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Review

Mycotoxin Formation and Safety Evaluation in Traditional Turkish Cheeses

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Abstract

Turkey, which has a rich cultural diversity due to its geographical location, is also very rich in agricultural and animal product diversity as a result of the blending of these cultures. Cheese, which is thought to have been transferred to our culture from the Mesopotamian culture, especially in ancient times, is one of the most consumed food products in our country. In addition, it is known that more than 130 types of cheese are produced in our country, most of them are traditional cheeses specific to the region where they are found and carry a geographical trace. This cheese variety is sometimes due to processing conditions, fermentation time, whether or not the curd is boiled or not, sometimes the way and amount of salting, and sometimes various microfungi or bacteria used in fermentation. However, scientific studies conducted over the years have determined that microfungi, which are specific to the cheese variety, giving flavor, smell and aroma, can also form toxic metabolites, and these metabolites are cancer-causing agents that are harmful to human health. In this review, the variety of cheese in Turkey, the molds that can occur in cheese, their toxins and food safety precautions to be taken in this context are mentioned.

Keywords: Mycotoxin, Food safety, Traditional Turkish cheese, Cheese production.

1. Introduction

Milk and dairy products such as cheese and yogurt in human nutrition have an important place among the foods consumed worldwide. It is not knownwhere, when and by whom the first cheese, was produced. In the inscriptions dated to 7000-10 000 BC found in the archaeological studies carried out in Mesopotamian lands, images showing that cheese was produced at that time were found. The etymological studies show that the word cheese entered Turkish from Persian and was used for the first time in the Egyptian Mamluk period. In one of the important manuscript of the Turkish literature, 'Divan-ü Lugatu Türk', written by Kaşgarlı Mahmut, the words "*udhıtma*" or "*udma*" are used, corresponding to the word cheese. Cheese, which is thought to have come to Anatolia during the migrations from Central Asia and settled in Turkish language, is a very valuable food product because it is rich in protein, fat, calcium, magnesium, zinc and vitamins, especially vitamins A and B2. It is also very valuable in terms of being able to be preserved for a longer period of time without spoiling compared to milk [1,2, 3, 4, 5].

During the transportation of milk in bag-like containers made of tuluk in ancient times, the production of cheese, which is thought to have been discovered by separating the curd from its water as a result of the increase in acidity due to temperature and agitation, today, it is realized with a wide variety of traditional and technological methods. There are more than 1000 types of cheese in the world and these cheeses show different physical, chemical, microbiological and sensory properties depending on the unique process of each country and each region. Cheese, one of the indispensable tastes of world cuisine, takes its diversity from the social and cultural transformations of the country of origin and reflects the richness of that country's cultural heritage. Cheese varieties, which are basically similar in terms of production technique, show various differences in the production process steps, and each one has unique feature depending on these differences. Today, cheese production is generally carried out by blending traditional methods with technological methods [3, 6, 7]. Figure 1 shows the basic stages of cheese production, and Figure 2 shows the production process and steps according to cheese types.

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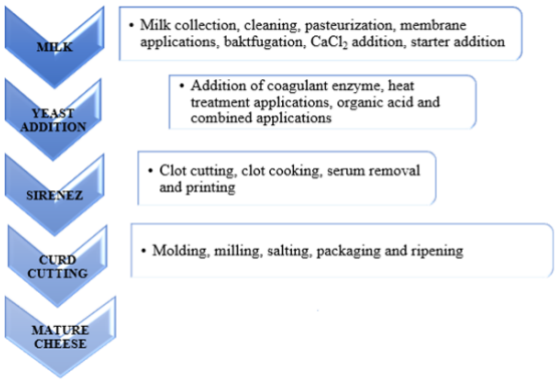

