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RESEARCH ARTICLE

"Alkaloids removal from popular Indian brands of cigarettes using low cost adsorbents".

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Abstract

The study aims to investigate the alkaloid concentration in five brands of cigarettes (Indian brands-Moments, capstan, goldflake, tambaku and bidi) and removal of these alkaloid in different contact time using various low cost adsorbents (Sawdust, bagasse, green tea leaves, coconut fiber, neem bark and green tea waste). These adsorbents are cheap source agriculture waste and industrial by-products, which are easily available. They can absorb the alkaloids on their surface, thus can remove alkaloids and reduce the toxic effect of tobacco. Their adsorption capacity depends upon the weight of adsorbent used and their contact time with the alkaloid. The alkaloid removal using low cost adsorbents in the above extracts showed a variation in their adsorption properties. For moments, lowest percentage removal was observed at 60 mins by sawdust adsorbent of 10.01% which increased upto 13.4% as the duration of contact increased (480 mins) with adsorbent. Bagasse did not showed a very significant result ranging from 12.886% to 13.99%. Highest percentage of alkaloid was seen in case of green tea (13.892%) at 60 mins. Coconut fiber showed an average percentage of 12-13%. The adsorbent which showed best result against these alkaloid extract were Sawdust, green tea leaves and green tea wastes. In some cases, as the time increased, adsorption capacity increased but, after certain period of time, removal starts decreasing. The study revealed that sawdust, green tea leaves, green tea waste turned out to be better adsorbent while bagasse and neem bark turned out to be less efficient.

Introduction:-

More than 4000 compounds have been identified in tobacco smoke, and at least 50 of these have been found to be carcinogenic **(Wynder and Hoffmann, 1967; Hoffmann *et al*., 1997)**. Tobacco includes any plant of the genus Nicotiana of the nightshade family (Solanaceae). Cultivated tobacco (*Nicotiana tabacum*) is the most widely planted species and is grown worldwide for the production of tobacco leaf. The presence of alkaloids, such as nicotine, nornicotine, anabasine, and anatabine, is characteristic of Nicotiana species. These are structurally related alkaloids which are found in tobacco, including nicotine, nornicotine, myosmine, anabasine, anatabine and isonicoteine (2,3-bypryidyl) (**Gorrod Wahren, 1993**). While nicotine is the most abundant alkaloid, accounting for approximately 95% of alkaloid content, the minor alkaloids have been shown to exhibit biological activity in animals **(Clark *et al*., 1965).** Tobacco use contributes in 10 global deaths and is the second major cause of mortality in the world **(Hammond and O'Connor 2008; WHO 2009)**. There are approximately 1.25 billion smokers in the world

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representing about a third of the adult global population; 800 million of these people live in developing countries. While the cigarette consumption has been increased in most of the developing countries, the past 25 years has been marked by a steady decline in cigarette consumption in some developed countries. However the world cigarette production has increased about four times during the last 50 years **(Lee *et al.*, 1998; Mackay and Crofton, 1996; Griesbach *et al.*, 2003; Fleming *et al.*, 2002; Agha Molaei and Zare, 2008).** It has been reported that to date, more than 3000 chemicals have been isolated from tobacco which more than 1000 of these chemical constituents present in unburnt **(Roberts, 1988; WHO, 2004).**

Filters are recognized as an integral part of cigarette design and are used extensively to meet a range of product parameters such as draw resistance, and perhaps more importantly tar and nicotine yields. By 1964, over 50% of all cigarettes smoked were filtered and today well over 99 % of all cigarettes are filtered. One of the principal uses for a cigarette filter is the overall reduction of smoke compounds. Paper and polypropylene do not show any selective filtration effects for filters with a pressure drop of about 80 mm WG and a circumference of 24.5 mm **(Taylor, 2014)**. The more volatile a compound the greater its availability for selective filtration due to its ability to diffuse to the site where selective removal is occurring **(Taylor, 2014)**.

