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Food Safety Debates of Salt

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Abstract
Salt is the most commonly used additive for preservatives, flavor enhancers, and retention and release of water in foods. Excessive salt consumption is a factor in the formation of cardiovascular diseases, hypertension, kidney diseases, osteoporosis, stomach diseases, obesity and some other diseases. For this reason, health institutions are working to reduce salt consumption. On the other hand, salt can contain important risks such as radioactives, heavy metals, microplastics, dynamite residues and exhaust in terms of food safety. In this study, salt was evaluated in terms of food safety.

Keywords: *Salt, Residue, Heavy Metal, Microplastic, Radioactivity*

Tuz Üzerine Gıda Güvenliği Tartışmaları

Özet
Tuz, gıdalarda koruyucu madde, lezzet arttırıcı, su tutma ve salınımı için en yaygın kullanılan katkı maddesidir. Aşırı tuz tüketimi, kardiyovasküler hastalıklar, hipertansiyon, böbrek hastalıkları, osteoporoz, mide hastalıkları, obezite ve bazı diğer hastalıkların oluşumunda bir faktördür. Bu nedenle, sağlık kurumları tuz tüketimini azaltmak için çalışmalar yapmaktadır. Öte yandan, tuz, gıda güvenliği açısından radyoaktif maddeler, ağır metaller, mikroplastikler, dinamit kalıntıları ve egzoz gibi önemli riskler içerebilir. Bu çalışmada, tuz gıda güvenliği açısından değerlendirilmiştir.

Anahtar kelimeler: *Tuz, Kalıntı, Ağır Metal, Mikroplastik, Radyoaktivite*

1. Introduction

For thousands of years, salt has been used as a unique food preservation method. While the development and widespread use of refrigeration and freezing technologies in the last century has reduced the importance of salt in food preservation, the taste feature of salt has become even more important. In addition, with scientific and technological developments, the usage area of salt has expanded and the amount of salt used in food has dropped below 25%. Although salt is found in food raw materials, it is the most common and/or widely used additive. In addition to playing important roles in human physiology, nutrition and health, salt has very important functions such as flavor, shelf life and texture in foods. The accessibility and cheapness of salt makes its use widespread in the food industry. There is almost no food that does not contain salt (except purified and concentrated foods such as refined sugar and oil). As a natural consequence, more than 75% of the salt consumed comes from processed foods [1]. However, with the increase in fast food and ready meal consumption in recent years, salt consumption has started to increase again.

Salt is the most commonly used additive for preservatives, flavor enhancers, and retention and release of water in foods. Normally, salt does not show antimicrobial activity, but it slows down or even stops microbial growth by reducing water activity, in other words, by reducing the water available to microorganisms. Techniques used in food preservation are based on limiting and/or stopping microorganisms found in foods [2]. Food preservation techniques; reducing water activity (drying and curing), temperature (high enough to kill microorganisms and low enough to slow down the activity of microorganisms), increasing acidity or lowering pH (by fermentation and/or addition of acids to food), chemical additives (nitrate, nitrite, sulfite), The use of salt in almost all techniques with competitive microorganisms (sucuk, yoghurt, pickles, wine) and gases in the atmosphere of food packaging (carbon dioxide, nitrogen, oxygen or vacuum) increases the microbial destruction effect [3]. Therefore, salt is more or less part of the production method in all ready-to-eat foods. Salt added to food by the final consumer constitutes approximately 25% of total salt consumption. In other words, 75% of the salt consumed by consumers is included in the content of the food when purchasing the food [4, 5].

However, excessive salt consumption paves the way for many diseases. The World Health Organization (WHO) recommends that daily salt intake should not exceed 5 grams in adults. The total amount of sodium entering the body is important in determining this amount. WHO recommends consuming less than 2 g sodium (5 g salt) per person per day. More than 95% of consumed sodium comes from salt (WHO, 2008). While per capita salt consumption is around 9-12 g in industrialized countries, it is stated to be 12 g in our country [6]. For this reason, public authorities in the world and in Turkey are working to reduce salt consumption. In this context, public awareness is increasing about hypertension, cardiovascular diseases, kidney stones, osteoporosis and some cancers caused by excessive sodium taken with salt. In Turkey, efforts to reduce salt consumption include reducing the salt content of processed foods by legal means and reporting the salt content of foods on their labels [7-13]. Salt reduction strategies are implemented in more than 75 countries. Salt reduction strategies; It is done in many ways, such as ensuring less salt use in the food industry by changing the formulations in processed foods, targeting foods with high sodium content, educating consumers, including salt content and total content on labels, increasing taxes on foods containing high salt, and interventions by public institutions.

