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Eskilstuna, Sweden  
International Baccalaureate

**Determination of the Aluminium Content in Different Brands of Deodorants using the EDTA Back -Titration Method**

Extended Essay- IB Exam May 2004

Subject and level: Chemistry HL

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Word count: 3922

## ABSTRACT

Nowadays people are becoming more aware of the connections between aluminium intake and harmful diseases, and it is widely spread that deodorants contain aluminium. Therefore I tested whether or not the aluminium content differs for the different brands of deodorants, thus my research question was: Do different brands of deodorants contain different amounts of aluminium? The focus of the experiment was on the aluminium content, and not on the environmental or biological effects of the use of deodorants. In order to determine the aluminium content, I found that the best way of conducting the experiment was at a Chemistry lab, where four volumetric flasks containing the different deodorant solutions being Nivea, Rexona and H&M, and a surplus of EDTA were prepared. After pH adjustment an indicator Dihitizone dissolved in alcohol was added to the deodorant solution, and the solution was then back-titrated by zinc sulphate solution. One of these samples was a blank control and thus titrated directly. The recorded data for each deodorant brand was used to calculate the aluminium content, which was the dependant variable. The conclusion drawn was that the aluminium content differed for different deodorants, and the results showed furthermore that Nivea is the brand with the least amount of aluminium, followed by Rexona, while H&M is the deodorant, containing the greatest amount of aluminium. Rexona showed to contain almost 48% and H&M approximately 65% more aluminium than Nivea. There is probably no way of reducing the exposure to aluminium since most of our intake comes from drinking water. After all, it seems reasonable to choose the deodorant containing the least amount of aluminium.

Word count: 268

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## 1. INTRODUCTION

It is unquestionable that deodorants have helped many people to mask bad body odour since they were introduced in the end of the 19<sup>th</sup> century. Masking of body odour is a natural part of the human species, common even among the Ancient Greeks, and probably something unchangeable<sup>1</sup>. Deodorants were regarded as “cheap miracle-products”<sup>2</sup> that helped humankind to get rid of body odour. Since then, the use of deodorants has flourished rapidly, with the increasing emphasis on personal hygiene among people. The deodorants seemed to make no digiment to the humans. The truth instead has appeared to be totally different and many researchers are now trying to produce less harmful products.

Consequently, all over the world, studies are performed to analyse and get a deeper understanding of the commonly consumed deodorants. Researches about deodorants are becoming more usual because of the simple reason that more and more people are using them regularly. However, still many professors and doctors know very little about these products and a multiple of thesis and possible harmful effects of the use of deodorants are circulating in the media. The ideas are divided among the scientists, but they all agree about one point; in the long run consumption of deodorants may and probably have harmful effects on the human body. Deodorants are complex solutions containing many chemical products, such as aluminium, with different properties and behaviours. Why is the aluminium there? Does it affect the human body? These are some of the questions that have preoccupied people; one possible reason for this could be that people feel an urge to broaden their perspectives of these common products. Analytical Chemistry is the area of Chemistry that analyses and identifies substances and it is therefore the area of interest for chemists, and the subject of matter I am going to write about in this Extended Essay.

Another reason why this topic is chosen is because of the massive supply of deodorants. Almost every individual brand entice with its own speciality. Therefore, I want to compare the brands, and determine whether or not they differ by any means. For those intentions, I will

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<sup>1</sup> Lodén, Marie. (2003), Ren, Mjuk och Vacker: Kemi och Funktion hos Kosmetika, Apotekarsocieteten; Stockholm. p.11.

<sup>2</sup> Johansson, Henry. and Zimerson, Erik. (1995), Tox-Info Handboken Kemiska Produkter, Första Upplagan, Svenskt Tryck AB; Göteborg. p. 29.

take the opportunity to test different brands of deodorants. It would be a nearly impossible task to test all the different brands on the market, and deliberate of that, I have chosen to focus on three brands commonly sold in Sweden, being Rexona, Nivea and H&M. Of course, there are many substances in the deodorant that may affect the human body and certainly do these three brands contain different ingredients that will be relatively more or less harmful. Aware of that I have selected to investigate and compare one ingredient common for all of the brands, being the aluminium content. Thus, I assume everything else constant, i.e. *ceteris paribus*.