Natural materials that are available in large quantities or certain waste from agricultural operations may have potential to be used as low cost adsorbents, as they represent unused resources, widely available and are environmentally friendly **(Deans,1992)**. In general, an adsorbent can be termed as a low cost adsorbent if it requires little processing, is abundant in nature, or is a by-product or waste material from another industry (**Nasim *et al.*, 2004**). There has been an increasing research into finding low-cost adsorbents for the removal of heavy metals from wastewaters. Agricultural by-products which have been studied for this purpose include peat, wood, pine bark, banana pith, cotton seed hulls, peanut shells, hazel nut shell, rice husk, saw dust, wool, orange peel, compost, maize cobs and guava leaves. Neem bark dust is a cheap material and the adsorption capacity of the Neem bark dust is high compared to other adsorbents, hence, it can be used as an effective adsorbent for removal of NO_2 **(Ansari and Deshkar, 2007; Kaushik, 1979; Dakiky *et al.*, 2002; Suhail *et al.*, 2010; Tarun *et al.*, 2008; Vinodhini and Das, 2009).**

Material & Methodology:-

The experimental samples used for this study were five different brands of cigarettes from India. The Indian cigarette brands used were **Moments, Goldflake, Capstan, Tambaku and Bidi.** Six low cost adsorbents were used-Sawdust, bagasse, green tea leaves, coconut fibre, neem bark and green tea waste. The adsorbents were washed extensively in running tap water to remove dirt and other particulate matter. Subsequently the adsorbents were oven dried at $80^{O}C$ for 24 hours. After complete drying the adsorbents were crushed and grinded separately in an electrical grinder and were passed through 2mm sieve in order to obtain uniform particle size and then stored in air tight bottles for subsequent steps.

Extraction:-

Commercial cigarettes were obtained from local retail outlets for the study. Tobacco weights of the cigarettes were based on an average of 10 cigarettes, while the tobacco weights of the bidi were based on an average of 20 bidis. For each brand of bidi and cigarette, the tobacco was removed from the wrapping, weighed, and pooled for chemical analysis and alkaloid extraction. The extraction for each cigarette was done with water.

Qualitative estimation (Test for alkaloids):-

Presence of alkaloid was confirmed by Dragendroff's method. A part of extract was dissolved in dilute HCL and 2 drops of Dragon drop's was added, a crystalline precipitate indicates presence of alkaloid. The sample which showed positive alkaloid was then subjected to further quantitative evaluation.

Separation of Alkaloid:-

A part of extract residue was dissolved in 2N HCL and then filtered. 1 ml of this solution was transferred to separatory funnel and washed with 10 ml chloroform (3 times). The pH of this solution was adjusted to neutral with 0.1 N NaOH. Then 5 ml of BCG solution and 5 ml of phosphate buffer were added to this solution. The mixture was shaken and complex extracted with 1, 2, 3 and 4 ml chloroform by vigorous shaking, the extract was then collected in a 10 ml volumetric flask and diluted with chloroform. The absorbance of the complex in chloroform was measured at spectrum of 470 nm in UV-Spectrophotometer (UV-Vis Double Beam Spectrophotometer) against the blank.

Determination of % removal

Percent removal R(%) was calculated as : $R(\%) = \{(C_i - C_f)/C_i)\} \times 100$

Where C_i and C_f are the initial and final concentrations of nicotine in mg/L.

Result & Discussion:-

The percentage removal of alkaloids using six different low cost adsorbents (Sawdust, bagasse, green tea leaves, coconut fiber, neem bark and green tea waste) was calculated according to the above given formula. Six adsorbents were treated against tobacco of five cigarette brands (Indian brands-Moments, capstan, goldflake, tambaku and bidi). Initial concentration (Ci) of alkaloid in each cigarette extract was calculated using standard graph of Atropine. Percentage removal of alkaloid has been analyzed at variable time interval from duration ranging between 60 mins-480 mins. A variation was seen in the removal percentage by the six adsorbents with some significant results while others non-significant.

