**Supplementary Table 1**: Heavy metals contamination in the cigarettes brands

| **Country** | **Year** | **Experiment type/analytical method** | **Heavy metals analyzed** | **Finding** | **Reference** |
| --- | --- | --- | --- | --- | --- |
| Bangladesh | 2023 | Atomic absorption spectrophotometry (AAS) | Pb, Cd, Co, Cu ,Ni, Fe, Cr, Mn, As and Zn | The carcinogenic risk posed by heavy metal follow the order of Cr Co Cd As Ni Pb. | (Hasan et al., 2023) |
| Benin and France | 2013 | AAS | Pb, Cd Ni and As | The results show that all the cigarette samples are contaminated with lead (Pb), Cadmium (Cd), Nickel (Ni) and Arsenic (As). | (Agbandji et al., 2013) |
| Brazil | 2011 | Graphite furnace atomic absorption spectrometry (GFAAS) | Pb, Cd, As, Ni and Cr | large variability in the levels of carcinogenic heavy metals in cigarettes, reaching up to 44.1% in the level in Cd. | (Viana et al., 2011) |
| Brazil | 2007 | Inductively coupled plasma optical emission spectrometry (ICP-OES) | Al, Ba, Ca, Cu, Fe, K, Mg, Mn, Na, P and Sr | Ca, K, Mg, and P are the major elements in all samples. Al, Fe, and Na are elements with an intermediate content. | (CRISPINO et al., 2007) |
| Brazil | 2021 | Square wave Anodic stripping Voltammetry | Cd, Pb and Cu | The detection limit where in order of Cd Pb Cu. | (Lisboa et al., 2021) |
| Brazil | 2020 | Electrothermal vaporization–atomic absorption spectrometry (EV-AAS) | Cr | The average Cr values found for the analyzed samples were in the range of 0.96 to 3.85 and from 0.32 to 0.80 μg/cigarette for tobacco and ashes, respectively. | (Lisboa et al., 2020) |
| Bulgaria | 2023 | AAS | Mn, Zn, Cu, Cd, Pb, and Ni | The average concentration of HMs in the RYO/MYO tobaccos blends was in the order Mn > Zn > Cu > Pb > Ni > Cd; respectively. | (Peeva et al., 2023) |
| China | 2014 | X-ray Fluorescence (XRF) | As, Cd, Cr and Pb | On average, from 2009 to 2012, As, Cd, Cr and Pb concentrations have decreased in Chinese tobacco. | (O’Connor et al., 2014) |
| China | 2020 | Indusively couple plasma mass atomic spectrometry (ICP-MAS) | Cd and Pb | The range concentration where in order Pb > Cd | (Li et al., 2020) |
| China | 2016 | GFAAS | Cu, Cd, Cr, Ni and Pb | The average concentration were of order Ni >Cr> Cd> Pb >Cu. | (Ren et al., 2016) |
| China | 2012 | GFAAS | Cd, Cu, Co, Ni, Zn and Pb | The average concentrations were of order of Zn> Ni >Cu >Co >Cd> Pb | (Pourkhabbaz and Pourkhabbaz, 2012) |
| Egypt | 2017 | Instrumental neutron activation analysis (INAA) | Ba, Br, Ca, Cd, Eu, K, Hf, Mg, Na Rd, Sb, Sc, Th and Yb. | The highest Element concentration were Na and lowest were Eu | (Abd El-Samad and Hanafi, 2017) |
| Ethiopia | 2017 | AAS | Cd, Pb, Cu and Zn | The results indicate that smoking and exposure to cigarette smoke is a serious problem to be considered when carrying out epidemiological studies on human exposure to trace metals. | (Engida, 2017) |
| Ghana | 2014 | AAS | As, Ld, Cu, Fe, Znc, Mn, Cd, Ni, and Cr | Estimated the mean of Pb, Mn and Cd was slightly higher than the recommended permissible limits of WHO/FAO/JECFA | (Etsey Sebiawu et al., 2014) |