The aim of this Extended Essay is to analyse the aluminium content in deodorants of different brands, to determine whether or not the brands contain different amount of aluminium. I will try to answer the question: Do different brands of deodorants contain different amount of aluminium? A rather similar method used by chemists will be employed. Four volumetric flasks containing the different deodorant solutions and a surplus of EDTA will be prepared and the indicator Dihitzone will be added. The solution will then be back titrated by zinc sulphate solution. One of the samples will be a blank control and thus will be titrated directly. The titrant is the independent variable. The amount of aluminium in each deodorant solution will be calculated, and is therefore the dependant variable. The experiments will be done in a Chemistry lab in order to get representative and reproducible results. Furthermore, the results will show that deodorants of different brands do contain different amounts of aluminium. It is also important to note that this essay will not focus on the environmental or biological effects of the use of deodorants, but rather on the aluminium content of them.

The following background information about deodorants, aluminium, EDTA and aluminium in deodorants will help the reader to understand and evaluate the results of the experiment.

### **Deodorants**

Deodorant products reduce the formation of unpleasant body odour while antiperspirant products both reduce the formation of unpleasant body odour and the amount of sweat released to keep the armpit dry and comfortable.<sup>3</sup> For simplicity only deodorants are considered in this

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<sup>3</sup> Lodén, Marie. (2003), Ren, Mjuk och Vacker: Kemi och Funktion hos Kosmetika, Apotekarsocieteten; Stockholm. p.148.

essay. While fragrance oils and aromatics have been used for centuries to mask body odour as well as impart pleasant smells, the formulation and the use of cosmetic preparations that control underarm odour and wetness began approximately for hundred years ago. Some people are sensitive to deodorants while others are not. There is no inter-mediate stage; you are either sensitive or non-sensitive<sup>4</sup>. There are few substitutes to the use of deodorants; one alternative is to use water and soap. If we instead want to take the very natural route, we can use salt crystals to deodorise armpits. These are available from most health stores.

## **Aluminium**

Aluminium is a light metal and is in the purest form silver-white, soft, and ductile. The metal is not found solidly in the environment. As a compound with other elements, aluminium is a common component in the earth-crust. The total aluminium content of the earth-crust is estimated to be approximately 8%<sup>5</sup>. Because of the metal's strong effort to combine with oxygen to form aluminium oxide, it is not found freely in the environment. As most other less noble elements aluminium may not be produced from its oxide by reduction with coal, because of its high affinity to oxygen. Therefore, minerals from the earth-crust are used in the production of aluminium. The best mining raw material is bauxit (the name comes from the place where it was found, Les Baux in South France). Bauxit is a compound of hydrated oxides of mainly aluminium, iron and titanium. It is produced by electrolysis from molten bauxite<sup>6</sup>. Aluminium is commonly found in deodorants due to the fact that it is easily absorbed through the skin and effectively blocks the sweat pores<sup>7</sup>.

## **EDTA**

Ethylenediaminetetraacetic acid, which will be used is commonly shortened to EDTA and is the most widely used complex metric titrant. EDTA is a white crystalline powder, odourless and with an acidic taste. It is not poisonous<sup>8</sup>. EDTA is a molecule with four acetic groups

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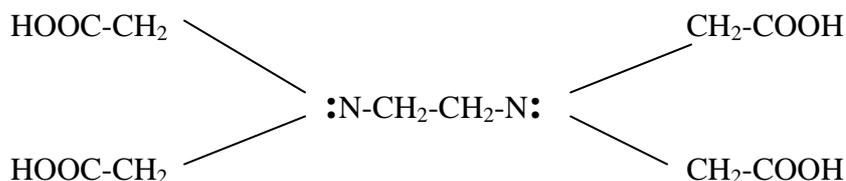
<sup>4</sup> Johansson, Henry. and Zimerson, Erik. (1995), Tox-Info Handboken Kemiska Produkter, Första Upplagan, Svenskt Tryck AB; Göteborg. p. 29.

<sup>5</sup> <sup>6</sup> AB Svenska Metallverken (1967), Aluminium, Framställning och egenskaper, Esselte Aktiebolag; Stockholm. p.10, 23.

<sup>7</sup> Lodén, Marie. (2003), Ren, Mjuk och Vacker: Kemi och Funktion hos Kosmetika, Apotekarsocieteten; Stockholm. p.192.

<sup>8</sup> Flaschka. H.A. (1964), EDTA Titrations: an introduction for theory and practice, Second Edition, Pergamon Press; Oxford. p.47.

working like claws that surround the metal ion when the complex is formed.



