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Multi-element analysis of selected brands of cigarettes in Nigerian market

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ABSTRACT

Instrumental Neutron Activation Analysis (INAA) technique was used to analyze 14 brands of cigarette sold in Nigerian market for trace and major elements. The samples were irradiated with thermal neutrons in nuclear reactor and the induced activities were counted by γ-ray spectrometry using efficient calibrated High Purity Germanium (HPGe) Detector. Thirty one elements including metals, metalloids, nonmetals and elements which exhibit high thermal neutron reaction cross section were detected. The concentrations of these elements in the analyzed samples range from 0.01 - 2929ppm while Lu, Cs, Ce, Ti, Ta, V and Dy were found below the detection limit of the instrument. The results were compared with various standard reference materials and good agreement was obtained with the certified values. The result for some of these elements is too high that it poses a health risk to persons exposed to these cigarette constituents.

Key words: Neutron Activation, Multi-element, Heavy metals, Cigarettes, Nigeria.

INTRODUCTION

Cigarette smoking has largely replaced other methods of tobacco use in many countries despite government effort to discourage its used by her citizen due to several reports indicting cigarette use to some health implications in man. The reason for its popularity has been attributed to the fact that it is readily available, resulting from large scale manufacture and greater convenience [1]. Tobacco smoke is a complex mixture of organic and inorganic constituent with particulate and vapor phases and highly reactive radicals [2]. Most of the constituents originate from the leaf while some arise from growing conditions such as soil, atmosphere and agricultural chemicals used. More than 3040 chemical compounds have been isolated from processed tobacco leaf [3], many of which are pharmacologically active, toxic, mutagenic, carcinogenic [2] [3] and are harmful to human [4]. According to WHO, at least one person dies per 10 second as a result of cigarette smoking [5]. Tobacco plant is known to easily absorb nickel, cadmium and other metals from the soil and concentrate them in leaves [6]. These metals are transferred to the smoke during smoking process. The smoke may contain arsenic especially when the tobacco has been treated with lead-arsenate insecticide [7]. The content of arsenic in tobacco grown on soils not treated with arsenic compounds is usually below 3mg/kg [8]. Out of the total amount of heavy and trace metals originally present in tobacco, 10 – 15% was recovered from mainstream smoke, the remainder mainly been distributed in the ash and butt [9]. Some studies have confirmed increased respiratory cancers to a series of other inhaled nickel compounds.

Considerable data also supported the statement that tobacco smoking acts synergistically with a number of respiratory carcinogens [10][11].

For most relevant metals, there percentage transfer from the burning cigarette to the smoke has been estimated [12][13][14][15]. Studies have shown that cigarette smoking is a significant factor in spontaneous abortion among pregnant women that smokes cigarette and that it contributes to a number of other threats to the health of the fetus [16].

The origin of excess trace metals and radioactive elements such as radium, ^{210}Pb, ^{210}Po etc. in counterfeit cigarette was attributed to heavy application of less expensive and contaminated phosphate fertilizers produced from apatite rock. Dangers in modern cigarette include contamination from pesticide used during tobacco growth, insecticides applied during storage to keep cured leaves from insects' attack and other chemicals added to enhance taste and make cigarette burn better. The processing, packaging and other technological processes can significantly increase the total trace metal concentration in cigarette. Not all the traces of metals in cigarettes are the result of human activities. Some arise through the absorption of naturally occurring soil components [17]

Smoking appears to induce oxidative stress in that smokers have diminished level of anti-oxidant such as vitamin C, vitamin E and cartenoids [18]. Metals such as cadmium, tin, lead and mercury affects the transmission of synaptic message both in the brain and peripheral nervous system, disrupt calcium metabolism which can affect cellular function [19]. Barium, for instance, is similar to calcium in chemical behavior. When absorbed in to the blood stream under 24 hours it gets deposited in delicate organs (liver, spleen, brain, heart, hair and bones) in similar way to calcium. In another study, the paralyses of the central nervous system was linked to the displacement of calcium from the cell membrane by barium, there by increased permeability and stimulation of the muscles which eventually resulted to paralyses of central nervous system [20]. Antimony at concentration of $0.01\mu gm^{-3}$ is recognized as urban air pollutant, [21] and its biological effects similar to arsenic [22]. The similarity of antimony to arsenic chemically and in some biological effect leads to the conclusion that tobacco smoke and antimony could interact in similar way to arsenic in producing toxicity.

