

## THE COMPARATIVE STUDY OF THE BENZENE SOLUBLE FRACTION (BSF) OF TAR IN ACTIVE AND PASSIVE SMOKE OF VARIOUS LOW AND HIGH COST CIGARETTES.

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**Abstract:** Cigarette smoke is an aerosol consisting of millions of particles per cubic centimeter of gaseous phase consisting of 60% gases and 40% particulate matter. About 3-40mg of tar is found in a single cigarette. The purpose of our study was to measure the amount of tar in different grades of low cost and high cost cigarettes and to compare the amount of BSF in active and passive smoke of different grades. The comparative analysis of BSF of active smoke of low cost and high cost cigarettes samples reveal that (i) the amount of BSF is higher in low cost cigarettes, (ii) the amount of BSF is less in high cost cigarettes and (iii) for every brand; the amount of BSF is higher in passive smoke than that in its active smoke. In the brands of high cost cigarettes, the filter is made of good quality that adsorbs and absorbs more amount of BSF but in the brands of low cost cigarettes, the filter is made of poor quality that adsorbs and absorbs less amount of BSF. Also in such brands the process of blending of cigarette leaves, and various types of additives determine the amount of BSF in cigarette smoke

### Introduction

Tar is yellowish brown condensate that consists of 3-40mg of tar in a single cigarette. [1]. High-tar cigarettes contain at least 22 milligrams (mg) of tar, medium-tar cigarettes from 15 mg to 21 mg and low-tar cigarettes 7 mg or less of tar. Cigarette smoke is an aerosol consisting of millions of particles per cubic centimeter of gaseous phase consisting of 60% gases and 40% particulate matter [2]. Active smoke (Main stream smoke) is the cigarette smoke inhaled by the smoker, from cigarette and passive smoke (side stream smoke) is the cigarette smoke inhaled by the non-smoker, from cigarette. This smoke appears through the burning end of cigarette [3]. The Polycyclic Aromatic Hydrocarbons (PAHs) and some of the alkaloids are soluble in benzene. There are more than 4000 chemicals found in cigarette smoke, out of which 60-90 chemicals are carcinogenic. The most of the PHAs found in cigarette smoke are carcinogenic. These are generated when

cigarette tobacco burns [4, 10]. Here, for convenience, alkaloids and PHAs have been named as BSF (Benzene Soluble Fraction). Polycyclic aromatic hydrocarbons (PAHs) constitute a large class of compounds, and hundreds of individual substances may be released during incomplete combustion or pyrolysis of organic matter, an important source of human exposure [5]. Studies of various environmentally relevant matrices, such as coal combustion effluents, motor vehicle exhaust, used motor lubricating oil, and tobacco smoke, have shown that the PAHs in these mixtures are mainly responsible for their carcinogenic potential. PAHs occur almost always in mixtures. Because the composition of such mixtures is complex and varies with the generating process, most of the PAHs are known carcinogens and their presence in the environment (particularly in food) is a cause of concern to health authorities. [6]. As these PHAs live longer, it is possible that smoking-related diseases, including lung

cancer, may become more common [7] . In the brands of high cost cigarettes, the filter is made of good quality that adsorbs and absorbs more amount of BSF but in the brands of low cost cigarettes, the filter is made of poor quality that adsorbs and absorbs less amount of BSF. Also in such brands the process of blending of cigarette leaves, and various types of additives determine the amount of BSF in cigarette smoke. [8].

### Materials and Methods

To study the amount of BSF in different brands of cigarette, a self developed method was adopted. This process involves the comparison of BSF in active and passive smoke of low cost cigarettes and high cost cigarette. For this purpose the active and passive smoke of various brands of high cost A, B, C, D, E and F and low cost brands L, M, N, O, P and Q were analyzed.

### For active smoke ( Main Stream Smoke)

For the study of amount of BSF in active smoke cigarette, active smoke was collected. For this purpose each cigarette was burnt and its smoke was collected in a syringe by suction. The syringe was rinsed with benzene. The smoke was then transferred to glass bottle. This bottle was already washed and rinsed with benzene. For each brand, three cigarettes were used. The collected smoke was dissolved in benzene. This solution was transferred to a pre-weighed petridish and benzene was allowed to evaporate. After complete evaporation, a yellow colored mass ( which turned brown if kept exposed to the atmosphere for sometime) was obtained as BSF. The petridish was again weighed to get the weight of BSF.

### For passive smoke (Side Stream Smoke)

For the study of passive smoke of a cigarette, passive smoke was collected.

