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Original article

Determining The Residual Aluminum and Zinc in Food Wrapped by Aluminum Foil (Sandwich Samples) Collected from Some Restaurants in El Bayda City, Libya

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Aluminum, Zinc, Aluminum Foil, Sandwich Samples, Libya.

ABSTRACT

The wrapping of foods with aluminum foil may cause the transfer of some elements presence in the foil as Aluminum (Al), Zinc (Zn), which are found in high concentrations in this foil. At high concentrations, these elements may be toxic to human health. The main problem of these elements is, they are not. This study aims to estimate Aluminum and Zinc in some sandwich samples collected from Libyan restaurants in El-Bayda city. Ten samples of different types of wrapped sandwiches by aluminum foil were studied in this investigation, the selected metal contents were measured by the atomic absorption spectrometry (AAS) method. The samples were designed by nitric acid. The results of this study recorded that the concentrations of aluminum and zinc ranged between (0.012 – 0.079 ppm) and (4.35 -10.93 ppm), respectively. The study did not record high variations between the studied samples in their contents of heavy metals. Some of the samples contained higher levels of Aluminum compared to the levels recommended by WHO.

Introduction

The aluminum foil is used to protect the heat of foods, especially in most restaurants around the world, also, many foods are covered by aluminum foil. The transfer of aluminum from the foil to the foods covered by it is possible, especially for the hot foods as sandwiches or meals. different studies were carried out on the aluminum toxicity during the consumption of some foods wrapped in aluminum foil. Some of these studies showed the toxicity of aluminum on the kidney and liver [1]. Some studies regard them as hazardous and do not recommend using them, especially in acidic foods. Other studies regard using an Al utensil and Al foils as safe for cooking [2]. Also, of reports stated that the Provisional Tolerance Weekly Intake (PTWI) of Al from WHO/ FDA (7 μg/g) body weight. On the other side, the value PTWI was updated to (1 μg/g) body weight, which reflected the neurotoxic potential of Al [3].

The concentrations of Aluminum. There are several analytical techniques to evaluate low-level metals, such as flame atomic absorption spectrometry (FAA), Atomic Absorption spectrometry (AAS), and inductively coupled plasma-optical emission spectrometry (ICP-OES). However, these are expensive instruments and they require high operational costs. The UV-Vis spectrophotometric method is a well-established analytical technique that provides low cost, simplicity, and a wide range of applications for Al^{3+} determinations in food and water with high precision. It is well known that Al dissolution is highly dependent on temperature, pH, and the presence of complexing agents. Using Eriochrome Cyanine R (EC) for analysis of Al^{3+} ions and some trace elements is not a new method [4,5].

In Libya, the contents of heavy metals were measured in different samples as vegetables, fruits, waters, and others, by using different methods [6-38]. Also, the radioactive elements were estimated in different samples [39-41]. Some compounds, which cause hazardous materials as Hydrocarbons, were estimated in fish [42-49]. The heavy metals were used in different applications as complexes [50-59]. Also, the studies on various plants to detect active compounds and their applications took place [60-89]. Some studies on the treatment of heavy metals and other chemical compounds have taken place in many studies [90-99]. Other toxic chemical compounds as pesticides, were measured [100-101]. The main aim of this study is to estimate the residual contents of Aluminum and Zinc metals in some sandwich samples collected from some restaurants in El-Bayda city, Libya.

Methods

Sampling

Ten different samples of covered sandwiches by aluminum foil from local restaurants in El Bayda city (Libya).as shown in (Table 1).

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Table 1. The studied samples

Sample No	Sample Name
1	Kabda
2	BergeTwesterr
3	TWESTER
4	Zeger
5	Mafroum
6	Kabda
7	Shish
8	Kabda
9	Shish
10	mafroum

Samples preparation
The selected samples of sandwich which studied were directly analyzed without any purifications.

Determination of Heavy Metals
Design
About 1 gram of each sample was transferred into a glass beaker, then 5 ml of concentrated nitric acid and 25 ml of water were added. The mixture was heated on a hot plate near dryness, then the mixture was cooled and filtered, and the filtrate was diluted to 100 ml. The design method was carried out according to previous studies used for solid samples to estimate heavy metals [12-14]. The concentrations (as ppm) of heavy metals were determined using atomic absorption (Type Thermo) at the Central Lab of Omar Al Mukhtar University.

Results
In the present study, the results showed small variations in aluminum contents. The concentrations ranged between (0.012– 0.079 ppm) and (2.40 -10.55ppm) were recorded in the studied samples, respectively, (Table 2) and (Figures 1-2).