**Figure 1. Structure of the EDTA molecule**

The EDTA molecule has six potential sites for bonding a metal ion: the four-carboxyl groups and the two amino groups, each of the latter with an unshared pair of electrons. Thus, EDTA is a hexa-dentate ligand. Because of its structure, EDTA forms complexes with nearly all materials, including aluminium. EDTA has many analytical applications; it is for instance used as masking reagent and chromogenic agent. It is frequently used as titrant, since practically all complexes contain metal and EDTA in the ratio 1:1.

### **Aluminium in deodorants**

The problem with many commercial deodorants is that they contain aluminium compounds which are easily absorbed through the skin. That is one of the main reasons why aluminium is occurring in deodorants. Many studies relate aluminium intake and Alzheimer's disease. The linkage is based on patients suffering from the disease have high levels of aluminium in their brains. Development of breast cancer is also related to high rates of aluminium. Scientists are currently investigating suggestions of a link between the use of deodorants and breast cancer rates. We have to be aware of the fact that nothing about the connections between these diseases and aluminium are proven yet. Some scientists claim that there is a certain link while others say the opposite. Nevertheless, the undeniable fact is that the brains of many of those who die from Alzheimer's disease have characteristically shown a high concentration of aluminium in their cells. As a consumer, it is hard to reduce the exposure to aluminium. Many scientists claim that avoiding the use of deodorants or aluminium pans will not make any difference, because most of our exposure to aluminium comes from things we cannot avoid, such as food and water<sup>9</sup>. Whether or not the metal is a cause (the diseases may have several causes) or the effect of Alzheimer's disease and breast cancer, the question is whether it makes sense

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<sup>9</sup> AB Svenska Metallverken (1967) Aluminium, Framställning och egenskaper, Esselte Aktiebolag; Stockholm. p.48.

to place one's health in jeopardy by increasing the intake of aluminium. It does not seem reasonable to make an already bad situation worse by using deodorants with high aluminium content. It does not really matter whether aluminium is the cause or the effect of the diseases, the answer is clear. The best solution would of course be to avoid the consumption of deodorants as much as possible. If we feel that it is impractical to avoid deodorants, we would at least shift to the product with the least amount of aluminium. Therefore, I take the opportunity to test if different brands of deodorants contain different amounts of aluminium.

## 2. MATERIALS AND METHODS

Below follows a table and description of the three different deodorants used in the investigation. (Note: please excuse, if any ingredients are misspelled in the description below since they are translated from Swedish to English.)

Brand Name	Rexona	Nivea	Hennes & Mauritz
Deodorant's name	Active Deo Roll On	Fresh Deodorant	Joyful Roll On
Production country	Sweden	Germany	Poland
Recommended price/100ml	65,0 SEK	53,0 SEK	32,5 SEK

**Table 1. The different deodorants**

### Rexona

Short description on the cover: "24HR Intensive with 0% Alcohol"

Ingredients: Aqua, Aluminium Chlorohydrate, Cetareth-20, Cetyl Alcohol, Decyl Oleate, Glyceryl Stearate, Perfume, Propylene Glycol, Marus Alba

### Nivea

Short description on the cover: "Natural freshness. Mild care and efficient protection without Alcohol."

Ingredients: Aqua, Aluminium Chlorohydrate, Isocetech-20, Butylenes Glycol, Dicaprylyl Ether, Glyceryl Isostearate, Perfume, PEG-150 Distearate

### H&M

Short description on the cover: "An anti-per spirant deodorant. Mild and soft without alcohol"

Ingredients: Aqua, Aluminium Chlorohydrate, Hydroxypropyl Methyl Cellulose, PEG-20, Glyceryl Laurate, Perfume.

