

## STUDY ON ARSENIC IN CIGARETTE SMOKE

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### ABSTRACT

*Cigarette smoking causes enormous health problems for active and passive smokers. Arsenic (As), is vital elements to most organisms in trace amounts. However, they can quickly become toxic when in higher concentrations or when they exist in non-native body locations. HACH EZ Arsenic testing method was used to determine the amounts of arsenic in cigarette tobacco, ash, and then calculate the amount in cigarette smoke. Ten types of cigarette sample were used for determining the As content in cigarette smoke. Arsenic was found in all cigarette tobacco but Arsenic was not found in tobacco ash because of the total combustion and release of arsenic from cigarette. The mean content of arsenic in cigarette smoke was 0.29µg/g (range 0.27–0.38 µg/g). There was a small variability in arsenic content among samples of cigarettes. The bioavailable arsenic was not found because arsenic may not be released from cigarette tobacco without heating. Comparison of experimental data with previous studies was shown in this study for arsenic in cigarette smoke. This study is also discussed the smoking pattern of selected smokers group and their arsenic exposure. Continuous monitoring of arsenic exposure and concentration in cigarettes is required to reduce the negative health impact.*

**Keywords:** Air pollution, Cigarette smoke, Atmospheric arsenic, Bioavailable arsenic

### 1. INTRODUCTION

Arsenic is a naturally occurring, poisonous, heavy metal and classified as being carcinogenic to humans. Arsenic trioxide is only slightly soluble in water; in sodium hydroxide it forms arsenite and with concentrated hydrochloric acid it forms arsenic trichloride. Sodium arsenite and sodium arsenate are highly soluble in water. Interchanges of valence state may occur in aqueous solutions, depending on the pH and on the presence of other substances which can be reduced or oxidized. The common sources of arsenic exposure are food, drinking water, and air. Inorganic arsenic can be present in tobacco products and their emission of smoke.

Today, the harm of smoking cigarettes is pretty much widely known and according to World Health Organization (WHO)'smoking cigarettes' is a worldwide problem. According to the (WHO, 2002) statistics, one in three adult people smokes cigarettes in the whole world and considering these statistics, more than 1.2 billion people smoke worldwide. People who smoke not only harm themselves but also others around them. Those who do not smoke yet somehow breath/get exposed to cigarette smoke are called inactive smokers and they get harm from it as well but they are more like minor harms compared to the ones the smoker gets.

Inorganic arsenic is present in mainstream tobacco smoke and presumably in side stream smoke as well. According to a report from the California Air Resources Board and the Department of Health Services, smokers breathe an estimated 0.8 to 2.4 micrograms of inorganic arsenic per pack of cigarettes, with approximately 40 percent of it being deposited in the respiratory tract (HUGHES, K. et al., 1994.). According to the data of WHO – in the 20th century, 100 million people have died from tobacco use (WHO, 2002). Arsenic has been identified and measured both in tobacco and cigarette smoke. It is observed that contents of arsenic in biological samples of human population are much higher in smokers than those in non-smokers. Human population is exposed to arsenic from many sources (air, water, soils, food stuffs, and anthropogenic sources). Smoking is not the main source of arsenic exposure for humans, but cigarette smoking influences arsenic toxicity.

Arsenic content in cigarette smoke mainly depend on tobacco use and arsenic content in tobacco depends on soil properties, atmospheric conditions, and requirements for tobacco farming. Tobacco plants take up arsenic from soil and concentrate this in leaves. For this reason, there are large variations in the content of arsenic in tobacco between countries. Cigarette smoke may contain arsenic, especially when the tobacco plants have been treated with lead arsenate insecticide.

This study was conducted to determine the amount of Arsenic (As) in Cigarette and cigarette smoke and to know the effect of arsenic on cigarette smoker. Ten types of cigarette were selected which are available in local market. The overall objectives of this research work are to evaluate the amount of arsenic in cigarette smoke by acid digestion.

## **2. METHODOLOGY**

For this research, the needed materials such as cigarettes, sulfuric acid, and nitric acid were collected from the local market in Khulna district in south western part of Bangladesh. Then the sample was prepared by using acid digestion and arsenic test was performed for prepared sample. By using output result various calculation were done and representing the result in different form. Then the mean value of arsenic in smoke was compared with other study. Finally questionnaire survey was performed on cigarette smoke and the collected data from the questionnaire survey was analysed and the output results have been showed in result and discussion chapter through the tabular form and graphical representation. The methodology for arsenic measurement in this experiment is followed a thesis paper named "Arsenic Mobilization in Soil".