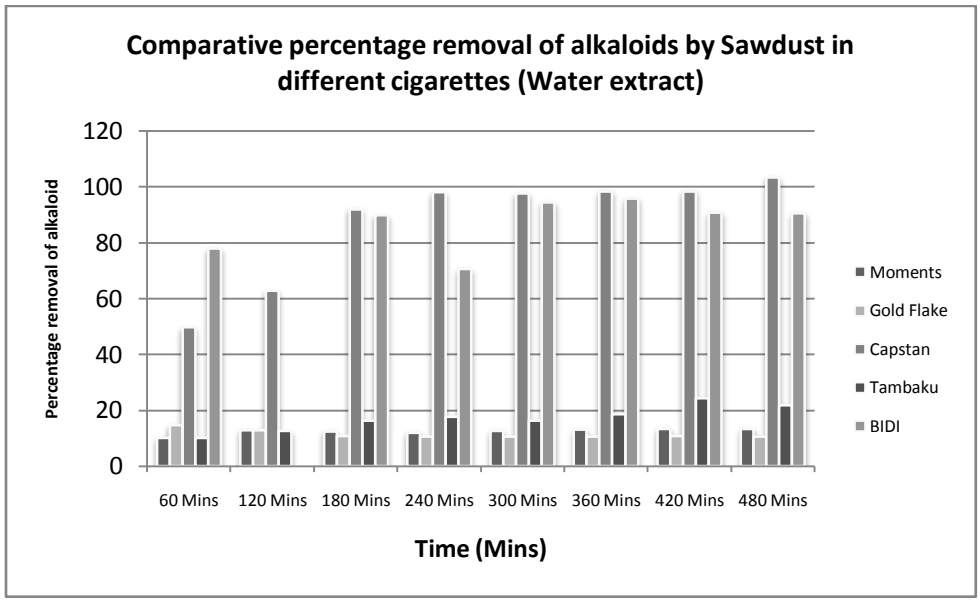

Figure 1:- Comparative percentage removal of alkaloids by Sawdust (water extract) in different cigarettes

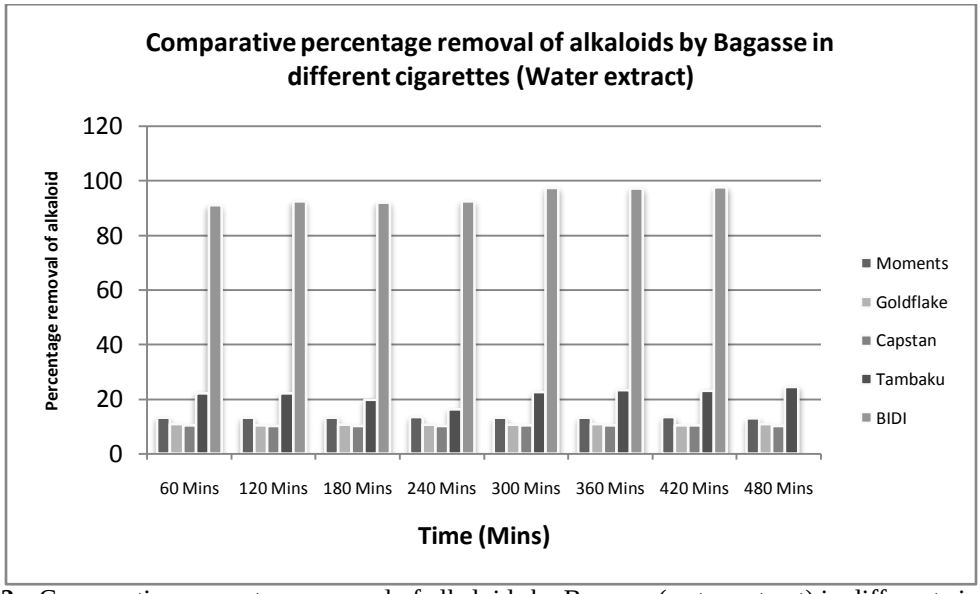

Figure 2:- Comparative percentage removal of alkaloids by Bagasse (water extract) in different cigarettes