| Hungary | 2002 | nductively coupled plasma atomic emission spectroscopy (ICP-AES) | Fe, Zn,Pb, and Cd | Fe is found in the highest concentration in tobacco followed in decreasing order by Zn, Pb and Cd | (Csalári and Szántai, 2002) |
| Hungary | 2009 | INAA | As, Ba, Br, Ca, Ce, Co, Cr, Cs, Eu, Fe, Hf, K, La, Na, Rb, Sb, Sc, Se, Sm, Sr, Ta, Tb, Th, Zn | The highest concentration element was Ar and lowest was Tb | (Hamidatou et al., 2009) |
| India | 2009 | DPASV for Pb, Cd, and Cu; square wave voltammetry for As; and cold vapor atomic absorption technique for Hg. | Pb,Cd, As, Cu,Hg, and Se | It was observed that almost 30% of gutkha brand samples exceeded the permissible levels of metals Pb and Cu, | (Dhaware et al., 2009) |
| India | 2022 | AAS | Cd, Cu, Fe, Pb,  Sn, Zn, and Hg. | Findings indicate that  cigarette litter is a major source of metal contamination in the aquatic ecosystem and that apparent  leaching may increase the risk of toxicity to aquatic organism | (Michael et al., 2022) |
| India | 2019 | ICP-AES | Cd, Co, Cr, Mo, Cu, Fe,Ni Pb,Ca, K, Mg, P, and S | The highest element concentration range were iron and lowest were Mo. | (Özcan et al., 2019) |
| India | 2010 | ICP-AES | Cd, Ni, Pb, Cr, Cu, Fe and Zn | The highest concentration element were Fe and lowest were Cd | (Verma et al., 2010) |
| Iran | 2016 | FAAS | Cd and Pb | Below the world standards for human consumption by plant. | (Ziarati et al., 2016) |
| Iran | 2015 | SPSS | Cd and Pb | Smoked cigarette filter have more concentration of Cd and Pb than non-smoked cigarette filter | (Pashapour et al., 2015) |
| Iran | 2019 | GFAA | Cd | Mean concentrations of Cd in imported cigarettes brands and cigarettes produced in Iran were 1.89 µg/g and 1.44µg/g respectively | (Ziyae Aldin Samsam Shariat et al., 2019) |
| Iraq | 2015 | FAAS | Pb ,Cd and Cr | The investigation confirmed that most of the Iraqi and imported cigarettes in Iraq are contaminated with Pb, Cd, and Cr and quantitatively their distribution is clearly above the safer limits of WHO | (Karbon et al., 2015) |
| Iraq | 2020 | FAAS | Pb and Cd | Generally, it has been found that the concentration of the studied heavy metals in the tobacco follows the order Pb > Cd | (Khleif et al., 2020) |
| Iraq | 2021 | FAAS | Cd, Cr, Pb and Zn | The total value of these four metals ishigher than the range of cancer risk specified by USEPA. | (M. Haleem and A. Amin, 2021) |
| Iraq | 2022 | ICP-AES | Na, P, K, Fe, Cu, Zn, Sr, Cd, Sn, and Ba | The element were of following order: K> P > Fe > Na > Sr > Sn > Zn > Ba > Cu > Cd | (Joda and Alheloo, 2022) |
| Iraq | 2015 | AAS | Cd, Ni, Cu, Fe, Zn and Pb | It was found that all the elements are found in cigarette tobacco according to the following order Fe>Zn>Cu>Pb>Ni>Cd | (Al-Jeboori et al., 2015) |
| Iraq | 2020 | FAAS | Cd, Pb, Cr and Zn | The average concentration of where in order of Pb > Cr >Zn >Cd | (Haleem et al., 2020) |