### **2.1 Sample Preparation by acid digestion**

Sample preparation for atmospheric arsenic:

Firstly, the tobacco was separated from cigarette paper and grinding. Then one gram of the tobacco sample was taken in the conical beaker (250 ml), 5 ml distilled water and 5 ml of 0.1N H<sub>2</sub>SO<sub>4</sub> was also added with that. The beaker was kept in hotplate and 1 ml of HNO<sub>3</sub> was added after two minute. Nitric acid was added continuously at 2 minute interval until the yellow fume disappeared. Finally the sample was filtered through whatman filter paper of 15 cm diameter and arsenic analysis was done.

Sample preparation for bioavailable arsenic:

Firstly, the tobacco was separated from cigarette paper and grinding. Then one gram of the tobacco sample was taken in the beaker (250 ml) and 100 ml distilled water was also added with that. The beaker was kept on magnetic stirrer for 24 hours. Finally the sample was filtered through whatman filter paper of 15 cm diameter and arsenic analysis was done

### **2.2 Arsenic Test**

Arsenic analysis was performed in the laboratory by using 'HACH EZ Arsenic Test Kit'. In this test, Arsenic test sampling bottle was used as apparatus and filter paper soaked in mercuric bromide solution, sulfamic acid, zinc powder were used as reagent. At first, 5 ml of digested sample was taken in the test sampling bottle and diluted with 45 ml of distilled water. The filter paper which is soaked in mercuric bromide solution was inserted into the rubber cork. One pack sulfamic acid was added into the bottle. Then one pack zinc powder was added also and allowing 20 minutes for completing reaction. The filter paper was taken out from the rubber cork and the colour of the filter was compared with a standard 'colour chart'.

## **3. RESULTS AND DISCUSSION**

The difference between the arsenic content in cigarette tobacco and the tobacco ash is representing the arsenic content in cigarette smoke. Arsenic content in cigarette basically depend on tobacco and tobacco depends on soil properties, atmospheric conditions, and requirements for tobacco farming (use of pesticide and fertilizer). Tobacco plants take up arsenic from soil and concentrate in leaves. For this reason, there are large variations in the content of arsenic in cigarette tobacco between countries.

Table 1: Content of Arsenic in Cigarette Smoke

Brands	Avg. As( $\mu\text{g/g}$ ) $\pm$ SD	As ( $\mu\text{g/cigarette}$ )
B1	0.38 $\pm$ 0.12	0.26
B2	0.31 $\pm$ 0.03	0.22
B3	0.28 $\pm$ 0.02	0.20
B4	0.31 $\pm$ 0.02	0.21
B5	0.27 $\pm$ 0.01	0.19
B6	0.27 $\pm$ 0.01	0.19
B7	0.28 $\pm$ 0.03	0.20
B8	0.29 $\pm$ 0.03	0.17
B9	0.27 $\pm$ 0.01	0.17
B10	0.27 $\pm$ 0.04	0.16

Table 2 shows that, the total As content in cigarette smoke ( $\mu\text{g/g}$ ) and As content per cigarette ( $\mu\text{g/cigarette}$ ). The range of arsenic content in cigarette smoke was found 0.27 to 0.38 $\mu\text{g/g}$ . The maximum value of arsenic content was found 0.38 $\mu\text{g/g}$  for the brand B1 and the lowest 0.27 $\mu\text{g/g}$  for four brands B5, B6, B9 and B10. The maximum value of standard deviation was found 0.12 $\mu\text{g/g}$  for brand B1 and lowest 0.01 $\mu\text{g/g}$  for brands B5, B6 and B9. The amount of arsenic content in cigarette smoke per cigarette is maximum for brand B1 and minimum for brand B10.

Table 2: Mass balance per cigarette

Brands	Mass tobacco (gm)	Mass tobacco ash (gm)	Mass of Smoke (gm)	% of Ash	% of Smoke	% of As in Smoke
B1	0.70	0.13	0.57	18.6	81.4	0.05
B2	0.70	0.13	0.57	18.6	81.4	0.04
B3	0.69	0.14	0.55	20.3	79.7	0.04
B4	0.68	0.13	0.55	19.1	80.9	0.04
B5	0.70	0.14	0.56	20.0	80.0	0.03
B6	0.70	0.14	0.56	20.0	80.0	0.03
B7	0.69	0.13	0.56	18.8	81.2	0.04
B8	0.60	0.16	0.44	26.7	73.3	0.04
B9	0.62	0.16	0.46	25.8	74.2	0.04
B10	0.60	0.17	0.43	28.3	71.7	0.04

This table is prepared by the experimental value and Table 2 shows the total mass of cigarette tobacco, mass of tobacco ash and mass of smoke per cigarette. It also shows the percentage mass of ash, smoke and the percentage of arsenic content in cigarette smoke. Among the ten types of brand maximum mass tobacco contain in brands B1, B2, B5 and B6. The mass of tobacco ash was found 0.17gm in brand B10 which was maximum. The maximum of smoke was found 0.57gm in brands B1 and B2 and the lowest was 0.43gm for brand B10. The percentage of ash was found maximum for brand B10 and lowest for brands for B1 and B2. The percentage of smoke was originated maximum for brands B1 and B2.