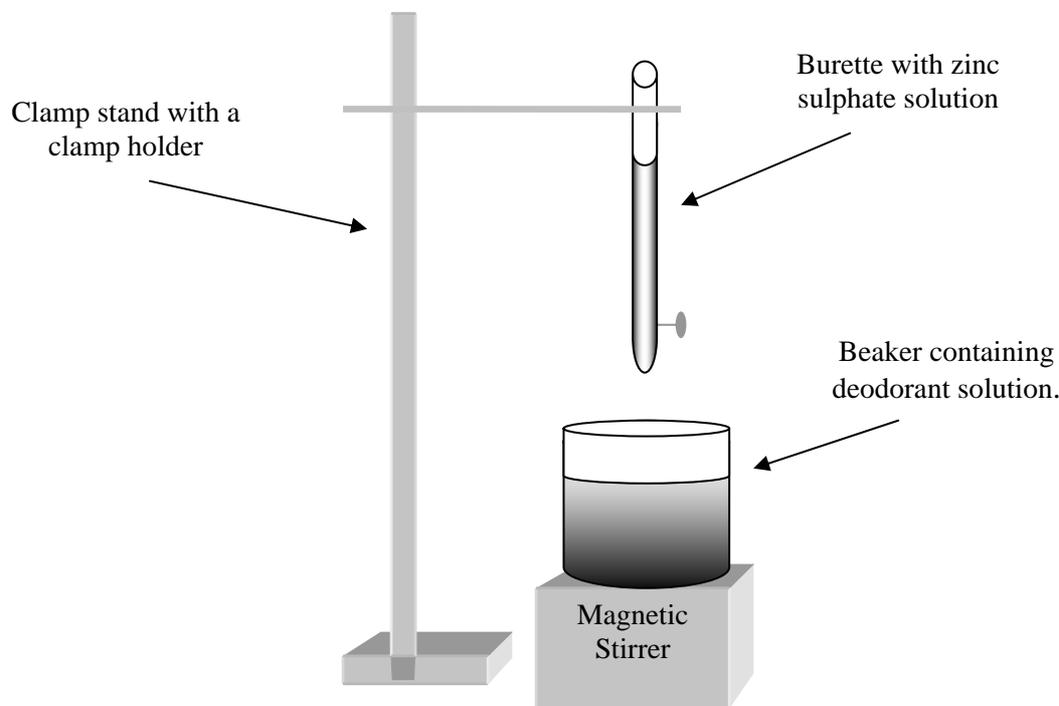
The aluminium content of deodorants can be determined in many ways. One could for instance use absorption spectroscopy. This method was however rejected since it would be extremely difficult to accomplish on a school laboratory. The choice fell on the EDTA back-titration method, partly because the needed chemicals were available at school, partly because the method was safe to perform. Back-titration is when you measure how much you have of the substances and then perform the titration<sup>10</sup>. In this process, amounts of titrant are added to the solution that is titrated. Back-titration was necessary since there are no useful indicators for aluminium. Instead an excess of EDTA was added and the surplus EDTA was titrated by zinc sulphate solution with Dithizone as indicator. The experiment was performed at the Chemistry Department in the college of Eskilstuna in order to get somewhat reliable results. It was also important that the investigation could be repeated easily, since the intention was to perform four tries for each of the different brands, and to take the mean result, in order to eliminate the reading errors as much as possible. The method employed was discussed with several chemists before the investigation was performed together with Tommie Lindahl, Chemistry lecturer at College of Mälardalen, Eskilstuna. Especially, the Umeå University lecturer in Chemistry, Svante Åberg, gave many helpful ideas and modifications at the planning stage of the investigation.

Initially some pilot runs were carried out at the school laboratory in order to get some approximate notion of the amount of the titrant, zinc sulphate, needed for each kind of deodorant. The pilot runs were also helpful when determining the volume of EDTA needed. As an example, the pilot runs indicated that 10,00 ml of EDTA that was used initially was not enough because the amount of EDTA added must be larger than the amount of aluminium, but not too large because then there will be greater errors of titration in the back-titration. However, at this stage the experiment was a failure, because the solution changed colour after just one drop of zinc sulphate added. The colour changed from light green-blue (peacock blue) to pink instantaneously. The result was a pink colour solution with deodorant odour but with sharp segmented layers. Therefore the volume of EDTA added was doubled to 20,00 ml.

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<sup>10</sup> Sharp, W.A David (2003), *The Penguin Dictionary of Chemistry*, Third Edition, Penguin Books Ltd: London. p.41.