| Iraq | 2018 | Energy dispersive X-ray fluorescence (EDXRF) | Sb, Ni, Zn, P, Pb, Cd, Ca, Si, S, Cr, Mg, Na, As, Al, Cl, and Sn. | Results proved the presence of dangerous elements such as Ni, Zn, P, Pb, Cd, Si, S, Cr, As, Al, Sb and Sn | (Al-Dahhan et al., 2018) |
| Ireland | 2015 | ICP-AES | As, Al, Ni and Pb | Mean concentration were in order of Al >Ni> Pb> As. | (Afridi et al., 2015a) |
| Ireland | 2015 | ICP-AES. | As, Cd, Hg, and Pb | The average concentration of were in order of Hg> Cd> Pb> As | (Afridi et al., 2015b) |
| Japan | 2021 | GF-AAS | Pb,Hg and Cd | The average concentration are in order Pb> Cd > Hg | (Dinh et al., 2021) |
| Jordan | 2005 | GF-AAS | Cd and Pb. | The concentration were of order Pb >Cd | (Massadeh et al., 2005) |
| Jordan | 2003 | AAS | Cu and Zn | Concentration were in order Cu >Zn | (Massadeh et al., 2003) |
| Jordan | 2003 | FGFAAS | Cd, Pb, Cu, Zn, and Fe | High concentration were of Pb and Cd | (Jaradat et al., 2003) |
| Kenya | 2015 | AAS | Pb, Cd, Cr, Cu and Zn | The primary heavy metal component in all the cigarette brands investigated was Pb while Cd was detected in low amounts | (Omari MO et al., 2015) |
| Kenya | 2020 | AAS | Cd, Zn and Pb | The concentration were of the order Pb >Zn> Cd | (Peter et al., 2020) |
| Malaysia | 2017 | XRF | As, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, and Zn | The highest element detected was Fe and elements with low concentration were Ni | (Ismail et al., 2017) |
| Malaysia | 2019 | AAS | Pb and Cd | The average concentration were of order Pb> Cd | (Janaydeh et al., 2019) |
| Mexico | 2008 | Total X-ray fluorescence (TXRF) | Cd and As | The average concentration were of order of Cd >As | (Martínez et al., 2008) |
| Nigeria | 2017 | FAAS | Cd, Cu, Fe, Mn, Pb, and Zn | Concentrations of heavy metals in the filler tobacco samples were consistently higher than those obtained for the cigarette filters except for Cd. | (Benson et al., 2017) |
| Nigeria | 2013 | AAS | Cr, Cd and Pb | The level of Cr, Cd and Pb in selected cigarettes and tobacco leaves were found to be below the WALOH standards for human consumption an plant uptake. | (Eneji et al., 2013) |
| Nigeria | 2019 | AAS | Zn, Cd and Pb | Concentration of metals in both cigarette brands group follows almost the same trend: Zn > Cd > Pb. | (Onojah et al., 2019) |
| Nigeria | 2011 | AAS | Cd, Cu,Zn, Cr and Ni | Zn concentration was highest in all the brands compared to the other metals; while Cd concentration was lowest in all the ten brands of cigarette analyzed | (Anhwange and Yiase, 2011) |
| Nigeria | 2019 | AAS | Cr, Cd and Pb | The concentration ranges of Cr and Cd in the samples are 60-100 µg/g and 4-20 µg/g respectively, which was found to be lower than the WHO standard. | (Azeez et al., 2019) |
| Nigeria | 2015 | AAS | Cd, Co, Cu, Pb, Ni, and Zn | The mean concentration were of order Zn> Pb> Cu >Co> Ni >Cd | (Yebpella and Shallangwa, 2015) |
| Nigeria | 2013 | INAA | Br, Sb, Sc, Ba ,Hf, Eu, Yb ,Th, As, Na, K ,Ca, Rb, Mg, Al, Mn, La, Sm, Lu, Cs, Ce, Ti, Ta, V, Cr ,Dy, Mn, Cu, Zn, Se and Ni. | 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 | (Yebpella et al., 2013) |