Table 3: Comparison with other studies

Reference	Mean( $\mu\text{g/g}$ )	Range( $\mu\text{g/g}$ )	Remarks
This study	0.29	0.27-0.38	
O'Connors et al. (2010)	0.82	0.3–3.33	Cigarettes sold in China
Viana et al. (2011)	0.07	0.05–0.13	Cigarettes commercialized in Brazil
Jung et al. (1998)	0.30	0.17–0.31	Cigarette brands sold in Korea
	0.12	0.078–0.1	Cigarette brands sold in UK
K' Lazarević et al.(2012)	0.11	<0.02–0.71	Cigarette brands sold in Serbia

Table 3 shows that, the comparison between the values described in the literature for arsenic in cigarettes, the mean levels of arsenic in the present study were lower than those reported in the studies in China (O'Connors et al. 2010), and from Korean domestic cigarettes (Jung et al.1998) and the mean level of arsenic to cigarettes sold in UK (Jung et al. (1998), Cigarette brands sold in Serbia (K' Lazarević et al., 2012) and Cigarette brands sold in Brazil (Viana et al.2011) was lower compared to that reported in our study (Table 3).

Table 4: Exposure of arsenic per day

Brands	% of users	Avg. no. of cigarette inhaled per day	As content per cigarette ( $\mu\text{g/g}$ )	As exposure per day ( $\mu\text{g}$ )
B1	28	7	0.26	1.82
B2	36	6	0.22	1.32
B3	5	5	0.20	1.00
B4	3	5	0.21	1.05
B5	10	5	0.19	0.95
B6	4	6	0.19	1.14
B7	3	5	0.20	1.00
B8	22	5	0.17	0.85
B9	4	6	0.17	1.02
B10	5	6	0.16	0.96

Table 4 shows the summary of the questionnaire survey on cigarette smoke. From this table it is observed that the percentage users of different brands of cigarette vary according education lever, occupation and income of the smoker. From survey data, B2 is used about 36% which is maximum because of their education level. This table also shows that how much arsenic inhaled per day of each smoker. The smokers which are used brand B1 they exposed 1.82 $\mu\text{g}$  per day.

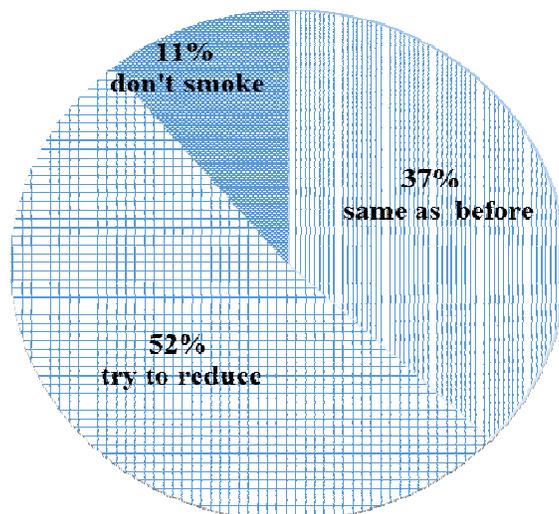


Figure 1: Variation of Smokers' perception as per knowledge of arsenic in cigarette

This figure 1 shows that the variation of the smoker's perception as per knowledge of arsenic in cigarette. Most of the smoker does not have knowledge about arsenic content in cigarette. After knowing about arsenic content in cigarette a significant amount of smoker about 52% changes their smoke behavior pattern that try to reduce. About 37% of smoker no changes and about 11% of smoker do not smoke.

#### 4. CONCLUSIONS

This study has highlighted the arsenic content in cigarette smoke of various brands. This study has also highlighted about the arsenic, sources of arsenic, its effects on human body, about cigarette, composition of cigarettes and its health effects on exposure. The summary of the findings of this study is described as below:

- ❖ Arsenic was found in all cigarette tobacco however not in tobacco ash may because of the total combustion and release of arsenic from cigarette.
- ❖ The mean content of arsenic in cigarette smoke was 0.29  $\mu\text{g/g}$  (0.27–0.38  $\mu\text{g/g}$ ).
- ❖ The bioavailable arsenic was not found because arsenic may not be released from cigarette tobacco without heating

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