Several methods exist for the determination of trace metals in tobacco cigarette but the need for multi element analysis is receiving greater attention as the toxicity might be greatly influence by synergistic effect of several metals. Instrumental Neutron Activation Analysis (INAA) was used for the detection of trace metal in major elements in tobacco by Schneider and Krivna ([15]. Levels of trace and major elements in various kinds of tobacco were poorly studied, so their determination in this matrix is important both from the point of view of health studies connected with smoking and more general aspects of the uptake of trace elements by plants. Because of its great sensitivity, neutron-activation analysis is very suitable for determination of trace heavy metals.

In the previous work, the levels of heavy metals (Pb, Cd, Cr, Ni, Cu and Zn) were measured and their toxicological implications were discussed extensively [12]. It was also found that the amounts of toxic metals estimated in cigarette smoke are capable of causing health complications in active and passive smokers. Considering the synergistic effect of elements arising from their interaction either in smoke or when absorbed by cigarette users, this research aimed at probing into elements that could be present in cigarette available in Nigerian market using NIRR-1 (INAA), to establish the level at which these elements are present in the selected brand of cigarette with attention to their synergistic effects in active and passive smokers, to make inference on the contributions of cigarette smoke to environmental pollution and to establish the adequacy of NIRR-1 (INAA) for analysis of tobacco and tobacco products

MATERIALS AND METHODS

Sampling procedure

Different brands of cigarettes available in Nigeria market were randomly collected at retailer outlet in Sabon Gari market, Zaria-Nigeria and analyzed using Nigeria Research Reactor (NIRR-1) at Centre for Energy Research and Training (CERT) Ahmadu Bello University (ABU), Zaria. Most of the samples analyzed were produced locally, some were imported into Nigerian market and some the country of production is not known. They include CRM1, CBH2, CEX3, CLF4, CDC5, CSM7, CLK10, CCM1and CPM12 produced in Nigeria, CAS6 a foreign product and CCT8, CLD9, CFR13, CBK14 in which the region of production could not be identified from the cigarette packed. The reactor in CERT is of low power and comprises of the following: enriched uranium as the fuel, light water as a

moderator and beryllium as reflector. Other facility indispensible of the reactor is the gamma-ray data acquisition system responsible for the measurement of radioactivity. Complete description of the reactor, irradiation facility, standardization of irradiation and counting facilities for instrumental neutron activation analysis, the determination of efficiency curves for the detector system at near and far source detector, geometry and extension of energy range fro 59.5 – 2254 KeV to 4000 KeV by semi empirical method have been given in literature[23][24][25].

Sample preparation

Cigarette samples were removed from their wrappers, dried to a constant weight at 90°C in an oven and allowed to cool in desiccators. The dried sample of each brand was fined powdered using agate mortal and homogenized properly using quaternary system. Analytical samples, both for short and long-lived irradiations were weighed and wrapped in a well prepared contaminant free polyethylene films. The bags were cleansed by soaking in 1:1 HNO_3 for 3 days, washed twice with de-ionized water, dried in an oven at 30 ^{0}C and cooled in desiccators.

Sample Irradiation Procedure

Samples were placed in a homogenous flux of thermal neutrons for a period of time sufficient enough to produce a measurable amount of radionuclide of the element to be determined. In this work, short-lived irradiation and long-lived irradiation regimes were adopted [24]. In the first scheme, nuclide with short half lives (less than two days) were measured to determine Calcium, Chlorine, Copper, Arsenic, Barium, Manganese, Molybdenum, Sodium, Potassium, Selenium, Titanium, Rubidium, Vanadium and Aluminum. The listed short-lived nuclides (Table 1) were measured using the nuclear data. For those elements leading to short lived activation product, no further packaging was necessary. The samples are therefore placed and sent for irradiation in turn in an outer irradiation channel designated B4 with soft neutron spectrum. The choice of the outer irradiation was to eliminate corrections due to nuclear interferences cause by threshold reaction notably Mg in the presence of Al; Al in the presence of Si etc. This is due to the proximity of the outer channels to miniature neutron source reactor to the core leading to higher ratio of fast to thermal neutrons [24]. The number of standards used with short lived irradiation was one per seven samples.
In the second scheme, nuclides with relative long half life (ie grater than five days) are analyzed to determine Copper, Chromium, Antimony, Iron, Nickel and Zinc. The prepared samples are irradiated for 6 hours in two of the small inner irradiation channels designated B1 and B2 to take advantage of the maximum value of thermal neutron flux in the inner channel. Both the samples and the standard were packaged in a polyethylene capsule (rabbit capsule) and irradiated at once to check flux variations. The power rating of 100 KW was used to give thermal neutrons fluxes thermalized to 5.0 x 10^{11} n/cm^{2}s suitable for long-lived activation and a flux of 2.5x 10^{11} n/cm^2 s for short lived activation.

