THE APPLICATION OF SMOKING AND POLYCYLIC AROMATIC HYDROCARBONS IN CHEESE

Abstract

Smoking has been a method used in foods since ancient times. Natural and buffered smoking are widely used in foods. The smoking process is used as a step in the process for some traditional cheeses. Only locally made cheese in Türkiye is smoked and consumed as Smoked Circassian cheese. The polycyclic aromatic hydracarbon content of smoked cheeses varies depending on the kind of wood used to produce smoke, the smoking process, and the type of cheese. Studies have shown that, in general, industrially produced smoked cheeses contain fewer polycyclic aromatic hydrocarbons than traditional (home-type) cheeses. In addition, it was observed that the buffered smoking method contains fewer polycyclic aromatic hydrocarbon compounds compared to the natural smoking method. It is important for food safety and consumer health to ensure the transition to standard smoking techniques in businesses that produce with the traditional method.

Keywords: smoked cheese; smoking; PAHs; Smoked Circassian cheese

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I. INTRODUCTION

Smoking and smoking of foods is one of the oldest methods of food preservation and sensory quality [1]. When the smoke structure was examined, it was determined that 500 of the 1000 smoke compounds were effective in enhancing the smoke flavor [2, 3]. Smoke is formed by the decomposition of wood-forming materials, which are turned into volatile substances and charcoal by heat [4].

Heterocyclic products, which are formed together with glucose and pentosans, result from the combustion of cellulose and hemicellulose. These are butyrolactone, butenolide, furan, furfural, pyrrole, pyrosine, and carbozal. These products are efficient in the formation of taste and aroma. In addition, alicyclic compounds in smoke are cyclopentanone, cyclopendadione, and their derivatives, and they create a caramel-like burnt odor [2].

Aromatic chemicals that are found in smoke include phenol alcohol, phenol aldehyde, phenol ketone, phenol acid, phenol ester, and polycyclic aromatic hydrocarbons. Phenol is one of the most essential molecules in the formation of smoky flavors. These molecules are both responsible for color formation, have an antioxidant effect, and also prevent fat oxidation [5].

Polycyclic aromatic hydrocarbons (PAHs) are lipophilic, hydrophobic compounds composed of two or more fused aromatic rings. It occurs through the incomplete combustion of organic material during pyrolysis. Low-molecular-weight compounds have fewer than four rings and are classified as such. Compounds with a high molecular weight have four or more rings [1].

There are two reasons why polycyclic aromatic hydrocarbons are found in foods. The former reason is contamination from air, soil, and water. The latter reason is contamination, which occurs due to polycyclic aromatic hydrocarbons PAHs during food preparation and cooking at high temperatures. The major sources of polycyclic aromatic hydrocarbons are food processing (smoking and drying) and high-temperature cooking (grilling, roasting, and frying). Pyrolysis occurs as a result of oil dropping into the flame, particularly in meals cooked at temperatures over 200 °C, and polycyclic aromatic hydrocarbons are conveyed to foods via the ensuing smoke [6, 7].

Polycyclic aromatic hydrocarbons (PAHs) include over 100 distinct chemicals, with benzo[a]pyrene (BaP) being one of them. Among the 100 distinct PAHs, the United States Environmental Protection Agency (EPA) and the European Food Safety Authority Panel (EFSA) classify 16 PAHs, including BaP, as important contaminants in the food chain (Figure 1). Benzo[a]pyrene is a five-ring aromatic hydrocarbon (PAH) that is one of the most potent carcinogenic PAH chemicals [8]. In the European Union, the maximum permitted level for BaP derived from incense flavoring compounds in meals has been found to be 0.03 µg/kg. Although no regulation governs the BaP content in smoked meals, it is set at a maximum of 1 µg/g in European Union nations [9].

Many studies have been performed to determine the quantity of BaP in foods. Olives [10, 11], different cheeses [12, 13], and infant foods [11] have all been studied for this value.