Figure 1. Basic processes and possible alternatives in cheese production

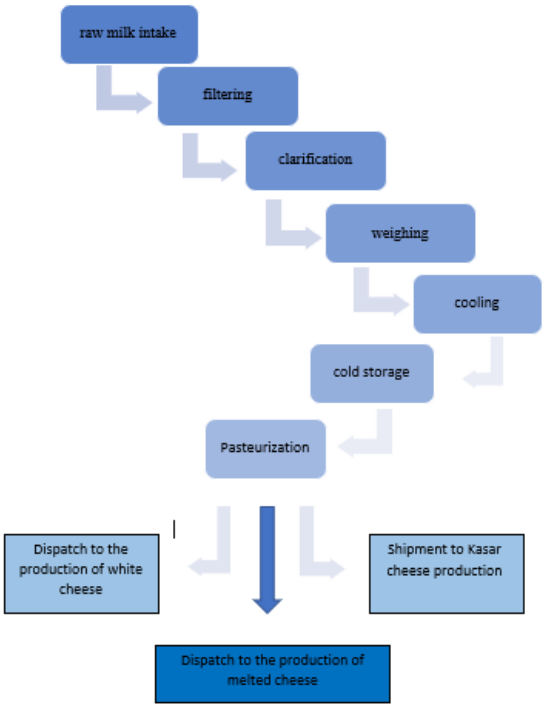

Figure 2. Cheese production work flow chart

2. Cheese Production and Diversity in Turkey

Conservation of milk by transforming into cheese, both in the world and in our country, has led to the emergence of many cheese varieties in parallel with the cultural richness for many years. The fact that our country has different climates and different vegetation due to its geographical location, has hosted many cultures throughout history, is suitable for livestock breeding due to its soil structure and land width, has allowed the emergence of products and production techniques specific. In addition to the diversity in the production technique, the type of milk (cow, dark, goat or buffalo milk), which is the raw material to be processed in the formation of different cheese types, whether the milk has been heat treated, the amount of fat in the milk (fat, semi-skimmed, non-fat), clot formation methods (yeast milk, acid). In the variety of cheese produced; many parameters such as the fermentation type (coagulation or acidification), the salt rate of the cheese and the salting method, the structure of the cheese (hard, soft, medium), ripening time and the addition of various additives are effective [8, 9, 10, 11, 12].

According to various sources, nearly 200 types of cheese are produced in Turkey with traditional methods, and more than 50 types of cheese are produced commercially. In addition, when the list of geographically indicated products announced by the Turkish Patent Institute is examined, it is seen that Turkey has a total of 14 geographically marked cheeses, 9 of which are named origin and 5 of which are geographical indication. Among these cheeses, the ones named origin: Erzincan Tulum Cheese, Thrace Ezine Cheese, Halloumi cheese, Kars Cheddar, Parmesan Cheese, Karaman Divle Obruğu Tulum Cheese, Malkara Old Cheddar Cheese, Antep Cheese (Antep Squeezed Cheese); The ones with the geographical sign mark are: Edirne White Cheese, Erzurum Civil Cheese, Erzurum Moldy Civil Cheese (Gögermiş Cheese), Diyarbakır Knitted Cheese, Yozgat Çanak cheese. Origin name; it is the name given to the products that have to be produced, processed and all other necessary processes in production in a geographical area whose borders are determined. If the geographical sign, is; It is defined as the name given to the products whose production, processing and at least one of the other processes must take place in a geographical area whose borders are determined [13, 11, 14, 15, 16].

Cheese, which is a very rich food in terms of nutritional values, is a very favorable environment for microorganisms to live and multiply. While some of these microorganisms (molds; give the unique taste, smell, aroma and textural properties of cheeses such as tulum, kaşar and cheddar, some bacteria can be used in fermentation) play a role in the production of food industrially, some of them cause a decrease in the quality of the food, a shortening of its shelf life and food poisoning in humans is happening. Bacteria and microfungi (molds and yeasts) have an important place among the microorganisms that deteriorate the product quality by causing taste, smell, aroma, appearance and deformities in cheese, shorten the shelf life and cause economic losses. Although microfungi are used in the production of many traditional cheeses such as Erzincan Tulum Cheese, Moldy Civil Cheese, Kars Kasar Cheese, Antakya Moldy Mulberry Cheese, Motal Cheese, Konya Moldy Cheese, Karaman Divle Obruk Tulum Cheese, Isparta Moldy Pot Cheese, Malkara Old Kasar Cheese, and in the formation of their unique taste, smell, aroma and textural properties; Scientific studies show that these microfungals form toxic metabolites that cause cancer [1, 17, 18, 19].