For this purpose each cigarette was burnt and its smoke was collected in a glass bottle. This bottle was already washed and rinsed with benzene. For each brand, three cigarettes were used. The collected smoke was dissolved in benzene. This solution was transferred to a pre-weighed petridish and benzene was allowed to evaporate. After complete evaporation, a yellow coloured mass (which turned dark brown if kept exposed to the atmosphere for sometime) was obtained as BSF. The petridish was again weighed to get the weight of BSF. The amount of BSF in all samples for active and passive smoke was calculated and recorded.

The amount of BSF in active as well as passive smoke in three cigarette for each sample was calculated as

$$\begin{aligned} \text{Weight of petridish} &= x \text{ g} \\ \text{Weight of petridish + BSF mass} &= y \text{ g} \\ \text{The amount of BSF} &= y - x = z \text{ g} \end{aligned}$$

Poly Aromatic Hydrocarbons (PAHs) and alkaloids are soluble in Benzene. The solutions of these PAHs and alkaloids have been abbreviated as BSF (Benzene Soluble Fraction). The Study of the result of the experimental work for comparison of BSFs in six brands each of high and low cost cigarette, for active and passive smoke, revealed the following results. (Tables 1,2)

### Results and Discussions

The amount of BSF in active smoke of high cost and low cost brands of cigarette have been given in Table 1 and Table 2. The comparative analysis of BSF of active smoke of low cost and high cost cigarettes samples reveal that:

1. The amount of BSF is higher in low cost cigarettes.
2. The amount of BSF is less in high cost cigarettes.

The reason is that in the brands of high

cost cigarettes, the filter is made of good quality that adsorbs more amount of BSF. Also in such brands the process of blending of cigarette leaves, and various types of additives determine the amount of BSF in cigarette smoke. [8].

In low cost cigarettes, the filters of poor quality are used that absorbs lesser quantity of BSF. Similarly, the additives in such cigarettes are also of low quality [8,9] that mostly burn and give more and more BSF.

The comparison of the amount of BSF in active and passive smoke of cigarette samples shows that BSF is found higher in amount in passive smoke (that is inhaled by non smoker) than that in active smoke ( inhaled by smoker). For example, sample A has BSF 0.018g in its active smoke but the amount of BSF in its passive smoke is 0.027g. This difference is mainly due to the filter.

The comparative analysis of the amount of BSF in cigarette and passive smoke, reveal the following facts:

1. The amount of BSF is higher in low cost cigarettes.
2. The amount of BSF is lesser in high cost cigarettes.
3. For every brand, the amount of BSF is higher in passive smoke than that in its active smoke.
4. No filter can absorb all the BSF from cigarette smoke.

The Results for the amount of BSF in active smoke of High and Low brands of cigarettes

**Table 1.**

| Sr. No. | High Cost Brands | Amount of BSF (In Grams) | Low Cost Brands | Amount of BSF (In Grams) |
|---------|------------------|--------------------------|-----------------|--------------------------|
| 1       | A                | 0.018                    | L               | 0.040                    |
| 2       | B                | 0.021                    | M               | 0.110                    |
| 3       | C                | 0.023                    | N               | 0.099                    |
| 4       | D                | 0.020                    | O               | 0.102                    |
| 5       | E                | 0.025                    | F               | 0.097                    |
| 6       | F                | 0.019                    | Q               | 0.111                    |

The Results for the amount of BSF in passive smoke of different brands of cigarettes

**Table 2**

| Sr. No. | High Cost Brands | Amount of BSF (In Grams) | Low Cost Brands | Amount of BSF (In Grams) |
|---------|------------------|--------------------------|-----------------|--------------------------|
| 1       | A                | 0.027                    | L               | 0.151                    |
| 2       | B                | 0.030                    | M               | 0.210                    |
| 3       | C                | 0.031                    | N               | 0.201                    |
| 4       | D                | 0.029                    | O               | 0.280                    |
| 5       | E                | 0.021                    | F               | 0.113                    |
| 6       | F                | 0.022                    | Q               | 0.197                    |

Comparison of BSF in Active and passive smoke of high cost brands of cigarette

**Table 3**

| S# | Brands | Amount of BSF in Active Smoke | Amount of BSF in Passive Smoke | Difference Passive - Active |
|----|--------|-------------------------------|--------------------------------|-----------------------------|
| 1  | A      | 0.018                         | 0.027                          | 0.009                       |
| 2  | B      | 0.021                         | 0.030                          | 0.009                       |
| 3  | C      | 0.023                         | 0.031                          | 0.008                       |
| 4  | D      | 0.020                         | 0.029                          | 0.009                       |
| 5  | E      | 0.030                         | 0.021                          | -0.009                      |
| 6  | F      | 0.019                         | 0.022                          | 0.003                       |