Especially in recent years, statements that ferrocyanides used as anti-crystallization or anti-caking additives in the production of refined food salt are toxic have changed the attitude of meticulous consumers towards refined salts. Food additives; Just like the active pharmaceutical ingredients, it is evaluated and permitted for use by the joint committee established by the World Health Organization and the Food and Agriculture Organization. The toxic dose of the additive is determined by toxicological tests performed first on guinea pigs and then on primates. Afterwards, the effective dose is determined for the foods to be used. Thus, it is determined that the potential food additive can be used in which food item and in what dosage. This value is usually around one percent of the toxic dose in primates. The amount of E536 (Potassium Ferrocyanide) and E538 (Calcium Ferrocyanide) that can be used in refined salts is determined by the World Health Organization and the Food and Agriculture Organization as 20mg/kg, and this value is one percent of the toxic dose. The use of ferrocyanides in food-grade salt is limited in industrial food production. For both ferrocyanides, the limit is 20 mg/kg in the European Union, Japan, and Turkey. Potassium ferrocyanide is banned and sodium ferrocyanide limited to maximum 13 mg/kg in the United States of America and both ferrocyanides are limited to 14 mg/kg for food-grade salts [14-17].

Marketing is done to encourage consumers not to consume unrefined salt and to consume raw salt, on the grounds that minerals that are essential for humans are removed through salt refining. Many sources state that some salts contain more than 80 minerals. Along with C, H, O, N, which participate in the organic structure in living organisms, Ca, P, Mg, K, Na, Cl, S, Fe, Cu, Co, Zn, Mn, Cr, Mo, F, Se, I, B The existence of elements such as , As, Br, Si, Ni, Al has been reported by various researchers. Among these, the macro minerals that the body needs more are Calcium (Ca), Sodium (Na), Potassium (K), Phosphorus (P), Magnesium (Mg); Zinc (Zn), Iodine (I), Copper (Cu), Selenium (Sl), Iron (Fe) can be given as examples of micro minerals that the body needs less. Crude salts generally contain more than 97% NaCl and more than 1% insoluble matter. Therefore, the mineral content of unprocessed salts is at most 2%. It is possible to consume 0.02 g of minerals with a maximum daily salt consumption of 5 g, which is considered appropriate for healthy individuals, but this does not make salt a mineral source. Most of the elements claimed to be minerals in unrefined salts are heavy metals or radioactive. On the other hand, while the human digestive system can absorb scientifically accepted minerals in their form bound to organic molecules, the absorption rate of inorganic ones is very low. It has been stated in many studies that in order to get even some of the daily needed minerals from salt, it is necessary to consume kilos of salt.

Health-conscious consumers have reduced their salt consumption to avoid the risk of excess salt, while also shifting their salt preferences from fine table salt to coarse salt to avoid food additives such as ferrocyanides. Salt producers also inform consumers through various channels that their salt contains essential minerals. On the other hand, the information that essential minerals are separated from salt during the salt refining process is announced to consumers in various ways. Advertising salt within the scope of reducing salt consumption is prohibited in Turkey and many other countries. Sea, lake, spring and rock salts may have different sensory properties desired by consumers, depending on the craft techniques. In recent years, there has been an increase in the consumption of natural coarse salt, which is usually sold with a spice grinder. The popularity of natural coarse salts, especially gourmet salts, is increasing. Gourmet salts are distinguished from ordinary salts by their special taste, easy dissolution, crisp texture and/or essential mineral content, as well as their salty taste. For these reasons, gourmet salts can find buyers at much higher prices than ordinary salts. Adulteration of gourmet salts can be accomplished by mixing or substituting with a cheaper table salt [18-20].