The alkaloid removal using low cost adsorbents in the above extracts showed a variation in their adsorption properties. For moments, lowest percentage removal was observed at 60 mins by sawdust adsorbant of 10.01% which increased upto 13.4% as the duration of contact increased (480 mins) with adsorbant. Bagasse did not showed a very significant result ranging from 12.886% to 13.99%. Highest percentage of alkaloid was seen in case of green tea (13.892%) at 60 mins.Coconut fiber showed an average percentage of 12-13%. As compared to water extracts of alkaloid, methanol extract showed a much higher percentage of alkaloid removal, having a minimum of 57.31% at 60 min by sawdust while maximum was seen in green tea waste at 60 minutes of 70.58%. The adsorption capacity reduced as the time exceede more than 240 mins. For Goldflake water extract, minimum removal of alkaloid was seen in case of neem bark (240 mins) of 10.35% while maximum by sawdust (14.77%). A very significant adsorption capacity was seen against capstan by green tea waste (90.68%), green tea leaves and neembark (99.14%).

Basher *et al.*, (2013) investigated **t**he ability of coconut fiber; saw dust and tea waste to adsorb nicotine, from aqueous solutions through batch experiments. The amount of nicotine adsorption was found to be dependent on adsorbent dosage and contact time. All experiments were carried out at a constant temperature of 30°C. The experimental isotherm was analyzed using the Langmuir and Freundlich's equations. The experiments showed that higher removal rate was shown by coconut fiber than saw dust and tea waste.

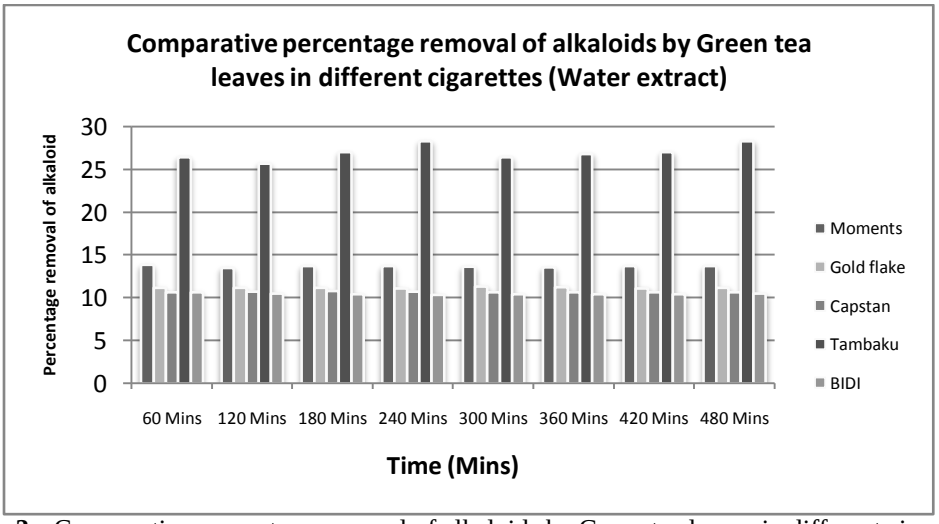

Figure 3:- Comparative percentage removal of alkaloids by Green tea leaves in different cigarettes