Comparison of BSF in Active and passive smoke of Low cost brands of cigarette

**Table 4**

| S # | Brands | Amount of BSF in Active Smoke | Amount of BSF in Passive Smoke | Difference Passive - Active |
|-----|--------|-------------------------------|--------------------------------|-----------------------------|
| 1   | L      | 0.040                         | 0.151                          | 0.111                       |
| 2   | M      | 0.110                         | 0.210                          | 0.1                         |
| 3   | N      | 0.099                         | 0.201                          | 0.102                       |
| 4   | O      | 0.102                         | 0.280                          | 0.178                       |
| 5   | P      | 0.097                         | 0.113                          | 0.016                       |
| 6   | Q      | 0.111                         | 0.197                          | 0.086                       |

BSF value was found high in Passive smoke as compared to the values of BSF in Active smoke. So the non smokers living in the company of smokers are at high risk as compared to smokers.

### IR Studies of Active and Passive Smoke Analysis

The results of IR spectra for above samples have been given in the Tables 5 and 6

**Table. 5** IR results for BSF of Active Smoke of few selective Brands

| Sample | Cm-1   | Intensity | Possible Vibration of Bonds                | Remarks                                     |
|--------|--------|-----------|--|---|
| A      | 3026.5 | Strong    | May be due of N-H stretch aromatics        | Aromatics indicated                         |
| B      | 3026.8 |           |  |   |
| N      | 3026.5 |           |  |   |
| A      | 728.7  | Strong    | May be due to C-H bending of aromatics     | Aromatics indicated                         |
| B      | 728.5  |           |  |   |
| N      | 728.4  |           |  |   |
| A      | 1494.5 |           | May be due to C – C ring stretch.          | Aromatics indicated                         |
| B      | 1494.6 |           |  |   |
| N      | 1494.7 |           |  |   |
| A      | 1603.5 | Medium    | May be due to C=N stretch                  | Nicotine indicated<br>anatabine may present |
| B      | 1603.6 |           |  |   |
| N      | 1603.7 |           |  |   |
| A      | 2930.3 | Strong    | May be due to stretch of N-CH <sub>3</sub> | Nicotine indicated<br>(anatabine absent)    |
| B      | 2920.1 |           |  |   |
| N      | 2920.2 |           |  |   |

**Table 6** IR results for BSFs of Passive Smoke of few selective Brands

| Sample | Cm-1   | Intensity | Possible Vibration of Bonds              | Remarks                                       |
|--------|--------|-----------|--|---|
| A      | 3026.0 | Strong    | May be due of C-H stretch of aromatics   | Aromatics indicated                           |
| B      | 3026.4 |           |  |   |
| N      | 3026.0 |           |  |   |
| A      | 728.2  | Strong    | May be due to C – H bending of aromatics | Aromatics indicated                           |
| B      | 728.3  |           |  |   |
| N      | 728.0  |           |  |   |
| A      | 1494.6 | Medium    | May be due to C – C ring stretch.        | Aromatics indicated                           |
| B      | 1494.7 |           |  |   |
| N      | 1494.7 |           |  |   |
| A      | 1603.6 | Medium    | May be due to C=N stretch                | Nicotine indicated<br>(anatabine may present) |
| B      | 1603.7 |           |  |   |
| N      | 1603.7 |           |  |   |
| A      | 2919.9 | Medium    | May be due to N-CH <sub>3</sub> stretch  | Nicotine indicated<br>(anatabine absent)      |
| B      | 2920.0 |           |  |   |
| N      | 2920.3 |           |  |   |

BSF value was found high in Passive smoke as compared to the values of BSF in Active smoke

The IR spectra of the smoke (active and passive) for the cigarette samples A, B and N revealed the presence of PAHs as well as Nicotine (alkaloid). It was found that all the smoke components are same in active and passive smoke. The IR spectra of all samples are very close. It shows that almost all cigarettes have same component. However the absorption values of the peaks shown in active smoke, are somewhat less intense as compared to that in passive smoke.

The aromatic compounds show strong peaks in the region of 900-675 cm<sup>-1</sup> (finger print region). The strong absorption peaks were found that confirmed the presence of poly aromatic compounds (PAHs). The significant peaks due to C-C and C-H bond etc. of benzene ring were also observed.

### **Conclusion**

The study of IR spectra of the cigarette smoke extract (BSF) revealed the presence of alkaloids, possibly Nicotine cigarette smoke. The comparison of IR spectra of active and passive smoke showed that the active and passive smoke have same PAHs. However, the amount of PAHs in active smoke was found to be somewhat less than that in passive smoke. Peaks for alkaloids were not prominent in IR spectra of smoke; this shows that some of alkaloids are converted to other products when cigarette tobacco burns.

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