The purpose of this research is to assess and evaluate smoking applications in cheeses as well as the relevance of polycyclic aromatic hydrocarbon components in cheese.

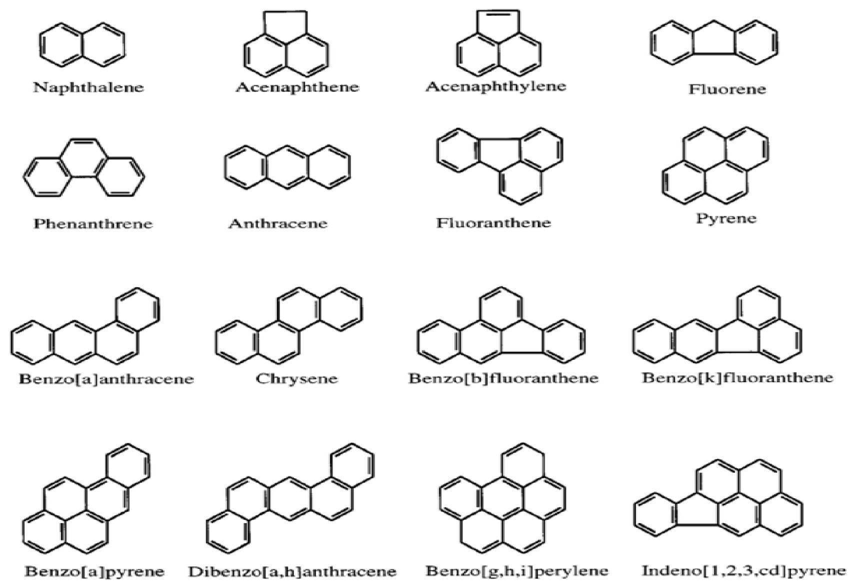

Figure 1: Structure of 16 U.S. EPA priority pollutant PAH compounds [14].

II. SMOKING APPLICATIONS IN CHEESE

Smoke is a polydisperse combination of air, carbon monoxide, carbon dioxide, water vapor, methane, and other gases in the form of liquid and gaseous solid compounds. Cellulose, hemicellulose, and lignin are formed during burning when oxygen is scarce. As the temperature rises, the thermal combustion of these pyrolysis products proceeds [1]. Guaikol and syringol are both efficient in the development of taste and odor [5].

Two types of smoking are common in foods. One of them is natural smoking, and the other is buffered smoking. Buffered smoking techniques have been developed in order to eliminate the disadvantages that may arise from natural smoking [15, 16].

Natural smoking is frequently performed in three ways:

- Cold smoking (at 10 – 20 °C)
- Hot smoking (at 30 °C)
- Very hot smoking (up to 80 °C) [17, 18].

The primary idea of buffered smoking is to obtain smoke molecules that are free of carcinogens. Depending on the technique of application, buffered smoke ratios applied to cheese range from 0.01% to 1% [19, 14].

Buffered smoke solutions contain some carboxylic acids with aroma and preservative effects and some esters with aroma-enhancing effects [2]. Buffered smoking has an important place in cheese technology as well as in the production of many foods in the food industry since the smoke compounds that give the product a smoke flavor and have antibacterial properties are better dispersed into the food with buffered smoking, and color and appearance defects are prevented after natural smoking [20, 21, 22]. However, it has been determined that there is no protective effect against microorganisms in buffered smoking compared to natural smoking made with wood [23 ,24, 25].

Buffered smoke can be done by one of the following methods:

- Using buffered smoke
- Addition to milk
- Spraying the curd before pressing
- Immersing the cheese mass, which is mixed with salt and wrapped with a permeable cloth, into a buffered smoke solution [16, 26].

The product to be smoked is smoked by hanging it in a smoky environment. Cold smoking (10-20 °C) is generally preferred for cheeses [16].