There was however no special titration establishment at the Chemistry Department, so an own system was built up, using various equipments and chemicals. An illustration of the construction is shown below:



**Figure 2. Illustration of the set-up**

The method described below was applied for all samples:

### **Preparation of the chemicals**

Initially the titrant zinc sulphate ( $\text{ZnSO}_4$ ) solution was prepared since the laboratory had only access to  $\text{ZnSO}_4$  in solid form. The same concentration for all the chemical solutions was required and that concentration was determined to be  $0,100 \text{ molL}^{-1}$ . Since the molar mass of  $\text{ZnSO}_4$  was known, the mass needed to get the right concentration was calculated to be 7,190 g. This amount of  $\text{ZnSO}_4$  was dissolved in 250,00 ml distilled water to get a zinc sulphate solution of  $0,250 \text{ dm}^3$ . In order to get the required concentration also the EDTA was dissolved in distilled water. Ammonium acetate functioned as the buffer and was obtained by mixing equal amounts of  $0,100 \text{ mol dm}^{-3}$  ammonia and  $0,100 \text{ mol dm}^{-3}$  ethanoic acid and then buffer the pH to be approximately 4,7, which is the most suitable pH for EDTA-complexes.

### **Preparation of the deodorant solution that was titrated and the titration**

10,00 ml of concentrated deodorant was dissolved in 90,00 ml distilled water, because the required volume of the deodorant solution was 100,00 ml. Then 20,00 ml of the prepared EDTA solution was added. This was stirred thoroughly by the help of a magnetic stirrer and a stirring magnet. The pH was then buffered to be in the interval 4-5 with 0,100 mol $\text{dm}^{-3}$  sodium hydroxide (to increase pH) or 0,100 mol $\text{dm}^{-3}$  hydrochloric acid (to decrease pH). It was important to stir the solution thoroughly before recording the pH because it was of great importance that the pH value was right since EDTA is an acid with four carboxylic groups. At low pH values all these four groups are stable that will say in the form R-COOH. These molecules will not form complexes with metal ions since they are not charged. The higher the pH the more protons are released. Since pH is different for different metal ions it has to be sufficient enough to form complex bonds. Therefore pH must to be in the interval 4 to 5, which is the most suitable interval for the majority of metal ions, so that the four carboxylic groups are protolysed, that will say in the form R-COO $^{-}$ . These four negative charges will form a strong complex with the metal ions. Furthermore, EDTA complexes become weaker with increasing acidity, so it is highly important that proper pH value is attained before the titration.<sup>11</sup>

A 20,00 ml aliquot of the prepared ammonium acetate ethanoic acid was then added to the solution and stirred thoroughly. Before the titration could be performed an indicator that could indicate when the reaction had taken place was required. In a separate measuring cylinder, one spatula tip of the indicator Dithizone was dissolved in 20,00 ml of the alcohol, Euro-red (denatured ethanol). The alcohol made the indicator to dissolve more easily. The indicator solution was then added to the deodorant solution. When the indicator solution was added the deodorant solution turned colour from the initial light grey to a shade of dark green-blue (peacock blue). By the help of a magnetic stirrer and a stirring magnet, the solution was thoroughly stirred while it was titrated with zinc sulphate until the colour of the deodorant solution changed to a nuance of pink-purple. If the aluminium content is small in the deodorant we have to add a lot of zinc sulphate because we are titrating on the amount of EDTA not bound to aluminium. Due to this, already at this stage one may predict and make a hypothesis that the deodorant requiring the greatest amount of zinc sulphate solution must be the deodorant containing the least amount of aluminium. A test experiment was also performed where

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<sup>11</sup> Dr.R.Pril. (1972), Analytical Applications of EDTA and Related Compounds, First Edition, Pergamon Press; Oxford. p.45

instead of concentrated deodorant a known amount of aluminium chloride was added. This was then titrated, and consequently the amount of aluminium was calculated in the control sample. If the titration was correct the calculated amount of aluminium must be equal to the known amount of aluminium added. The calculated amount and the added amount of aluminium turned out to be equal. Hence it proves that the titration is giving reliable and true results.

### 3. RESULTS

Thus, there were three volumetric flasks containing the different deodorant solutions where in each one of them among other chemicals a surplus of EDTA was added. The tables below show the recorded data from the experiments carried out in the lab.