Table 2. The contents (ppm) of Aluminum and Zinc values in the studied samples

Samples	Aluminum	Zinc
1	0.079	4.30
2	0.012	10.55
3	0.062	8.98
4	0.009	6.35
5	0.075	2.40
6	0.025	6.64
7	0.099	8.44
8	0.029	5.52
9	0.020	5.77
10	0.067	9.64
Average	0.0477	6.859
±SD	0.032	2.540

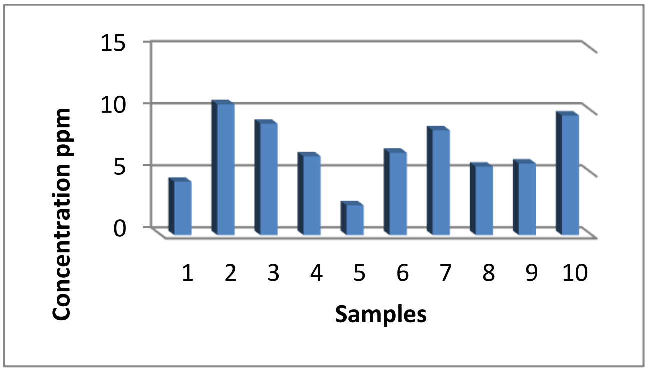

Figure 1. The distribution of Zinc (Zn) in the studied samples

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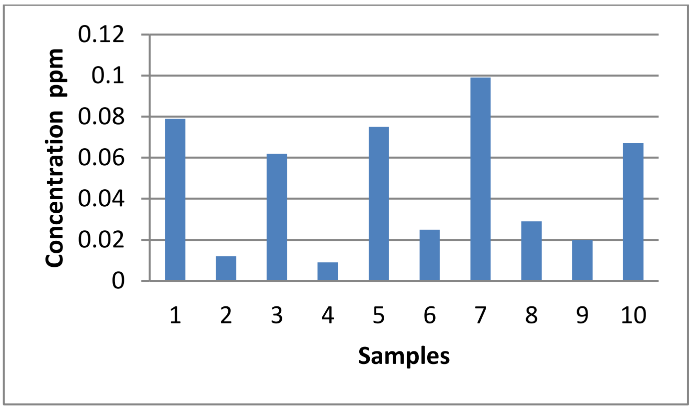

Figure 2. The distribution of Aluminum (Al) in the studied samples

Discussion

Aluminum foil remains a ubiquitous and highly versatile tool in modern kitchens and the food industry, valued for its exceptional barrier properties, heat conductivity, and convenience. Its widespread use, however, brings forth important considerations regarding the potential for aluminum migration into food. The scientific literature consistently demonstrates that while aluminum foil is generally safe under normal use, certain conditions significantly increase the likelihood and extent of aluminum leaching [102]. The core mechanism of aluminum migration involves the chemical dissolution of its protective oxide layer, which is highly susceptible to acidic and strongly alkaline environments, as well as the presence of chloride ions (salt). Elevated temperatures and prolonged contact times further accelerate this process, leading to a measurable increase in the aluminum content of cooked or stored foods. Visual evidence of foil degradation, characterized by microscopic holes, corroborates the chemical interactions occurring at the food-foil interface.

The effectiveness of coated and anodized aluminum products in significantly reducing this migration underscores the importance of material engineering in enhancing food safety [103]. The toxicological profile of aluminum indicates that while the human body can excrete small amounts, chronic or excessive exposure can lead to accumulation in various organs, including the brain, bones, and liver, potentially impacting neurological, skeletal, cardiovascular, gastrointestinal, pulmonary, renal, and reproductive systems. Vulnerable populations, such as children and individuals with impaired kidney function, are at higher risk. While the direct causal link between dietary aluminum and neurodegenerative diseases like Alzheimer's remains a subject of ongoing scientific debate, the potential for adverse effects warrants a cautious approach to exposure [104].

Regulatory bodies globally, including EFSA, JECFA, FDA, Health Canada, FSANZ, and authorities in Japan and China, have established guidelines and limits for aluminum in food and food contact materials. These include tolerable weekly intake (TWI) values and specific release limits (SRLs) for food contact materials, though approaches and specific limits can vary between regions. This regulatory complexity highlights the continuous efforts to balance the utility of aluminum with public health protection. The findings presented in this review underscore that aluminum leaching is not a simple, single-factor phenomenon but rather a complex interplay of multiple variables. The combined effect of factors like high acidity, high salinity, elevated temperatures, and extended contact times can synergistically amplify aluminum migration, creating specific "risk combinations" that consumers should be particularly aware of. This necessitates a more nuanced understanding of safe usage rather than a blanket assumption of safety or hazard. To minimize dietary aluminum exposure from foil, consumers are advised to avoid its use with highly acidic or salty foods, especially at high temperatures or for prolonged storage. Opting for coated or anodized aluminum products, or choosing alternatives such as parchment paper, silicone mats, glass, ceramic, or stainless-steel containers, can significantly reduce migration. These practical measures, combined with a balanced diet, empower consumers to make informed choices that contribute to overall food safety and health. Continued research into aluminum toxic kinetics, long-term exposure effects, and the development of safer food contact materials remains crucial for advancing public health [105].

Conclusion

According to the results recorded in this study, which was carried out on some samples of sandwiches collected from different restaurants at some El-bayda city, there are high values of zinc were detected in the studied samples beside presence small amounts of aluminum contents, the study concluded that the presence of the studied metals in the samples mainly coming from the Aluminum foil wrapped the sandwich samples.

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Conflict
The authors state that no conflict of the results recorded in this study with the other studies.

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