| Nigeria | 2014 | GFAAS | Cd ,Co, Cu, Cr, Pb, Ni and Zn | The range concentration were of order Cu> Pb> Cd >Ni> >Co >Cr | (Iwegbue, 2014) |
| Nigeria | 2010 | INAA | Mn, La, Th, Eu, and Hf | The mean concentration are order of Mn> La >Hf >Th> Eu | (Yebpella et al., 2010) |
| Nigeria | 2013 | AAS | Cd, Cr, Ni Cu and Zn | Generally the levels of content of the metals in all the brands except Zinc were high compared with the WHO threshold values. | (IWUOHA et al., 2013) |
| Nigeria | 2009 | AAS | Cr, Mn, Ni, Pb, Zn, Cd, Cu, and Co | levels of some toxic heavy metals and pollution index were higher in unashed cigarettes than in ashes | (Asubiojo et al., 2009) |
| Nigeria | 2015 | AAS | Fe,Ca, Zn, Cd, Co and Ni | The average concentration were in order of Fe >Zn > Ca >Co > Ni > Cd | (Abudu et al., 2015) |
| Nigeria, UK, USA and Germany | 2005 | AAS | Cd | Higher Cd concentrations were found in imported brands  compared to the Nigerian brands. | (Nnorom et al., 2005) |
| Pakistan | 2008 | FAAS | Co, Cu, Cd,Mn,Pb and Zn | The highest concentration element were Mn and lowest were Cd | (Ajab et al., 2008) |
| Pakistan | 2011 | AAS | Ni, Mn, Cu, Cr, Fe, Zn, Co and Cd | Average concentrations of Fe and Mn in locally cigarette brands were found having excess values while Co, Zn, Ni, Cu and more toxic Cd have very small values | (Ahmad et al., 2011) |
| Pakistan | 2017 | AAS | Cd and Zn | Quantitatively allocation is above the tolerable limits as depicted by the WHO | (Asim et al., 2017) |
| Pakistan | 2009 | AAS | Cu, Mn, Ni and Zn | The mean range concentration were of order Mn >Zn> Ni >Cu | (Siddiqui et al., 2009) |
| Pakistan | 2020 | Particle-induced X-ray emission (PIXE) | S, Cl, K,Ca, Sr Cr, Sb, Hg, Cd, Pb, Zn, Fe Mn, Ni Cu and Co. | The element arranged in order of dencrease their Mean concentration as follows K, Ca, S, Cl, Fe, Mn, Sr, Zn, Cu, Ni, Pb, Cr, Cd, Sb and Hg. | (Mahmood et al., 2020) |
| Pakistan | 2009 | Electrothermal Atomic Absorption Spectrometry (ETAAS) | Al, Cd, Ni and Pb | The highest concentration element were Al and lowest was Cd. | (Kazi et al., 2009) |
| Pakistan | 2024 | AAS | Cd, Pb, Cr, Mn, Fe, Co, Ni, Cu and Zn | The highest concentration element was Zn and lowest was Cd | (Hussain et al., 2024) |
| Palestine | 2015 | FAAS | Cd, Pb, Co, Ni, Cu and Zn | The average concentration where in order of Cd Pb Co Ni Cu Zn | (Abu-Obaid et al., 2015) |
| Philippines | 2013 | FAAS | Pb, Cr and Cd | Cd in the cigarettes tested when ingested did not exceed the safety limit in blood | (Solidum, 2013) |
| Poland | 2021 | N.A | Cd, Hg | The average concentration were of order Cd> Hg | (Tyka and Rusin, 2021) |
| Poland | 2008 | AAS | Pb,Cd | The average concentration were of order Pb Cd | (Galażyn-Sidorczuk et al., 2008) |
| Portugal | 2017 | ICP-MS | Co, Cd, Pb, As and Ti | The highest transfer rate from tobacco to cigarette smoke was found for Ti and lowest were As. | (Pinto et al., 2017) |