#### Rexona

Sample number	I	II	III	IV
Amount of NaOH added* [ml] $\pm$ 0,75 ml	5,00	5,00	5,00	5,00
pH $\pm$ 0,01	4,35	4,44	4,42	4,35
Amount of NaOH added <sup>o</sup> [ml] $\pm$ 0,5 ml	3,00	3,00	3,00	3,00
pH $\pm$ 0,01	4,67	4,67	4,68	4,67
Amount of zinc sulphate added [ml] $\pm$ 0,20 ml	6,0	5,0	5,4	5,8

**Table 2. Recorded data for the deodorant Rexona**

#### Nivea

Sample number	I	II	III	IV
Amount of NaOH added* [ml] $\pm$ 0,75 ml	2,00	2,00	2,00	2,00
pH $\pm$ 0,01	4,39	4,42	4,37	4,42
Amount of NaOH added <sup>o</sup> [ml] $\pm$ 0,5 ml	2,00	2,00	2,00	2,00
pH $\pm$ 0,01	4,69	4,69	4,65	4,67
Amount of zinc sulphate added [ml] $\pm$ 0,20 ml	10,0	10,5	11,0	10,0

**Table 3. Recorded data for the deodorant Nivea**

## H&M

Sample number	I	II	III	IV
Amount of NaOH added* [ml] $\pm 0,75$ ml	2,00	2,00	2,00	2,00
pH $\pm 0,01$	4,38	4,36	3,43	4,47
Amount of NaOH added $^{\diamond}$ [ml] $\pm 0,5$ ml	2,00	2,00	2,00	2,00
pH $\pm 0,01$	4,66	4,71	4,69	4,73
Amount of zinc sulphate added [ml] $\pm 0,20$ ml	4,0	4,5	3,8	4,0

**Table 4. Recorded data for the deodorant H&M**

Key:

\* = Row representing the volume of NaOH added to deodorant solution to adjust pH to be in the interval 4-5.

$^{\diamond}$  = Row representing the volume of NaOH added to deodorant solution containing ammonium acetate ethanoic acid to adjust pH to be approximately 4, 7

## 4. CALCULATIONS

In order to calculate the amount of aluminium the following procedure was followed:

No of moles EDTA – No of moles  $\text{ZnSO}_4$  = No of moles  $\text{Al}^{3+}$

This no of moles of  $\text{Al}^{3+}$  was obtained from 10,00 ml concentrated deodorant.

In order to get the amount of  $\text{Al}^{3+}$  from 100,0 ml of concentrated deodorants, the no of moles of  $\text{Al}^{3+}$  was multiplied by a factor 10.

From the IB Chemistry Data Booklet, the molar mass of  $\text{Al}^{3+}$  was found, to be  $26,98 \text{ gmol}^{-1}$ .

Thus mass of  $\text{Al}^{3+}$  in 100,0 ml concentrated deodorants = No of moles  $\text{Al}^{3+}$  in 100,0 ml concentrated deodorant\*  $26,98 \text{ gmol}^{-1}$ .

Example:

Volume of EDTA added: 20,00 ml = 0,0200 L

No of moles EDTA:  $0,100 \text{ molL}^{-1} * 0,0200 \text{ L} = 2,00 * 10^{-3} \text{ mol}$

Volume of  $\text{ZnSO}_4$  added: 6,0 ml = 0,0060 L

No of moles  $\text{ZnSO}_4$ :  $0,100 \text{ molL}^{-1} * 0,0060 \text{ L} = 6,00 * 10^{-4} \text{ mol}$

$$2,00 \times 10^{-3} \text{ mol} - 6,00 \times 10^{-4} \text{ mol} = 0,00140 \text{ mol}$$

0,00140 mol of  $\text{Al}^{3+}$  from 10,00 ml concentrated deodorant

Amount of  $\text{Al}^{3+}$  from 100,0 ml concentrated deodorant:  $0,00140 \text{ mol} \times 10 = 0,014 \text{ mol } \text{Al}^{3+}$

Mass of  $\text{Al}^{3+}$  in 100,0 ml concentrated deodorant:  $0,014 \text{ mol} \times 26,98 \text{ gmol}^{-1} = 0,37772 \text{ g } \text{Al}^{3+}$

$0,37772 \text{ g } \text{Al}^{3+} / 100 \text{ ml concentrated deodorant}$

Similar calculations are made for each sample, and the results are presented in the following tables:

## Rexona

### Titration

Sample number	I	II	III	IV
Conc. EDTA [ $\text{mol dm}^{-3}$ ]	0,100	0,100	0,100	0,100
Volume EDTA [ml]	20,00	20,00	20,00	20,00
No of moles EDTA [mol]	0,002	0,002	0,002	0,002
Conc. $\text{ZnSO}_4$ [ $\text{mol dm}^{-3}$ ]	0,100	0,100	0,100	0,100
Volume $\text{ZnSO}_4$ [ml]	6,00	5,00	5,40	5,80
No of moles $\text{ZnSO}_4$ [mol]	0,0006	0,0005	0,00054	0,00058