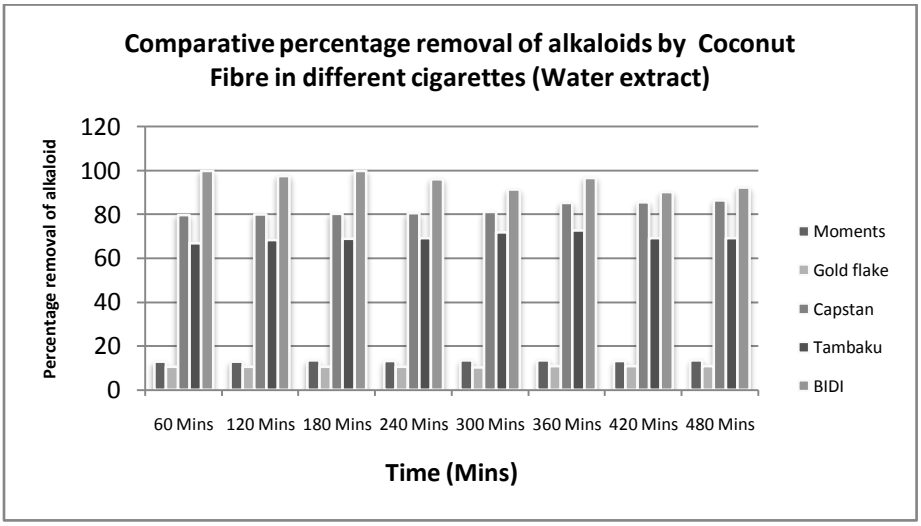

Figure 4:- Comparative percentage removal of alkaloids by Coconut fiber in different cigarettes

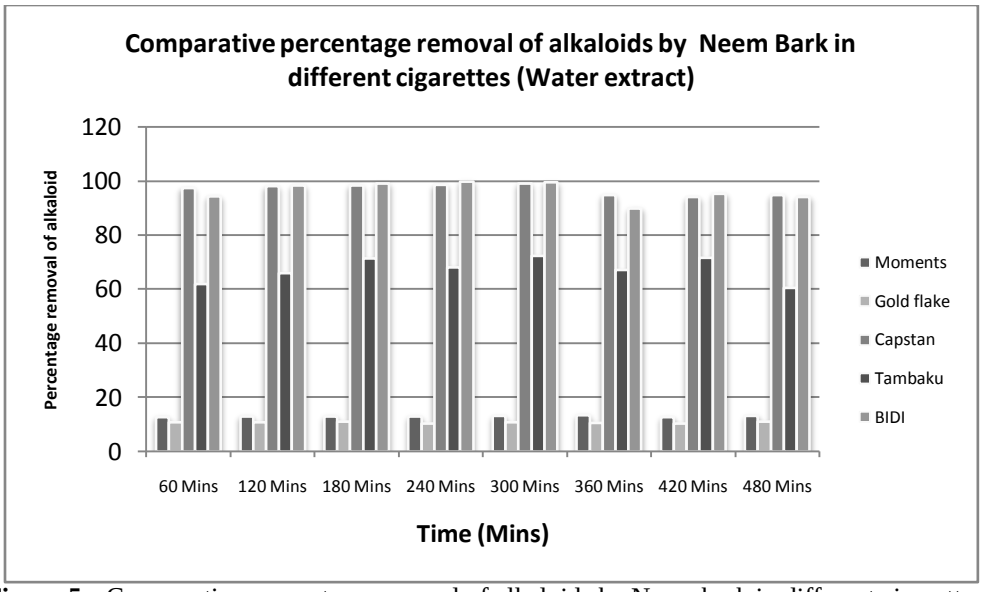

Figure 5:- Comparative percentage removal of alkaloids by Neem bark in different cigarettes

The adsorbent which showed best result against these alkaloid extract were Sawdust, green tea leaves and green tea wastes. In some cases, as the time increased, adsorption capacity increased but, after certain period of time, removal starts decreasing. Adsorption of nicotine was measured at specified time using six adsorbents like coconut fibre , saw dust and waste tea leaves, bagasse, neem bark, green tea leaves for ten different cigarettes . The plot reveals that the amount of nicotine removed by saw dust, green tea leaves and green tea waste were higher, then the amount of nicotine was removed by using neem bark and coconut fiber .The result showed that saw dust, green tea leaves and green tea waste had more efficiency than waste tea leaves as adsorbents to remove nicotine in cigarettes. Therefore active carbon fibers of saw dust, green tea leaves and green tea waste with unmatchable pore structure and surface characteristics that have materials and high efficiency for a number of applications, these organic materials can be used for adsorption of wide number of molecules of organic matter as observed **(Manocha, 2003).**