Traditionally, in cheese smoking, the relative humidity should be high and the temperature low. Smoke at high temperatures causes fat melting, weight loss, and deformities. In order to prevent the formation of black particles on the cheese surface, it is necessary to filter the smoke and select quality cheeses. Since the crust prevents the passage of smoke, the cheese to be smoked must not have a crust. It is desirable that the smoking temperature not rise above 25 °C. Cheeses are generally smoked at 10–20 °C [27, 28].

After ripening, several varieties of hard cheese become smoky. Cheddar and Provolone are the most commonly smoked cheeses. Idiazabal, Vrancea, Cociocovollo, Vologotski, Ricotto, Kabardinski, and Kolbanski are some additional smoked cheeses [27, 29, 22]. Only locally made cheese in Turkey is smoked and consumed as Smoked Circassian cheese [30, 31].

1. **Smoked Circassian Cheese:** Circassian cheese is a traditional cheese that plays a major role in the Turkish dairy sector, both in terms of production and consumption. It is a cheese produced in family businesses and small dairy farms in Samsun, Adapazarı, Kayseri, Sinop, Balıkesir, Bursa, Sivas, Düzce, Biga, and other provinces where Circassians are concentrated [32, 33, 34, 35].

   The consumption of open brown, thin-shelled, yellow, or cream-colored corn Smoked Circassian cheese, especially produced in Düzce and Hendek, is increasing. This type of cheese is low-fat, low-salt, fragrant, and smoked. In Manyas region, smoked Circassian cheese is also called "Kara Usul Çerkez" cheese [35].

   Circassian cheese, like Ricotta, Kareish, and Quesco Blanco cheeses, coagulates with acid and heat. As a raw material, raw milk is utilized. Although there are changes in production throughout time, raw milk is heated and pre-soured whey is gently added at the beginning of boiling in the production techniques of the traditional Circassian households. After the curd is collected with a scoop from the edges of the container to the middle. In this way, it is mixed slowly, and the acid is distributed to the whole mass. When the separation of white cheese clots and green curd juice is observed, it is taken into a filter mold. When the curd takes the shape of a container or basket, it is salted. Depending on the size of the cheese and the quality of the milk, approximately 5 hours is sufficient for the whey to be filtered at the desired level. After the filtering process, the size reduction process is performed, and the fumigation process is carried out. Figure 2 shows Circassian cheese smoked using the traditional method [36].

Figure 2: Traditionally Smoked Circassian Cheese[36].

In incense, woods such as hornbeam or oak with embers and less tar are used. The cheeses are smoked on the grills, suspended on specially made hooks inside the stove. Here, the cheese is both heated and dried, with the effect of heat and the soot caused by the fire burning at the bottom. Since the strong fire will dry the cheese and make it crusty, it is necessary to be careful that the fire is not too hot. The smoking process takes 3–4 days [31].

Smoking, on the other hand, is carried out at dairy establishments on specially designed shelves in the smoking room, with or without wrapping the salted cheeses in cheesecloth. In the center of the room, wood is being burned, and cheese is being smoked alongside it. When it is determined that it has been adequately dried and processed, it is removed from the shelves and made available for sale [33].

Natural smoked and buffered smoked Circassian cheese were evaluated in research that looked at the level of benzo(a)pyrene in each. While 5 µg/kg BaP was found in the shell portion of the natural smoked cheese, it was established that it was less than the limit value (0.25 µg/kg) in the interior portion. Benzo(a)pyrene was found to be below the limit values (0.25 µg/kg) both inside and outside of Circassian cheese smoked using buffered smoking [37].

III. POLYCYCLIC AROMATIC HYDROCARBONS

Pure polycyclic aromatic hydrocarbons are usually colored, crystalline solids at ambient temperature. Polycyclic aromatic hydrocarbons have a high molecular weight and low volatility and vapor pressure [38]. The lowest molecular weight is inden with 116 Da, and the highest is dibenzopyrene with 302 Da. The volatility diminishes as the number of fused rings increases. Some of the polycyclic aromatic hydrocarbons are colorless, pale yellow, or bright yellow. The melting point of most polycyclic aromatic hydrocarbon compounds is below 200 °C [39].