Table 1. Irradiation and counting regimes developed for NIRR-1 Facilities.

Flux energy/ irradiation channels	procedure	T_{irr}	T_d	T_c	Activation product
2.5x10^{11} n/cm^{2}s/ outer irradiation channels (B4,A2)	S1	5min	2-15min	10min	^{28}Al, ^{27}Mg, ^{38}Cl, ^{49}Ca,
	S2	5min	3-4hrs	10min	^{24}Na, ^{42}K, ^{56}Mn, ^{152}Eu
5x10^{11} n/cm^{2}s/ inner irradiation channels (B1,B2,B3 and A1)	L1	6hrs	4-5d	30min	^{24}Na, ^{42}K, ^{140}La, ^{153}Sm, ^{122}Sb, ^{82}Br, ^{72}As, ^{72}Ga
	L2	6hrs	10-15d	30min	^{46}Sc, ^{131}Ba, ^{86}Rb, ^{175}Yb, ^{181}Hf, ^{233}Pa (Th), ^{60}Co

T_{irr} = irradiation time, T_d = delay or decay time, T_c = counting time, S1&2: short lived activation 1 &2, L1&2: long lived activation 1&2

Counting Procedure

After successful irradiation of the sample in the reactor, by means of pneumatic transfer system the irradiated samples were made available for counting.

For the short irradiation schemes, the conditions that necessitated effective counting after irradiation of samples with 2.5 x 10 ^{11} n/cm^{2}s thermal neutron flux for 5 minutes includes: 5 minutes for cooling time, enough to remove prompt gamma-ray leaving the delay gamma-ray and 10 minutes counting period for first round of counting (Table 1). The sample was placed on a plexi glass holder designated H2 corresponding to source geometry of 5 cm. The second round of counting also was carried out for 10 minutes after a waiting time of 3-4 hours. For element leading to long-lived irradiation, the conditions necessary for effective counting after irradiation with 5x10^{11}n/cm^{2}s thermal neutron flux for 6hours includes 4-5 days cooling time to remove prompt gamma-ray and 30 minutes counting time on a plexi glass holder designated H1 corresponding to source detector geometry of 1cm. The second round of counting was performed for 30 minutes after a waiting period of 10 days on a plexi glass holder designated H1.The choice of cooling time and sample detector geometry was such that detectors dead time is controlled to be less than 10%.

By means of the multi-channel analyzer (MCA) card, the spectral intensities of the samples were accumulated. Each spectrum was analyzed using the gamma-ray spectrum analysis software, WINSPAN 2004. This calculates an average background by integrating areas indicated by the analysts' on each side of the desired peak. This was then subtracted from the peak. Where peaks overlapped, Gaussian fitting routine were employed. These were capable of resolving up to 5 overlapping peaks by varying the height, full width at half-maximum and the centered of each peak until the best fit to the data was obtained. The result from the above were corrected for dead time, tobacco weights and half-life and then compared to the mean value of all the standards for the same peak. The computer then processed this information by a program called SPAN USERS and calculated the concentration in part per million (ppm) for each sample.

Validation of analytical method

In order to check the reliability of the analytical methods employed for trace metals determination, Lichens coded IAEA-366 and cabbage (IAEA359) were also prepared and then analyzed following the same procedure.

RESULTS AND DISCUSSION

To evaluate the accuracy and precision of our analytical procedure, standard reference materials (lichen IAEA-366 and cabbage IAEA-359) were analyzed in like manner to our samples. The values determined and the certified values of the seven (7) elements determined were very close suggesting the reliability of the method employed.