| Romania | 2014 | AAS | Cd, Pb, Cr, Ni, Cu and Zn, | Highest Concentration level was recorded in Cu, followed in descending order by Cr, Pb, Zn, Cd and Ni. | (AGOROAEI et al., 2014) |
| Romania | 2018 | GF-AAS | Cd, Ni, Cu, Cr and Pb | They concluded that the metal content in tobacco depends on factors such as land where the plant was cultivated and manufacturing process used, which requires a series of harmful chemicals. | (Strungaru et al., 2018) |
| Saudi Arabia | 2021 | ICP-OES | Cr, Cd,Cu, Fe, Pb,Mn and Zn | The concentration for both Pb and Cd, the potent human carcigones were greater than the recommended threshold set forth by WHO and FAO. | (Dahlawi et al., 2021) |
| Saudi Arabia | 2012 | GFAAS | Cd and Pb | The concentration were of order Pb> Cd | (Ashraf, 2012) |
| Serbia | 2012 | ETAAS | Pb and As | Positive correlation between lead and arsenic contents in tobacco was found (r=0.22; p<0.0001). | (Lazarević et al., 2012) |
| Spain | 2015 | ICP-OES | Al, Cd ,Co,Cr, Mn ,Ni, Pb and Sr | The means concentration are of order Al >Mn> Sr> Pb> Cr> Cd >Ni> Co | (Armendáriz et al., 2015) |
| Tanzania | 2024 | AAS | Cu, Cd, Cr, Zn and Ni | The means concentration are of order Cu> Cr> Ni> Zn> Cd. | (Ntarisa, 2024) |
| Turkey | 2012 | GFAAS | Cd | Cd levels in tobacco were found between 503-2742 ng/cigarette | (KADIOĞLU et al., 2012) |
| Turkey | 2012 | FAAS | Co ,Ni, Fe, Cu, Mn, Pb, Cr and Cd | The mean value concentration where in order of Fe> Mn> Cu >Cr> Ni >Pb> Co> Cd. | (Duran et al., 2012) |
| Turkey | 2017 | ICP-OES | Sn, Cd, Pb, Al, Fe, Zn, Cr, Ni, Cu, Mn, As and Hg | It has been reported that one cigarette contains about 0.5- 2 μg of Cd and that about 10% of the Cd content is inhaled when the cigarette is smoked. | (Söğüt and Uruş, 2017) |
| Turkey | 2013 | Flame atomic absorption spectrometry | Cd, Zn, Cu and Mn | The determined values agreed with the standard values for the heavy metals analyzed | (Pelit et al., 2013) |
| Turkey | 2001 | ICP-MS | Cd,Cr, Co,Ni,Cu,As,Hg  And Pb | The highest concentration element were Cu and lowest were Ni | (Barlas et al., 2001) |
| USA | 2013 | XRF | As, Cd, Cr, Ni, and Pb | Overall, metal concentrations were only weakly intercorrelated. Nickel and chromium concentrations were highly related | (Caruso et al., 2013) |
| USA | 2006 | Gas chromatograph equipped with a flame ionization detector. | Cd, Pb and Th | Mainstream smoke levels of all three metals were far greater for counterfeit than the authentic brands | (Pappas, 2011) |

**Supplementary Table 2** : Heavy metals concentrations of Cd in the cigarettes brands

| **Manufactures country** | **Year** | **N** | **Heavy metal concentrations range ()** | **Mean Heavy metal concentrations ()** | **Reference** |
| --- | --- | --- | --- | --- | --- |
| Bangladesh | 2023 | 10 | 0.6-3.0 | N.A | (Hasan et al., 2023) |
| Benin | 2012 | 5 | 26.0- 84.8 | 47.2 | (Agbandji et al., 2013) |
| Brazil | 2011 | 20 | 0.5-0.9 | 0.7 | (Viana et al., 2011) |
| Bulgaria | 2023 | 5 | 0.4-1.8 | 0.8 | (Peeva et al., 2023) |