PAHs are polycyclic aromatic hydrocarbons made up of two or more fused aromatic rings. They have a strong lipophilic character and, form a widespread group of contaminants.

Contaminants (also known as PAHs) are classified into four categories. Pyrolysis, or incomplete combustion of organic material, produces polycyclic aromatic hydrocarbons [1]. PAHs contain a diverse spectrum of molecular components. They are classified as light polycyclic aromatic hydrocarbons (from naphthalene to benzo(a)anthracene) and heavy polycyclic aromatic hydrocarbons (from benzo(a)anthracene to further) [12].

It has been found throughout the environment, particularly in the air, soil, water, and food. PAHs are mostly released into the environment through volcanoes, burning forests, burning wood in settlements, coal tar, agricultural fires, asphalt roads, coal, cigarette smoke, municipal waste, the combustion of industrial waste, hazardous waste, and car and truck exhaust [40].

There are two reasons why PAHs are present in foods. The first is environmental (with air, soil, and water), whereas the second is created during food preparation and cooking. The primary sources of PAH synthesis are food processing operations (smoking, drying) and high-temperature cooking (frying, grilling, and roasting). When food comes into direct contact with a flame, the amount of PAH in the meal increases even more [41, 42].

Polycyclic aromatic hydrocarbons constitute the largest of the known chemical carcinogen classes, and they can be found on the surface of the water thanks to the waste water generated after the treatment in the plant and the water discharged from the industrial facilities. Leaking hazardous items from storage containers might discharge harmful compounds into the earth. The characteristic of polycyclic aromatic hydrocarbons, such as their capacity to dissolve in water and evaporate in air, determine their mobility in the environment. Polycyclic aromatic hydrocarbons are generally not readily soluble in water. It exists as small solid particles stuck on surfaces or as vapor in the air [40].

1. **Chemical and Physical Properties of PAHs:** PAHs are organic compounds that include at least two condensed or fused aromatic rings, as well as hydrogen and carbon atoms. At room temperature, pure polycyclic aromatic hydrocarbons often take the shape of a colorful, solid crystal. Their physical qualities differ depending on molecular weight and structure. The vapor pressure of polycyclic aromatic hydrocarbons drops as their molecular weight increases. Lipophilicity is high in polycyclic aromatic hydrocarbons. As a result, it can be combined with organic solvents. Furthermore, the water solubility of the polycyclic aromatic hydrocarbon diminishes with each additional ring. Light sensitivity, heat resistance, conductivity, corrosion resistance, and physiological impacts are all characteristics of polycyclic aromatic hydrocarbons. The UV absorbance spectra of polycyclic aromatic hydrocarbons are distinctive. This is very effective for determining polycyclic aromatic hydrocarbons. When stimulated, most polycyclic aromatic hydrocarbons have fluorescence characteristics and produce distinct wavelengths of light [38].

   Polycyclic aromatic hydrocarbons are soluble in acetic acid, benzene, acetone, toluene, xylene, 1,4-dioxane, mineral oil, olive oil, and cyclohexane. However, they are insoluble in diethylether and petroleum ether. PAHs are poorly soluble in water. The reduction in water solubility is proportional to the number of benzene rings [39].

2. **Effect of PAHs on Human Health:** PAHs circulate in the environment due to features such as water solubility and quick evaporation in the air. In this phase, these chemicals may travel quite a distance with the wind. PAHs can enter the human body when humans breathe this contaminated air. Ingestion of PAH-containing drinking water, food, and other items is another way these compounds reach the human body. PAHs can infiltrate all fat-containing tissues in the body. They are most often kept in the liver, fat, and kidneys [43]. In the general population, the major sources of exposure to polycyclic aromatic hydrocarbons are breathing ambient air, ingesting foods containing polycyclic aromatic hydrocarbons, smoking, or inhaling fireplace smoke. Food is the most dangerous factor for nonsmokers. The major sources of polycyclic aromatic hydrocarbon generation include processing (such as drying and smoking) and high-temperature cooking (grilling, roasting, and frying). Wheat, rye, and lentils, for example, can generate polycyclic aromatic hydrocarbons or absorb them through water, air, or soil [38]. More than 20 PAHs have been detected in foods, and more than ten of them have been shown in animal studies to be carcinogenic. Some PAHs ingested by inhalation or skin have been shown to cause cancer in the lungs and skin, while others have tumor-forming properties.