Mold is deliberately used in the production of some world-renowned cheeses such as Camembert and Roquefort. However, some contaminating or

technological fungal species have the potential to produce undesirable metabolites such as mycotoxins. Microfungi belonging to the genus *Aspergillus, Fusarium, Cladosporium, Geotrichum, Mucor, Trichoderma* and *Penicillium* are among the fungi that cause deterioration in the structure of cheese and the production of toxic substances that pose a great risk to human health. The toxic substances produced by these fungi are called mycotoxins. The most dangerous mycotoxins in cheese are M1 aflatoxin and A ochratoxin. These are followed by the contamination of milk and therefore cheese. Derived from the Greek words 'mykes' and 'toxicum', mycotoxins were first discovered in 1962 when turkeys ate peanut flour contaminated by *Aspergillus flavus*, as a result of a crisis that killed nearly 100,000 turkeys. Mycotoxins, identified as second metabolites, are not directly required for normal fungal growth and development and are generally found at low molecular weight. However, Mycotoxins are very dangerous substances for human health, even though they occur in very small amounts such as ppm or ppb, and when the necessary environmental conditions are met, about 400 mold species can produce toxic substances called mycotoxins [20, 21, 22, 23, 24, 25, 26, 27, 28].

Various mycotoxins have been detected in cheese in many studies from the past to the present. The most commonly identified of these mycotoxins is Roquefortin C. This mycotoxin has been measured at levels reaching 12000 μg/kg in blue cheese, manchego cheese and commercial Finnish cheeses. The presence of MPA has been reported at much lower levels, as much as 0.0003 μg/kg, for different types of blue mold cheese. The presence of AFM1 mycotoxin in cheese has been observed if it is present in milk. On the other hand, there are very few studies describing AFG1 and AFB1 in cheese.

Aflatoxin produced by *Aspergillus flavus* is formed by taking the letter "A" from *Aspergillus* and the letters "fla" in *flavus* and adding the word toxin to the end of Afla and is abbreviated as AF in nomenclature. [20, 21, 22, 23, 24, 25, 26, 27, 28].

Aflatoxins, which are the most concerned mycotoxins in cheese due to their frequent occurrence in milk and feed, can be added to dairy products in two different ways:

1. Consumption of contaminated feed during lactation period
2. Mold growth during ripening and storage of these products.

Aspergillus species synthesizing aflatoxin are common in the environment and can thrive in all climatic conditions. In addition, aflatoxins produced by *Aspergillus flavus* are resistant to temperatures up to 300°C and do not decompose in pasteurization heat. Therefore, cheese, which is a very valuable and high calorie food due to the richness of the nutrients it contains, can sometimes pose a risk to public health with pathogenic microorganisms, toxins and chemical residues [7, 27, 28, 29, 30, 31, 32, 33, 34].

3. Conclusions

Mycotoxins, which are common in cheese varieties produced both in the world and in Turkey, especially aflatoxins produced by *Aspergillus falvus* seriously threaten human health and cause economic losses to a large extent. In this regard, attention should be paid to mold formations that may occur during the production of traditional moldy cheeses unique to Turkey, the ripening of Tulum and Kasar cheese, and the ripening and storage of other cheese varieties; Necessary precautions should be taken to prevent mold and toxic substance transfer to milk by the consumption of moldy, contaminated food and feed by animals.

Conflict of Interest

The authors declare no conflict of interest.

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