economic constraints for monitoring programs have been connected with the high prevalence rate of liver cancer (FAO, 2004).

The Commission of the European Communities established a limit for AFM1 of 50 ng/kg formilk and a variable limit for cheese, depending on concentration caused by drying process or processing. In this Regulation the Commission stated that ‘‘even if AFM1 is regarded as aless dangerous genotoxic carcinogenic substance than AFB1, it is necessary to prevent the presence in milk, and consequently in milk products, intended for human consumption and for young children in particular (Prandini *et al*., 2007).

If aflatoxin is detected in milk, it is critical that records be maintained of all feeds, feeding practices, milk quantities and contamination levels, plus animal health and performance. If the grain or related feed is fed to other animals, these records should be maintained also. After milk has been detected with greater than 0.5 ppb of aflatoxin in one load, all grain products fed to animals should be removed from the ration immediately and new grain and/or related items replaced in the diet. As cottonseed and corn are the most likely sources of aflatoxin contamination, these grains should be tested to determine their level of aflatoxin It is illegal to sell grain with levels greater than 20 ppb aflatoxin for lactating dairy cows, and the seller of the grain is responsible for damage resulting from the sale of grain. However, in most cases, perhaps 60 percent of the time, the exact source of feed contamination is not determined (Jodie, 2012).

Table 2 Maximumlimits for aflatoxin M1 in milk and milk products in various countries((Sherma, 2000).

Country	Maximum limit (µg/kg or µg/l)
France	0.05 Adult's milk 0.03 Children's milk
Turkey	0.05 Milk and products 0.25 Cheese
Czech Republic	0.1 Children's milk 0.5 Adult's milk
Belgium	0.050 Milk
USA	0.50 Milk
Switzerland	0.050 Milk and milk products 0.250 Cheese
Netherlands	0.020 Butter 0.200 Cheese
Germany	0.050 Milk
Australia	0.050 Milk

8. PREVENTION AND CONTROL

As corn infection from *A.flavus* mainly takes place in field, the prevention of fungal contamination in pre-harvest represents the best way to reduce risks of aflatoxin contamination and to guarantee a safe foodstuff (Prandini *et al.*, 2009).Controlling mold growth and aflatoxin formation in traditional farms and warehouses is highly important. In this regard, several studies have been carried out on quality of livestock feed and the amount of aflatoxin in produced milk (Creppy, 2002). For example, it has been shown that the amount of aflatoxin in milk produced in autumn and winter is higher compared to spring and summer this is because in cold seasons, feeding livestock on fresh forages is not possible due to unfavorable weather conditions and farmers have to use stored forages. Regarding that warehouse improper temperature and moisture conditions favor mold growth; therefore, it is necessary to improve storage conditions of livestock feed (Prandini *et al*., 2009).

Prevention during silage and storage is necessary to apply all those practices that allow compacting and closing of corn silage, practices which guarantee the fast activation of lactic fermentation. Use of organic acids (propionic and/or propionate, formic, etc. . .) is advisable; as they have been shown to be effective in reducing fungal development and mycotoxinformation (Jodie, 2012).

De silage operations; depth of the daily advancement front of the silage mass has to be of 30 In the case of corn grain silage, , taking greater care with the ensilage and cm in winter and 60–80 cm in summer(Creppy, 2002). .

Post-harvest prevention is necessary to limit to 24 h the permanence in heap ofwet grains with a temperature higher than 26–28 °C and to 48 h with lower temperatures; vice versa the heaps remained over 48 h and with mass temperatures higher than 26–28 °C have to be treated with organic acids (For example: Sodium propionate 0.3–0.4% in weight). It must be absolutely avoided the practice of preserving corn as wet ears into large net boxes (Hungarian boxes).for short-term storage (<3 months) and <12% for long-term storage (from 3 months to 3 years); if grain temperature is held under 12 °C and moisture to 14% can also beconsidered sufficiently sure for long-term storage. Kernelmechanical damages must be minimized, with progressivevariations of grain drying temperature, foreseeing an attenuation of heights of grain fall in the drying plant and areduction of grain handling through metallic elevator. (Prandini *et al*.,2009).Grains must be cleaned before and after the drying process, regulating the sieves and the ventilation in order to remove impurity, dusts, fragments, breaks and extraneous parts; there exist low cost mechanical sifting processes which can reduce over the 200% of the toxin. A timely cooling

of grains through refrigerator would be optimal and desirable, to lead mass to temperatures <20 °C. Subsequently, at the first cold period, it needs to ventilate the mass for conservative refrigeration and to lead the mass to 5–8 °C (Stark, 2010).

Storage sheds and silos have to be cleaned with care at the end of the season, mechanically removing the residues and everything adhering to walls and floors. It is advisable to preventively treat with specific insecticides, fumigant, baits and rodenticide; insecticides should be vaporized in the escape points of the silos or on the surfaces in contact with grains; use of fumigants is recommended in closed environments where a homogeneous diffusion or a fast removal of gas is possible (Chun *et al.*, 2009).

Good Feeding practices is also very important because mycotoxin content of feed is greater when maturationof plants and the first ensilage phases happen under high temperature conditions, typical of early cutting. For this reason it would be better use, corn silage obtained duringlate cutting for milking cows and those ones obtained during early cutting for less sensitive animals. If the presence of aflatoxins has been verified in farm feedstuffs or if an elevated number of positive samples has been found in corn silage, i.e. AFM1 content of milk >0.05 ng/kg , corn flour needs to be removed from the diet and replaced with another grain or feedstuff, wheat or barley(Creppy, 2002).

9. CONCLUSSION AND RECOMMONDATION

Aflatoxin is a highly toxic fungus that cause serious problem on animals and humans. It can be detected in agricultural products during harvesting, processing and storage. In order to face the problem of aflatoxin M1 in milk and dairy products, it is necessary to focus the attention on the most sensitive steps of feedstuff production for lactatingcows. There are also animal feeds those are more affected by aflatoxin than other feed sources such as peanut meal, maize and cottonseed meal.Different methodsare used to analysis aflatoxin in milk but ELISA is the most sensitive, quick and economical .Aflatoxin M1 remains is yet to be investigated in most of developing countries including Africa. As long as conditions favorable for aflatoxin contamination in food and animal feed are present, AFM1 in milk and milk products will continue to be an issue that needs constant monitoring because of the serious effects it could cause on human health, particularly children.

Developing countries compared to developed nations need to develop and implement regulations and control systems that would regulate AFM1 in milk and its products thus ensuring food quality and safety. In order to promote health and sanitation in the society and to decrease toxic levels of AFM1, Educating producers about planting, harvesting, newways to store and transport, especially ships that aresuitable for fungal growth;Extension of Industrial livestock husbandry and familiarity with the principles of proper livestock husbandry; Inspection of food products and animal feed by regular sampling Equipment, the Laboratories at the national level as well asmilk and dairy factories for testing some toxins. Prevent contamination of milk and dairy products duringprocessing and packaging; Knowledge of state health officials and administrators about the dangers that AFs plays in health, especially inhuman carcinogenesis. Regular inspection of dairy plants by relevantexperts, Try to implement further studies in the field ofoptimization techniques to reduce contamination ofAFM1.

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ABBREVIATION

DNA…….deoxyribonucleic acid
ELISA……....enzyme linked immune sorbent assays
HACCP…….hazard analysis and critical control points
HPLC……..high performance liquid chromatograph
TLC……..thin-layer chromatography

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