PAHs that are very likely carcinogenic, according to the International Agency for Research on Cancer, are benzo(a)anthracene, benzo(a)pyrene, and dibenzo(a,h) anthracene. PAHs that are possible carcinogens are as follows: benzo(k) fluoranthene, benzo(b)fluoranthene, chrysene, benzo(j)fluoranthene, 7Hdibenz(c,g) carbazole, dibenzo(a,i)pyrene, dibenzo (a,1) pyrene, indeno (1,2,3-cd)pyrene, dibenz (a,h) acridine, dibenzo (a,e) pyrene, dibenzo (a,h) pyrene [6]. PAHs, in general, are linked to an elevated risk of cancer.

PAHs, which can harm genetic elements and so cause cancer to form [40]. PAHs move to the hydrophobic sections of the food chain due to their physical and chemical characteristics. As a result, they accumulate in lipids at the bottom of the food chain. The majority of persons are exposed to these substances via their food [44]. The carcinogenic benzo(a)pyrene is widely used to detect the presence of PAHs in foods and water. For food eaten without preparation, the maximum permitted quantity of BaP from European Union incense flavoring agents is 0.03 µg/kg. Although there is no regulation governing the quantity of BaP in smoked foods, the European Union set a limit of 1 µg/g, which was followed by Austria, Israel, Switzerland, and East Germany [9].

IV. SOME RESEARCH ON SMOKING AND POLYCYCLIC AROMATIC HYDROCARBONS IN CHEESE

Cheese has an important place among various smoked foods. Cheese smoking is often carried out in both traditional and industrial ways. The smoke method and level are important in the smoking process. In general, the status of smoking procedures can influence the amount of PAH in smoked foods [45]. Some research on smoking and polycyclic aromatic hydrocarbons are given (Table 1).

Table 1: Some Research on Smoking and Polycyclic Aromatic Hydrocarbons

Cheese Type	Smoked method	PAHs which is determined	Reference
Smoked cheeses of different origin	Commercial smoked cheese	Benzo(a)pyrene	Guillén and Sopelana,[46].
Pasta filata cheese	Traditional smoking (warm smoke)	16 PAHs	Pluta-Kubicca et al. [47].
Local and Indusrial cheeses	Commercial smoked cheese	15 PAHs	Polak-Śliwińska et al. [48].
Smoked cheese in the Canary Islands	Traditional smoking (Drum and kiln type)	18 PAHs	Conde et al. [49].
Smoked buffalo Mozzeralla cheese	Different smoked methods	8 PAHs	Fasano et al. [50].
Slovakian smoked cheese	Home-made oven	Benzo(a)pyrene	Michalski and Germuska, [51].
Smoked stirred curd Cheddar cheese	Cold wood smoke in aa chamber		Rizzo et al. [52].

In the preparation of smoked foods, several types of wood and materials are employed as smoke sources. Five buffered smoked samples from various wood species (oak, cherry wood, beech, poplar, and grapevine shoots) were tested in the research. The results of the oak, cherry and beech samples were extremely comparable. Poplar was found to have the highest individual and total PAH concentrations [23].

Pagliuca et al. [53] found total high molecular weight polycyclic aromatic hydrocarbons in 15 smoked Diavoletto cheeses ranging from 0.12 to 6.21 ppb. The sample smoked with pine wood had the greatest quantity of benzo[b]fluoranthene (BbF) (0.44 g/kg). BbF levels (0.41 g/kg) were found to be comparable in fir wood and smoked cheese. Wheat straw and smoked cheeses had the lowest quantities of high-molecular-weight polycyclic aromatic hydrocarbons [53].