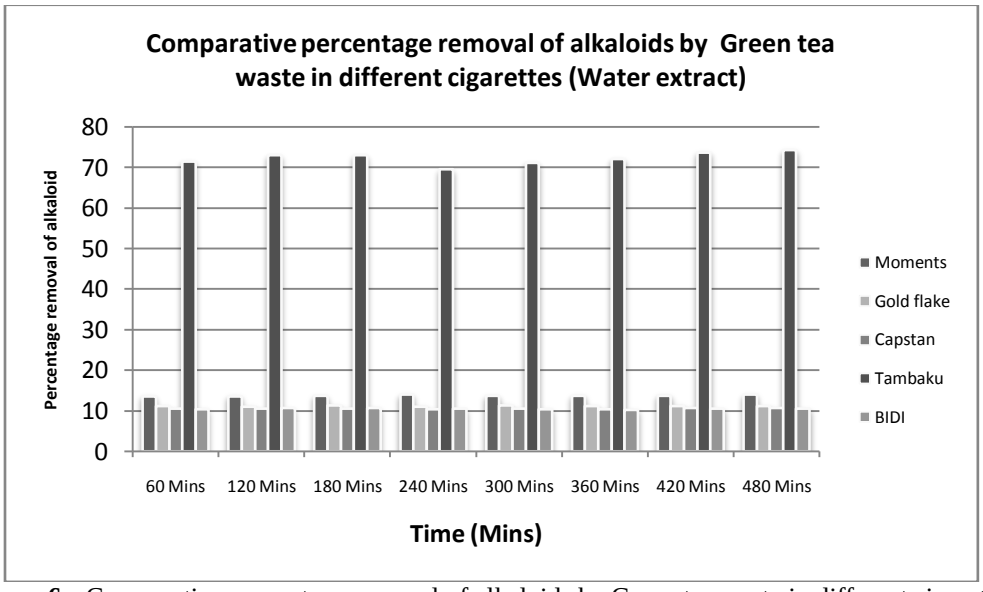

Figure 6:- Comparative percentage removal of alkaloids by Green tea waste in different cigarettes

The low cost adsorbents, like neem and sawdust has been earlier evaluated by **Kumar and Shrivastava (2015)** in the comparative performance i.e. Cr (VI) percent removal and loading capacity. At 311K Chromium percent removal for Neem and rice husk sawdust are 66 and 46 % respectively. Analysis of results shows high uptake

capacity of Neem sawdust (6.84 mg/g) at 311K temperature as compared to rice husk (4.63 mg/g) when compared at 50 mg/L of initial Cr concentration. These results indicate that Neem Sawdust has better capability of Chromium removal at 311K compared to rice husk Sawdust adsorbents. Bagasse has been used as adsorbent in **Raymundo *et al.* (2010)** study, where the highest percentages of adsorption occurred at pH 10, being approximately 65, 75 and 82% for the particles size 1 to 3, respectively. Thus there was a higher efficiency on the dye removal when carried out with the bagasse at pH 10. The particles size of cane bagasse has a strong effect on the adsorptive processes when the diameter reduction of particles achieves the µm scale **Raymundo *et al.* (2010)**.

Conclusion:-

In this study, the alkaloid removal using low cost adsorbents in the extracts from various brands of Indian cigarettes have been analyzed. As these adsorbents are available in large amount at low cost and more availability, therefore their efficiency in alkaloid adsorption would be of great interest. The work showed a variation in the adsorption capacity of different adsorbents. Analysis of their percentage removal of alkaloid from the extract was based on the contact between adsorbent and the tobacco extract. For moments, lowest percentage removal was observed at 60 mins by sawdust adsorbent which increased as the duration of contact increased (480 mins). Bagasse did not show a very significant result. Highest percentage of alkaloid removal was seen in case of green tea at 60 mins. Coconut fiber showed an average percentage removal of alkaloid. The adsorption capacity reduced as the time exceeded more than 240 mins. For Goldflake water extract, minimum removal of alkaloid was seen in case of neem bark (240 mins) while maximum by sawdust. A very significant adsorption capacity was seen against capstan by green tea waste, green tea leaves and neembark. Thus the study revealed that these adsorbents have considerable potential for removal of harmful alkaloid content in different brands of cigarettes.

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