Table 2 Results of standard reference materials (Lichens and Cabbage) and their certified values

	Cabbage		Lichens	
Elements	CV	AV	CV	AV
Na(%)	580	571	320	311
K(%)	32500	33040	1840	1798
Ca(%)	18500	19050	-	-
Mg(%)	2160	2158	-	-
Sc(ppm)	-	-	0.17	0.12
Sb(ppm)	-	-	-	-
Sm(ppm)	-	-	0.11	0.1

CV = Certified value. AV = Analyzed value

Table 3 shows radioisotopes produce, half-lives of radioisotopes, energies of radioisotopes and absolute disintegration rate in percent. The knowledge of the above mentioned parameters under satisfied experimental condition, determine the sensitivity of the method.

Table 3. Results of half-lives and energies of some radio-nuclides produced

Element	Radioisotopes produce	Half-life	Energy (kev)	Rate (%)
Na	$^{24}N_a$	15hours	2754.0	2.22
K	^{42}K	12.4hours	1524.6	97.32
C_a	^{49}Ca	8.72minutes	3084.5	80.79
Rb	^{86}Rb	18.7days	1076.6	
Mg	^{27}Mg	9.46minutes	1014.4	17.96
AI	^{28}AI	2.24minutes	1779.0	1.26
Mn	^{56}Mn	2.58hoursr	2113.1	0.46
La	^{140}La	40hours	1596.2	0.28
Sm	^{153}Sm	46.3hours	103.2	0.00
Br	^{82}Br	35.3hours	776.5	0.00
Sb	^{122}Sb	64.8hours	564.2	0.00
Sc	^{46}Sc	83.8days	889.3	0.00
Fe	^{59}Fe	44.5days	1099.3	0.00
Ba	^{131}Ba	11.8days	496.3	0.301
Zn	^{65}Zn	344days	1115.6	1.10
Co	^{60}Co	5327years	1332.5	0.009
Hf	^{181}Hf	42.4days	4808.0	
Cr	^{51}Cr	27.7days	320.1	0.36
Eu	^{152}Eu	13.3years	1408.0	0.00
Yb	^{175}Yb	4.19days	396.3	0.003
Th	Th^{233}	27days	312.0	0.05

Concentration of elements detected in the selected brands of cigarettes analyzed

The average levels of essentials and non-essential elements analyzed in each brand of cigarette in this study was presented in Table 4.

The nutritionally essential elements were detected in all brands of cigarette investigated under this study at a range of 115.57-872.05ppm Na; 2.39-4.68% K; 2.10-17.41% Ca; 118.50-267.10ppm Mn; 0.42-2.55% Mg. Mg was not detected in the brand CEK3. Ca, Na, K and Mg are low molecular weight cations that do not have the physical properties of metals. Notwithstanding, these cations are essential in terms of human health because of their important role in mammalian metabolism. In terms of risk assessment they are important because of potential interactions with principal metals e.g. association between cadmium (Cd) and other bivalent metals such as Mn, Cu, Zn, Se and Ni. Barium (Ba) in chemical respect is similar to calcium and got deposited in delicate organs such as spleen, heart, liver, brain, even on hair and bones in the same manner to calcium. The displacement of calcium from the cell membrane cause increase permeability and stimulation of the muscle, a possible cause of central nervous system paralysis.

Metals with no known beneficial effect such as Al and La were detected in all the brands at a range of 295.30-8067ppm and 0.72-31.09ppm respectively while others were not found in all the brands of cigarettes analyzed. Antimony at concentration of $0.01\mu gm^{-3}$ is recognized as urban air pollutant [21] and its biological effect is similar to arsenic [22]. The similarity of antimony to arsenic chemically and in some biological effect leads to the conclusion that tobacco smoke and antimony could interact in similar way to arsenic in producing toxicity. The level of Sb detected in cigarette brands analyzed in the present work in conjunction with arsenic could contribute to environmental toxicity and health effect of both active and passive smoker. Barium is known to activate the secretion of catecholamine from the adrenal medulla without prior calcium deprivation and it was found to be present in the following brands CSM7, CCT8, CPM12 and CBK14 at the level of 13.78ppm, 5.05ppm, 5.77ppm and 18.14ppm respectively. When one is exposed to Ba through inhalation as in cigarette smoke, the primary targets include cardiovascular system, reproduction and developmental system. Samarium (Sm) was detected in the brands CLF4 (0.03ppm), CSM7 (0.15ppm), CCT8 (0.10ppm), CPM12 (0.07ppm) and CBK14 (0.20ppm).