The smoking method also affects BaP and benzo(a)anthracene (BaA) levels in cheese. There are many studies comparing the industrial-scale smoking process with the traditional method. Gul et al. [54] examined the polycyclic aromatic hydrocarbon content of 50 industrially produced (25 smoked, 25 unsmoked) and 20 traditionally produced Circassian cheeses (10 smoked, 10 unsmoked). Traditional smoked cheese samples were found to have higher polycyclic aromatic hydrocarbon components than industrial smoked cheese samples. Suchanovâ et al. [55] investigated the PAH concentrations of 36 different smoked cheeses. The PAH concentration of the smoked samples was determined to be 0.11 µg/kg under industrial conditions. It was determined that the cheeses produced by the traditional method had a higher PAH content. A value below the BaP limit value (0.03 µg/kg) was found in commercial goods produced by fuming technology. It was detected in the range of 0.6 µg/kg to 0.9 µg/kg in traditional smoked cheeses.

According to reports, their position in the smoking chamber has an influence on the overall quantity of PAH chemicals in cheese. Guillén et al. [12] discovered that the content of total polycyclic aromatic hydrocarbons in smoked Herreno cheeses differed substantially (1915.16 µg/kg and 423.39 µg/kg) in their investigation. Cheeses closer to the smoke intake have been shown to contain higher levels of polycyclic aromatic hydrocarbons. As a result, they observed that smoke entering the smokehouse from varied heights and sides can result in a more homogenous distribution of smoke on the cheese surface and a more homogeneous degree of smoking of the cheeses. Furthermore, they claimed that increasing the distance between the source of the smoke and the smoke chamber could avoid or at least decrease the formation of PAH chemicals.

Simultaneously, the BaP level of smoked cheeses fluctuates depending on the outside and inside of the cheese. BaP residues ranged from 0.50 to 2.40 g/kg in the crust, 0.22 to 1.03 g/kg in the slice, and 0.18 to 0.46 g/kg in the interior, according to Anastasio et al. [56]. The rind of the cardboard and smoked Mozzarella cheese had the highest BaP value of 2.40 g/kg. Naccari et al. [13] studied the BaP and BaA levels in Provola cheeses, both natural and buffered smoked. When the BaP and BaA concentrations in the cheese's core, outside section, crust, and slice were compared, it was determined that the crust was the most polluted and the inside part was the least.

1. **Microbial, Sensory and Chemical Properties of Smoked Cheese:** Several studies have been conducted to investigate the microbiological, sensory, and chemical aspects of smoked cheeses. Majcher et al. [57], for example, investigated the sensory and microbiological profiles, as well as volatile components, during the smoking of Oscypek cheese. They determined that there were fifty-four volatile compounds in nine different groups (free fatty acid, ester, ketone, alcohol, aldehyde, furan, phenol, sulfur, and milk flavor) in smoked Oscypek cheese. They discovered that the sensory aroma profile study of smoked and unsmoked cheeses correlated with the volatile chemical analyses. According to the microbiological profile, several bacteria were reduced in smoked cheeses. In this study, it was observed that smoked cheeses consisted of three compound groups. They stated that the first group is composed of compounds formed by biochemical reactions (free fatty acids, ester, ketone, alcohol, aldehyde, sulfur), the second is composed of smoke-induced compounds (furan, phenol), and the third is milk flavor (terpenes) affected by smoking. Adhikari et al. [58] used sensory and instrumental methodologies to evaluate the association of full-fat, low-fat, and smoked cheeses with sensory and instrumental information. The structure, taste, and smell of nine commercial cheeses were analyzed in the study, and an instrumental texture profile was developed. In sensory assessments, nine panelists evaluated the cheeses as smoked or unsmoked based on fragrance and taste, and their fundamental structure as dry and crumbly or sticky and creamy. Due to fairly similar "stickiness" ratings, the textural data grouped the smoked cheeses together. According to the statistical analysis, there was a relationship between sensory texture and instrumental texture data. Elortondo et al. [59] evaluated the influence of smoking on the sensory qualities and acceptability of Idiazabal cheese during ripening. They discovered that conventional smoking had a bigger impact on cheese acceptance than brine time and enhanced the look, odor, and texture of the cheese. They also noticed that smoking had a favorable effect on the cheese rind.