2. Food safety and Salt

Food is essential for life, so safe food is a fundamental human right. The most summary goal of food safety is; The products produced do not harm consumers or the environment we live in in terms of biological, physical and chemical aspects. Food safety is the whole of the measures taken to ensure food production without risk to human health. Food that does not harm human health if consumed is safe food. According to the Turkish Food Codex Salt Communiqué published in the Official Gazette

No. 28737 on 16 August 2013, safe food production is aimed by envisaging the production, preparation, processing, preservation, storage, transportation and marketing of salt in a technical and hygienic manner. Salt does not inherently carry microbial risks. However, chemical contamination poses major food safety risks for salts produced for food purposes. In terms of food safety, salts, heavy metals, radioactive elements, microplastics, exhaust, dynamite/explosive residues and organic residues pose risks. While direct human consumption of unprocessed raw salts is not recommended due to their impurities, on the contrary, the increase in different raw salts in the market shows that these salts are consumed with food [21,22]. Salt is one of the most common molecules on the planet. Sea, lake, river and rock salt can be produced all over the world. However, the residues contained in these salts are directly related to the pollution of the place where production takes place. Heavy metal and microplastic pollution in sea and lake salts around the world have been detected by many researchers. Radioactive elements can be found in places where radioactive experiments are conducted, nuclear leaks occur and active volcanoes exist. On the other hand, radioactivity can also be detected on the routes of nuclear ships and submarines. River salt washes underground salt mines and carries the salt to the surface. Heavy metal residues may also be found in these salts.

2.1. Microplastic Pollution in Salts

The presence of microplastics in ecology is a global environmental pollution problem. The presence of microplastics in food is a serious food safety problem. In recent years , microplastics have been detected in sea, lake, stream and rock salts; has made microplastic a food safety risk for salts. Even in refined salt samples from salt water, microplastics can contaminate the salt. On the other hand, salt can grind the packaging material in which it is placed and the packaging can contaminate the salt. For this reason, microplastics can be detected in natural and refined salts obtained from rock salts. Studies have shown that while the salt with the lowest microplastic content is rock salt, microplastic pollution in rivers, lakes and sea salts increases respectively. Microplastic analysis in salt samples is much easier than in other food samples because the salt is easily washed away. Microplastics detected in salts are physically broken down forms of the most commonly used polyethylene, polyester and polyvinyl chloride. Polyethylene, polyester and polyvinyl chloride are among the most commonly used salt packaging materials. If packaging that does not pose a threat to the environment and human health, such as cotton and glass, is used in salt produced for food purposes, microplastic contamination in rock salt can be prevented. On the other hand, microplastics can be removed from the product at the very beginning of production by adding a filtration step to the production processes of salts obtained from salt water. Especially in table grinding salt shakers used for unrefined salt, the plasticity of the grinder part can cause microplastic contamination in the salt. For this reason, porcelain and stone mills have been used in recent years [23,24].

2.2. Heavy Metal Pollution in Salts

Heavy metals are durable and common elements in nature, with high atomic weights, metallic properties, density greater than 5 g/cm^3, conductors of electricity and liquids. The ever-increasing use of heavy metals in industry, agriculture and technology causes the accumulation of these metals in air, water, soil and food. Heavy metals; They are elements that can have toxic effects even at low concentrations. They are called metals or semi-metals (metalloids), which are often associated with contamination and potential toxicity or eco-toxicity. Heavy metals are taken into the organism through the mouth, breathing and skin, and most of them cannot be excreted through the body's excretory pathways (kidney, liver, intestine, lung, skin) without special support. For this reason, most of the heavy metals accumulate in biological organisms. These metals, which accumulate in living beings as a result of accumulation, can cause serious diseases (such as thyroid, neurological, autism and infertility) and even death when they reach effective doses. Hançerlioğulları and Eyüboğlu (2020) in their study on Çankırı salts; The average values of vanadium, chromium, manganese, iron, nickel, copper, zinc, molybdenum and lead concentrations are 2.7 mg/kg, 2.3 mg/kg, 12.9 mg/kg, 504.0

mg/kg, respectively. It was determined as 3.6 mg/kg, 1.9 mg/kg, 2.0 mg/kg, 0.1 mg/kg and 1.4 mg/kg. In the same study, mercury, cadmium, cobalt and tin concentrations were found below detectable values.