The result of this work was compared with other reports. The averaged levels obtained for K and Ca in this work does not agree with the reported value in the literature [26]. Ca is found to be present in a level higher than K level, contrary to the previously reported value in the literature [26] The range obtained for Mn (118.50-267.10ppm) and La (0.72-31.09ppm) in this work bracket the level reported in a previous work [27] for Mn: 113-144ppm and La: 1.69-28.3ppm.

Another important element of interest in this work because of its high toxicity even at a very low concentration is arsenic (As). Tobacco smoke has been reported to contain arsenic, especially when the tobacco has been treated with lead arsenate insecticide [7]. Although the use of arsenic pesticides is now prohibited in most countries, the natural content of arsenic in tobacco may still result in some exposure. Arsenic was found to be present in the brands CEX3, CLF4 and CDC5 at 5.55ppm, 1.9ppm and 13ppm respectively. The highest concentration of this toxic element was observed in the brand CDC5 while in other brands were found to be below the detection limit of instrumental neutron activation analysis technique. Interestingly these brands were produced in Nigeria suggesting that the manufacturing companies might still be using chemical containing arsenic compound either to boost yield or as insecticide. The value obtained for arsenic in this work was observed to be ten times higher than arsenic level in cigarette reported in the literature for countries like Brazil [28], United Kingdom and Korea [29], China [30] and Serbia [31]. The California Proposition 65 has listed arsenic as a carcinogen and has been assigned No – Significant – Risk – Levels of 0.06µg/day for inhalation exposure [32]. This value is far lower than the value obtained in this work.

The elements Thorium (Th), Europium (Eu), Hafnium (Hf), Yttabium (Yb) and Uranium (U) which were known to exhibit high thermal neutron reaction cross section were also detected in some brands of cigarettes analyzed. Thorium was found in the brand CLD9 at 0.01ppm and not detected in other brands. Europium was detected in three brands coded CLF4, CAS6 and CLK10 at 0.01ppm, 0.01ppm and 0.02ppm respectively. Europium level obtained in this work is lower compare to the previously reported value for Egyptian and Nigerian cigarette [29]. Hafnium was detected at 0.47ppm and 1.10ppm in the brands coded CEX3 and CLF4 respectively. Yb, was found only in the brand of cigarette coded CLK10 at 0.16ppm. The presence of these elements in cigarettes available in Nigerian

market is a thing to look into due to the short-time and long-time devastating effects of these elements in the vital organs of the body.

Alongside these elements are those whose concentrations were observed at background levels. They include: Lu, Cs, Ce, Ti, Ta, V, Cr and Dy. The information about their presence is significant because some of these metals are toxic at appreciable concentration.

Table 4a Concentration of elements determined in some selected brands of cigarettes in Nigeria