According to research that looked at the influence of smoking on the microbiological characteristics of cheeses, smoked cheese had greater mold development than natural unsmoked cheeses. It has been found that phenolic chemicals in smoke impede mold development and have a fungistatic effect. Only isoeugenol was shown to be inhibitory for all three molds tested (*Penicillium roqueforti, Penicillium camemberti*, and *Aspergillus oryzae*) [60]. Shaiban et al. [61] used three types of local wood materials: spiny jujube (*Zizyphus spina christi*), Acacia tree (*Acacia asak*), and Dodenya (*Dodonia viscosa*) in cheese smoking in Yemen. The total phenol content of the smoked cheese samples was then determined. It has been reported that there was no variation in the phenol content of cheeses smoked with three different woods. The overall phenol level of commercial smoked cheeses has been observed to be greater than that of cheese prepared with these three distinct woods.

V. MICROBIAL DECREASE OF POLYCYCLIC AROMATIC HYDROCARBONS

The first method for destroying PAH contamination is the biodegradation of polycyclic aromatic hydrocarbons conveyed to the environment by natural microorganisms. *Achromobacter, Acinetobacter, Alcaligenes, Arthrobacter, Bacillus, Flavobacterium, Nocardia, Pseudomonas,* and *Corineforms* have been found to be the most common PAH-degrading bacteria in both soil and marine environments [62]. PAH concentrations in milk samples were shown to be reduced by *Bifidobacterium bifidum*. Many things influence the reduction process. These elements are as follows: pH may be used to describe microbial development parameters such as microbe kind, microbial concentration, and temperature [63]. In their research, Abou-Arab et al. [40] evaluated the impact of several lactic acid bacteria on the breakdown of PAHs. They added 0.25 µg of 16 polycyclic aromatic hydrocarbons to the MRS medium. It was observed that after 72 hours of incubation at 37 °C, lactic acid bacteria reduced polycyclic aromatic hydrocarbons. Naphthalene, acenaphthene, acenaphthylene, and 2-bromonaphthalene were not detectable in the samples after 48 hours of incubation. *L. bulgaricus* produced similar findings as *B. bifidium*. At the 48th hour of incubation, acenaphthene, acenaphthylene, naphthalene, and 2-bromonaphthalene compounds were also lost.

VI. CONCLUSION

The smoking of foodshas been used as a preservation method for centuries. The smoking process is used as a step in the process for some traditional cheeses. Polycyclic aromatic hydrocarbons are lipophilic, hydrophobic compounds composed of two or more fused aromatic rings. Polycyclic aromatic compounds formed during this process are important for consumer health. The polycyclic aromatic hydracarbon content of smoked cheeses varies depending on the kind of wood used to produce smoke, the smoking process, and the type of cheese (hard, soft, fatty, or low-fat).

Studies have shown that, in general, industrially produced smoked cheeses contain fewer polycyclic aromatic hydrocarbons than traditional (home-type) cheeses. It may be due to the fact that the production is carried out under more controlled conditions in industrial production, and there is no standard smoking process in traditionally produced cheeses. In addition, it was observed that the buffered smoking method contains fewer polycyclic aromatic hydrocarbon compounds compared to the natural smoking method. It is important for food safety and consumer health to ensure the transition to standard smoking techniques in businesses that produce with the traditional method.

It has been stated in studies that the shell, which is the part of smoked cheese samples, contains higher amounts of PAH compounds than the center of the smoked cheese. In terms of consumer health, the consumption of smoked products from industrial scale companies is recommended, while the consumption of the shell part of the cheese should be avoided due to the possible exposure to PAH compounds.

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