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Determination of Aluminum Concentration in Deodorant Samples

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A B S T R A C T

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This study aimed to estimate aluminum levels in seven antiperspirant samples collected from various sources in the local markets of Al-Bayda city, Libya. Aluminum concentration was determined using an Atomic Absorption Spectrometer. The results indicated that the aluminum concentration range in the samples was between 0.108 and 0.289 parts per million (ppm), and the percentage of aluminum in these samples ranged from 21% to 57%. These data suggest that six samples exceeded the permissible limit set by the U.S. Food and Drug Administration (FDA) for over-the-counter products. The FDA allows aluminum percentages between 1% and 25% in antiperspirants without a prescription, and between 25% and 40% with a prescription.

Introduction

Sweating is a vital physiological process for maintaining body temperature, but it can cause unpleasant odors, especially in the underarm area. Therefore, antiperspirants are used to reduce and control sweat, particularly by individuals suffering from hyperhidrosis [1]. Antiperspirants are chemical agents that temporarily plug sweat ducts to prevent or reduce perspiration and consequently minimize odor [2]. These products typically consist of aluminum salts as active ingredients, such as aluminum chloride or aluminum-zirconium tetrachlorohydrate, along with other excipients like glycine, glycerol stearate, and acetyl alcohol [3].

The U.S. Food and Drug Administration (FDA) classifies antiperspirants as both cosmetic products and drugs. Similar to drugs, the FDA specifies a permissible percentage of aluminum in these products; the standard range is between 1% and 25% for over-the-counter products and between 20% and 40% for prescription products, with the actual quantity varying by brand [4].

Aluminum is considered a toxic heavy metal, and scientific evidence has shown that high doses of aluminum have neurotoxic effects on humans and embryotoxic effects on animals [5]. Some studies suggest that long-term exposure to low levels of aluminum may play a role in the increasing incidence of breast cancer [6]. Some scientists have proposed that aluminum salts in underarm antiperspirants, which are applied frequently and left on the skin near the breast, may be absorbed through the skin and cause estrogen-linked effects, as estrogen has the ability to promote the growth of breast cancer cells [7, 8]. Other studies have also shown that the absorption of aluminum through the skin can cause neurological problems and increase the risk of Alzheimer's disease [9, 10].

In this study, an Atomic Absorption Spectrometer was used to determine the concentration levels of aluminum metal.

Materials and Methods

Materials and Sample Collection

Seven commercially available antiperspirant samples were collected from the local market in Al-Bayda city, Libya. The samples represented different international and regional brands (Table 1). All chemicals used in the analysis were of analytical grade. Concentrated hydrochloric acid (HCl), nitric acid (HNO₃), and deionized water were employed throughout the study.

Sample Preparation and Digestion

Sample digestion was performed according to the method described in reference [11], with minor modifications. In brief, 2 mL of each antiperspirant sample was placed into a digestion flask, followed by the addition of 10 mL of concentrated aqua regia ($HCl:HNO_3$, 3:1 v/v). The mixture was heated until the emission of brown fumes

completely disappeared, indicating the end of the digestion process. After cooling, the digested solution was transferred quantitatively to a 25 mL volumetric flask and diluted to the mark with deionized water.

Instrumentation and Measurement

The concentration of aluminum in the digested samples was determined using an Atomic Absorption Spectrophotometer (AAS, Thermo Scientific AA 950, USA). The instrument was calibrated using standard aluminum solutions under identical conditions. All measurements were carried out in triplicate, and the mean values were recorded.

Sample Identification

Details of the samples, including origin and brand, are presented in Table 1.

Table 1. Sources of the Samples Under Study.

Sample No.	Origin of Manufacture/Brand
1	South Africa/Dove
2	Italy/Neutro
3	USA/Rexona
4	Malaysia/Levinia
5	--/Nivea
6	Emirates/Fa
7	Emirates/Fa

RESULTS

The concentration and percentage of aluminum in seven commercial antiperspirant samples were determined using atomic absorption spectrophotometry. The results are summarized in Table 2, while Figure 1 provides a comparative illustration of aluminum content across the different brands.

Table 2. Concentration & Percentage of Aluminum in Antiperspirants.