Heavy metal pollution in sea, lake, river and rock salts varies depending on the source. The presence of heavy metals in sea salts is a natural consequence of marine pollution. Heavy metals, which are a sign of pollution in inland waters, may also contain impurities found in the soil of the region. Heavy metals found in rock salts contain impurities found in the soil of the region. According to the research conducted by Ercoşkun (2021) on salt samples from different parts of the world; Arsenic, mercury, tin and antimony were not detected in any of the analyzed salt samples, the highest cadmium was in Maldon salt at 5.97±0.21 ppm, the highest chromium was in Himalayan Pink, Himalayan Black, Nakhchivan, Maldon, Hawaii Black and Urmia salt samples. Nickel is found only in Himalayan Pink and Himalayan Black salt samples, the highest lead content in Himalayan Black salt samples, the highest barium amount in Çankırı and Himalayan Pink rock salts; lithium only in Guérande flake sea salt; highest aluminum in Himalayan Pink and Himalayan Black salts; The highest titanium salts are in Izmir; highest vanadium in Himalayan pink (57.10±6.46 ppb), Himalayan black (31.50±5.68 ppb) and Margherita di Savoia (20.97±2.22 ppb); cobolt is found only in Himalayan pink (624.87±7.08 ppb) and black (458.27±5.81 ppb) salts, and the highest copper content is found in Himalayan pink (486.80±13.06 ppb) and black (523.30 ppb) salts. ±10.21 ppb) salts; The highest iron content is in Himalayan black (402.67±22.12ppb) and pink (298.67±32.32 ppb) salts; The highest zinc, manganese, magnesium and calcium contents were detected in Himalayan pink and black salts.

2.3. Radioactivity in Salts

Human beings have been constantly exposed to natural radioactive rays since their existence on earth. People can be exposed to radiation from natural and artificial sources in their normal living environments in three ways; external gamma rays, inhalation of radon and other radioactive nuclides, and ingestion of radioisotopes through food and water. In particular, natural radioactivity in food comes mainly from 40K; Products of uranium and thorium can usually be found in trace amounts. Ingested or inhaled radionuclides are distributed throughout the body through the circulatory system. Analysis of salt taken with food in terms of chemical and radioactive contamination is extremely important to protect human health. Consuming contaminated food increases the amount of radioactivity and chemical contamination within the individual and therefore increases the health risks associated with radiation exposure and metal contamination. The exact effects on health depend on the type and amount of pollutants consumed. Naturally, some radioactivity results from the presence of cosmogenic and radionuclides in the earth's crust. On the other hand, artificial radioactive fallout originating from humans pose greater risks in terms of environment and food safety. The nuclear bombs dropped on Osaka and Hiroshima, the Chernobyl nuclear accident, the Fukushima nuclear accident, the nuclear bomb tests carried out especially on the Pacific islands, the authority vacuum created especially with the dissolution of the Soviets, and the nuclear wastes thrown into the seas from nuclear ships and submarines pose a food safety risk, especially for sea salts [25-26].

There are not many publications about natural and artificial radioactivity in salts. Tahir and Alaamer (2008) reported that the natural radionuclides in Himalayan salt samples obtained from the Khewra salt mine were below the effective dose. Baloch et al. (2012), in their study in the Khewra salt mine, reported that visitors and workers were directly exposed to the internal and external radiological hazards of radon and gamma rays. Hançerliogulları and Eyupoğlu (2020) investigated the natural radionuclide and potential toxic heavy metal contents of rock salt samples collected from three different salt mines in Çankırı province and found it to be 8.4 μSv, which is significantly lower than the annual average effective dose of 290 μSv received by ingesting natural radionuclides.

3. Conclusion

In conclusion, while salt remains a fundamental component in food preservation and flavor enhancement, its role in food safety has become increasingly complex due to environmental contamination concerns, particularly regarding microplastics and heavy metals. Although salt itself is crucial for human health and a vital ingredient in food processing, the risks associated with contaminants in various types of salts, such as sea, lake, river, and rock salts, necessitate careful consideration. The increasing presence of microplastics and heavy metals in salt is a growing public health concern, underscoring the need for stricter regulations, improved processing methods, and safer packaging alternatives. Furthermore, while unrefined salts are marketed for their mineral content, it is crucial to recognize that these minerals are present in minimal amounts and often accompanied by potentially harmful substances. As consumers become more health-conscious, there is a clear shift towards natural and gourmet salts; however, the safety and purity of these products must be ensured through rigorous quality control and adherence to food safety standards. Ultimately, balancing the beneficial properties of salt with the potential risks of contamination is essential for maintaining both public health and the integrity of food products.

Declarations and Ethical Standards

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Author Contribution

H. Ercoşkun conceived of the presented idea. F. Bayrakçeken Nişancı developed the theory, performed the computations and carried out the experiments. H. Ercoskun supervised the findings of this work. All authors discussed the results and contributed to the final manuscript.

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