### Calculation

No of moles Al [mol]	0,014	0,015	0,0146	0,0142
Mass Al [g]	0,37772	0,4047	0,393908	0,383116

Mean mass of Al [g]	Standard Deviation	Result	Relative Uncertainty
0,390	0,010	$0,390 \pm 0,010 \text{ g } \text{Al}^{3+} / 100 \text{ ml (n = 4)}$	2,6%

## Nivea

### Titration

Sample number	I	II	III	IV
Conc. EDTA [ $\text{mol dm}^{-3}$ ]	0,100	0,100	0,100	0,100
Volume EDTA [ml]	20,00	20,00	20,00	20,00
No of moles EDTA [mol]	0,002	0,002	0,002	0,002
Conc. $\text{ZnSO}_4$ [ $\text{mol dm}^{-3}$ ]	0,100	0,100	0,100	0,100
Volume $\text{ZnSO}_4$ [ml]	10,0	10,5	11,0	10,0
No of moles $\text{ZnSO}_4$ [mol]	0,001	0,00105	0,0011	0,001

### Calculation

No of moles Al [mol]	0,01	0,0095	0,009	0,01
Mass Al [g]	0,2698	0,25631	0,24282	0,2698

Mean mass of Al [g]	Standard Deviation	Result	Relative Uncertainty
0,260	0,011	0,260±0,011g Al <sup>3+</sup> / 100 ml (n = 4)	4,2%

### H&M

#### Titration

Sample number	I	II	III	IV
Conc. EDTA [mol dm <sup>-3</sup> ]	0,100	0,100	0,100	0,100
Volume EDTA [ml]	20.00	20.00	20.00	20.00
No of moles EDTA [mol]	0,002	0,002	0,002	0,002
Conc. ZnSO <sub>4</sub> [mol dm <sup>-3</sup> ]	0,100	0,100	0,100	0,100
Volume ZnSO <sub>4</sub> [ml]	4,00	4,50	3,80	4,00
No of moles ZnSO <sub>4</sub> [mol]	0,0004	0,00045	0,00038	0,0004

### Calculation

No of moles Al [mol]	0,0016	0,0155	0,0162	0,016
Mass Al [g]	0,43168	0,41819	0,437076	0,43168

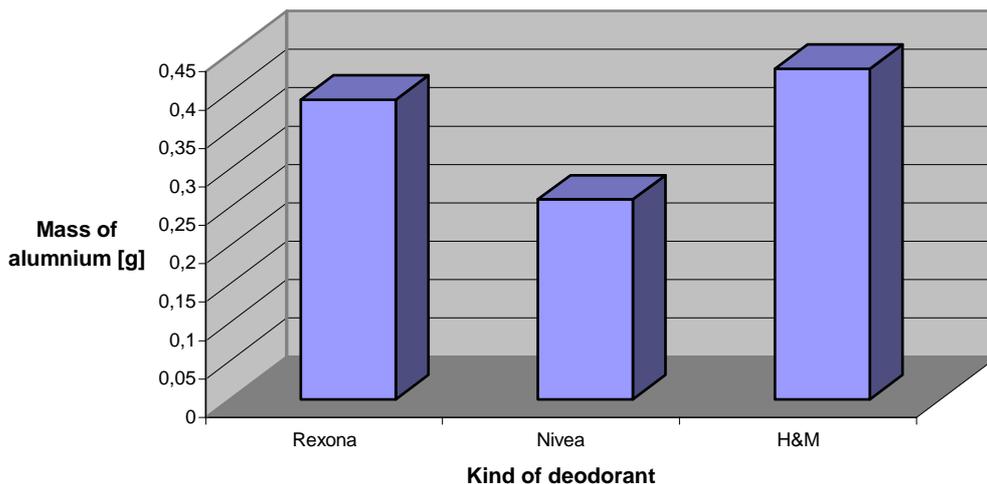
Mean mass of Al [g]	Standard Deviation	Result	Relative Uncertainty
0,430	0,007	0,430±0,007g Al <sup>3+</sup> / 100 ml (n = 4)	1,6%

The brands listed in order of increasing aluminium content:

Nivea 0,260 ± 0,011 g Al<sup>3+</sup>/ 100 ml (n = 4)