Sample Code	ELEMENTS								
	Na(ppm)	K(%)	Ca(%)	Rb(ppm)	Mg(%)	Al(ppm)	Mn(ppm)	La(ppm)	Sm(ppm)
CRM1	872.1±19.2	3.60±0.12	2.5±0.12	BDL	0.56±0.05	391.6±23.1	173.0±3.11	1.39±0.34	BDL
CBH2	328.2±19.2	3.16±012	2.23±0.12	2.29±1.25	0.42±0.06	295.3±12.4	198.8±3.38	16.93±2.74	BDL
CEX3	254.5±8.40	4.33±0.13	2.10±0.12	3.34±0.88	BDL	457.6±25.6	227.1±1.82	1.30±0.17	BDL
CLF4	775.0±19.4	3.81±0.15	2.28±0.11	BDL	0.53±0.08	413.8±12.4	198.6±2.48	1.25±0.29	0.03±0.02
CDC5	788.4±17.4	3.75±0.14	2.65±0.13	BDL	0.53±0.06	467.9±33.7	214.1±1.50	1.37±0.31	BDL
CAS6	559.9±10.6	4.68±0.16	12.8±0.33	3.50±1.16	2.38±0.13	2453±39.3	168.6±4.38	12.81±2.31	BDL
CSM7	115.8±2.78	3.94±0.14	10.96±2.77	2.07±082	2.06±0.11	1526±27.5	150.7±1.06	11.12±2.45	0.15±0.03
CCT8	638.6±13.4	2.87±0.13	17.4±0.40	BDL	1.80±0.12	2216±37.7	123.7±0.87	0.72±0.20	0.10±0.02
CLD9	828.5±28.2	3.36±0.22	12.45±0.31	BDL	2.53±0.14	2455±36.8	267.10±1.87	1.02±0.27	BDL
CLK10	503.8±30.2	4.06±0.12	BDL	1.61±0.08	8067±2.1	123.60±0.9	31..09±4.48	BDL	2929±196.2
CLM11	545.5±19.1	3.65±020	8.65±0.24	BDL	2.15±0.11	1493±31.4	183.10±1.10	1.98±0.29	BDL
CPM12	815.7±18.8	4.06±0.18	9.14±0.25	2.51±0.98	1.66±0.10	1381±29.0	167.35±1.00	1.01±0.16	0.07±0.02
CFR13	672.2±1.16	2.39±0.17	15.6±0.36	3.42±1.02	2.44±0.12	1969±35.4	118.5±0.95	0.86±0.28	BDL
CBK14	464.4±15	3.52±0.19	12.9±0.30	BDL	2.55±0.12	2302±29.9	160.2±0.96	3.23±0.44	0.20±0.07

Table 4b Concentration of elements determined in some selected brands of cigarettes in Nigeria

Sample Code	Br(ppm)	Sb(ppm)	Sc(ppm)	Ba(ppm)	Hf(ppm)	Eu(ppm)	Yb(pmm	Th(ppm)	As(ppm)
CRM1	104.20±1.98	1.02±0.38	BDL	BDL	BDL	BDL	BDL	BDL	BDL
CBH2	126.7±1.90	BDL	0.10±0.05	BDL	BDL	BDL	BDL	BDL	BDL
CEX3	33.3±2.33	0.86±0.00	0.14±0.07	BDL	0.47±0.4	BDL	BDL	BDL	5.55±1.00
CLF4	58.5±2.46	0.03±0.00	BDL	BDL	1.10±0.7	0.01±0.00	BDL	BDL	1.9±0.01
CDC5	98.4±1.77	BDL	0.13±0.00	BDL	BDL	BDL	BDL	DBDL	13.1±4.07
CAS6	170.9±2.22	BDL	0.15±0.08	BDL	BDL	0.01±0.0	BDL	BDL	BDL
CSM7	91.7±18.3	BDL	BDL	143.8±5.32	BDL	BDL	BDL	BDL	BDL
CCT8	17.2±1.15	BDL	0.01±0.00	5.05±3.99	BDL	BDL	BDL	BDL	BDL
CLD9	333.00±4.00	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
CLK10	BDL	0.39±0.07	BDL	BDL	0.02±0.0	0.16±0.0	BDL	0.16±0.0	BDL
CLM11	5998±1.44	BDL	0.11±0.07	BDL	BDL	BDL	BDL	BDL	BDL
CPM12	61.73±1.67	0.42±0.31	0.12±0.06	5.77±3.24	BDL	BDL	BDL	BDL	BDL
CFR13	6265±28.2	0.79±0.59	0.16±0.05	BDL	BDL	BDL	BDL	BDL	BDL
CBK14	810.6±6.49	BDL	0.14±0.10	18.1±7.76	BDL	BDL	BDL	BDL	BDL

BDL= Below Detection Limit

CONCLUSION

In this study the concentration of constituents element present in 14 brands of cigarette in Nigerian market have been determined. The levels of these elements, particularly those perceived to be toxic such as arsenic are high. This pose a great health hazards to persons exposed to cigarette in Nigeria. It has been observed that the application of chemical fertilizers, herbicides, etc to boost yield and preserve cured leaves from destruction contribute to elemental content of tobacco leaves. So therefore farmers should use organic fertilizers in preference to inorganic fertilizers. Cigarette manufacturers should conduct a research on filter construction in attempt to come up with filters capable of trapping metals in cigarette smoke. The increase use of cigarette in Nigeria is essentially fuelled by advertisement and campaign lunched frequently by manufacturers. Government should therefore, through adequate legislation outlaw advertisement and public use of cigarette in Nigeria.

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