Sample No.	Origin of Manufacture/Brand	Al Concentration (mg/L)	% Of Al
1	South Africa/Dove	0.108	21
2	Italy/Neutro	0.213	42
3	USA/Rexona	0.249	49
4	Malaysia/Levinia	0.282	56
5	--/Nivea	0.247	49
6	Emirates/Fa	0.280	56
7	Emirates/Fa	0.289	57

Discussion

The results indicate noticeable variations in aluminum content among the tested brands. The highest aluminum concentration was observed in sample 7 (Emirates / Fa) with 0.289 mg/L (57%), while the lowest concentration was recorded in sample 1 (South Africa / Dove) with 0.108 mg/L (21%). Most of the tested products (six out of seven) exhibited aluminum levels higher than 40%, which are relatively elevated when compared with the permissible limits recommended by the U.S[13]. Food and Drug Administration (FDA) for over-the-counter products. Although aluminum-based compounds are widely used in antiperspirants due to their ability to block sweat ducts, the potential health implications of aluminum exposure remain controversial. While several studies have addressed aluminum intake from dietary sources (food, beverages, cookware, and packaging materials), fewer studies have examined the absorption and long-term effects of aluminum from topical applications such as antiperspirants [12]. Currently, there is insufficient scientific evidence to establish a direct causal link

be-tween aluminum absorption from antiperspirants and diseases such as breast cancer or neurodegenerative dis-orders (e.g., Alzheimer's disease). Nevertheless, the high aluminum content observed in the present study rais-es concerns, particularly regarding cumulative exposure over long periods. Therefore, caution is recommended, and the use of aluminum-free alternatives may represent a safer option, especially for individuals with sensi-tive skin or those advised by physicians to minimize aluminum exposure [14].
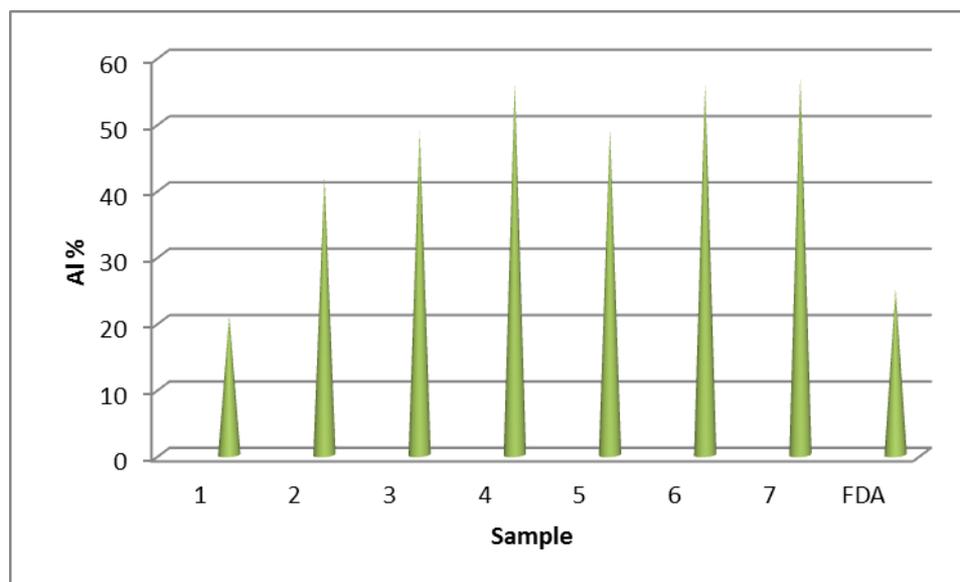

Figure 1. Shows a comparison between aluminum content in different samples.

Conclusion

This study evaluated the aluminum content in seven commercially available antiperspirant products collected from the local market in Al-Bayda city, Libya. The results revealed significant variations in aluminum concentration among the investigated brands, ranging from 0.108 mg/L (21%) to 0.289 mg/L (57%). Notably, six out of seven samples exhibited aluminum levels above 40%, which may pose potential health concerns considering the cumulative exposure through long-term use. Although aluminum salts remain the most effective active ingredients in antiperspirants, their possible association with adverse health effects, such as neurodegenerative disorders and breast cancer, warrants further investigation. The current findings highlight the need for more comprehensive studies addressing the absorption and systemic effects of aluminum from topical applications.

In light of the results, it is advisable to exercise caution in the frequent use of aluminum-based antiperspirants. Consumers may consider aluminum-free alternatives as a safer option, particularly for individuals with health sensitivities or those under medical advice to reduce aluminum exposure.

Acknowledgement

ETHICS

No ethical issues are expected to arise from the publication of this manuscript. The study was based solely on commercially available antiperspirant samples purchased from the local market and did not involve human or animal subjects.

Conflicts of Interest

The authors declare no conflicts of interest.

Author contributions: Hana S. Mohamed carried out all aspects of this work, including conceptualization, experimental design, sample analysis, data interpretation, and manuscript preparation.

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