Rexona 0,390 ± 0,010 g Al<sup>3+</sup>/ 100 ml (n = 4)

H&M 0,430 ± 0,007 g Al<sup>3+</sup>/ 100 ml (n = 4)



**Diagram 3. Average mass of aluminium per 100 ml conc. deodorant**

## 5. DISCUSSION AND CONCLUSION

In line with the hypothesis the investigation showed that the aluminium content is divergent for the different brands. Thus, I believe that I have found an answer to my research question: Do different brands of deodorants contain different amounts of aluminium? The answer is clearly yes, different deodorants contain different amounts of aluminium. Despite the weaknesses and uncertainties of my investigation, I may draw the conclusion that of the three different deodorant brands tested here, Nivea definitely showed to be superior as it contained almost half the amount of aluminium as H&M.

If we assume that one person regularly uses deodorants twice a day and every time rolls twice per armpit. Then a deodorant flask á 50 ml will be used up during a time period of one and a half month. If this is true, eight (12 month/1, 5 month) flasks of deodorants will be used annually by one person. Hence, it will take approximately two and half years to use up one full litre of concentrated deodorant. The amount of absorbed aluminium then differs by almost 1,7 g between the deodorant with the least aluminium content according to this investigation, Nivea and H&M, the deodorant with the highest concentration of aluminium. However, we have to be aware of the fact that when the deodorant is used, it does not mean it is spread to the body directly. Practically most of the deodorant is washed away, so much is not taken up by the body. However, Rexona showed to contain almost 48% and H&M approximately 65% more aluminium than Nivea. This means that one person using H&M receives 65% higher

exposure to aluminium on the skin than a person using Nivea. However we do not know how much of this is absorbed by the skin.

### **Evaluation of the method used, errors and some suggested improvements**

I believe the method used gave me reliable results even though I do not have any Data Booklet values to compare with. The aim of my investigation was to determine if the aluminium content differs for different deodorants, and the method helped me to obtain the answer. The errors with this experiment are widely spread over many factors which affect the result. Even though the experiment was taken place on a laboratory at a College, there were still some inevitable experimental inaccuracies, such as the poorly calibrated instruments and other systematic errors as well as the reading errors. Despite these errors, I believe the major inaccuracy was at the endpoint of the titration. The colour change was sharp and clear to observe with the human eye at the blank control, but it was not that easy when deodorants were added to the samples. Deodorants made the solution thick and “milkish,” so it was hard to recognise any accurate colour changes. Consequently, it is here where the major improvements can be made. I could for example have tried to make the solution less “milkish”. Nevertheless, this is probably something which requires special techniques. One can only assume that the investigation would give the same results even if the “milky” consistency was removed. Another factor which should have been considered more is the amount of indicator added. I did dissolve one spatula tip of indicator with 20,00 ml of alcohol. I should instead have added a specific amount of indicator for all samples since it is the indicator that makes the colour change and is therefore of great importance. As it was in the investigation, the colour change differed a lot for the different samples, even if the deodorant brand was the same.

### **Conclusion**

The idea of the use of this experiment was to determine the aluminium content of different brands of deodorants. The investigation demonstrated that, the three brands considered here, Rexona, Nivea and H&M, contained different amounts of aluminium. If aluminium exposure is connected to harmful diseases as Alzheimer’s disease and breast cancer, and even if most of our aluminium intake is from things we cannot avoid, such as food and water, it would be wise to shift to the deodorant with the least amount of aluminium. That would, according to this investigation be Nivea. We should also consider the fact that not all the deodorant is absorbed by the skin, but most of it is washed away. A great improvement would have been to eliminate the “milky” consistency. Despite the problems, I feel that the investigation has been

successful. Although, the research could have been improved, and in conducting a future experiment I would have proceeded differently, I feel that my experimental technique improved, and the investigation gave me a great insight of how sophisticated scientists work.

Consequently, aluminum seems to be a vital ingredient in deodorants as it is found in a majority of brands. I cannot help wondering why the aluminum content is different for different kind of deodorants. The resulting question would of course be: whether or not the deodorant with the highest aluminum content will mask body odour more efficiently. If aluminum is so essential, why are there some aluminum-free deodorants? Is the aluminum content different for different forms of deodorants, that will say roll-ons, sticks and sprays? However, one thing is for certain; more research is needed on the area.

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