| China | 2017 | 11 | N.A | 0.1 | (Ren et al., 2016) |
| China | 2016 | 20 | 2.9-5.5 | N.A | (Li et al., 2020) |
| China | 2014 | Several | 2.0–5.4 | 3.2 | (O’Connor et al., 2014) |
| Egypt | 2017 | 10 | 2.8-6.4 | 4.4 | (Abd El-Samad and Hanafi, 2017) |
| Ethiopia | 2016 | 11 | 1.3−7.6 | 2.5 | (Engida, 2017) |
| France | 2012 | 3 | 13.3-63.5 | 41 | (Agbandji et al., 2013) |
| Germany | 2005 | 4 | 1.2-2.2 | 1.8 | (Nnorom et al., 2005) |
| Hungary | 2002 | 30 | 0.2-0.3 | 0.3 | (Csalári and Szántai, 2002) |
| India | 2009 | 25 | 0.01-3 | 0.4 | (Dhaware et al., 2009) |
| India | 2022 | 3 | N.A | N.A | (Michael et al., 2022) |
| India | 2019 | 5 | 0.5-0.7 | 0.6 | (Özcan et al., 2019) |
| India | 2010 | 10 | 0.3-0.9 | 0.5 | (Verma et al., 2010) |
| Iran | 2016 | 10 | 1.8-5.4 | 0.6 | (Ziarati et al., 2016) |
| Iran | 2012 | 19 | 1.8-3.2 | 2.7 | (Pourkhabbaz and Pourkhabbaz, 2012) |
| Iran | 2019 | 8 | 1.4-1.6 | 1.6 | (Ziyae Aldin Samsam Shariat et al., 2019) |
| Iran | 2015 | 10 | 0.2-0.5 | 0.4 | (Pashapour et al., 2015) |
| Iraq | 2021 | 25 | N.A | 0.4 | (M. Haleem and A. Amin, 2021) |
| Iraq | 2019 | 25 | 0.0-1.6 | 0.4 | (Haleem et al., 2020) |
| Iraq | 2015 | 20 | 0.1-1.6 | 0.57 | (Karbon et al., 2015) |
| Iraq | 2020 | 9 | 0.02 -0.06 | N.A | (Khleif et al., 2020) |
| Iraq | 2022 | 16 | 0.2-2.0 | 1.6 | (Joda and Alheloo, 2022) |
| Iraq | 2015 | 17 | 0.03-0.5 | 0.1 | (Al-Jeboori et al., 2015) |
| Iraq | 2018 | 3 | <1 | <1 | (Al-Dahhan et al., 2018) |
| Ireland | 2015 | 7 | 0.3-0.6 | 0.4 | (Afridi et al., 2015b) |
| Japan | 2021 | 10 | N.A | 0.9 | (Dinh et al., 2021) |
| Jordan | 2005 | 19 | 2.2 - 3.1 | 2.6 | (Massadeh et al., 2005) |
| Jordan | 2003 | 4 | 0.1-0.4 | 0.3 | (Jaradat et al., 2003) |
| Jordan | 2004 | 19 | 2.2-3.1 | 2.6 | (Massadeh et al., 2003) |
| Kenya | 2015 | 3 | 0.06-0.09 | 0.08 | (Omari MO et al., 2015) |
| Kenya | 2020 | 5 | 0.09-0.2 | 0.1 | (Peter et al., 2020) |
| Malaysia | 2017 | 16 | 0-5.0 | 0.9 | (Ismail et al., 2017) |
| Malaysia | 2019 | 15 | N.A | 0.8 | (Janaydeh et al., 2019) |
| Mexico | 2008 | 9 | N.A | 1.2 | (Martínez et al., 2008) |
| Nigeria | 2017 | 10 | 5.9–7.9 | N.A | (Benson et al., 2017) |
| Nigeria | 2013 | 10 | 0.01-0.014 | 0.01 | (Eneji et al., 2013) |
| Nigeria | 2019 | 5 | 1.0-2.1 | 1.4 | (Onojah et al., 2019) |
| Nigeria | 2013 | 4 | 0.5-0.6 | 0.6 | (IWUOHA et al., 2013) |
| Nigeria | 2011 | 10 | 0.2-2.1 | 1.4 | (Anhwange and Yiase, 2011) |
| Nigeria | 2015 | 7 | 0.12-0.15 | 0.13 | (Abudu et al., 2015) |
| Nigeria | 2019 | 7 | 0.6-4.5 | 1.4 | (Azeez et al., 2019) |
| Nigeria | 2005 | 7 | 0.9-1.9 | 1.3 | (Nnorom et al., 2005) |
| Nigeria | 2011 | 14 | 0.3-0.7 | 0.7 | (Yebpella et al., 2010) |
| Nigeria | 2018 | 5 | 1.0 – 2.1 | 1.4 | (Onojah et al., 2019) |
| Nigeria | 2009 | N.A | 0.01-2.64 | N.A | (Iwegbue, 2014) |
| Pakistan | 2008 | 10 | 0.3-0.6 | 0.5 | (Ajab et al., 2008) |
| Pakistan | 2011 | 10 | 0.1-0.3 | 0.2 | (Ahmad et al., 2011) |
| Pakistan | 2019 | 19 | 1.9-9.5 | 0.5 | (Mahmood et al., 2020) |
| Pakistan. | 2017 | 9 | 0.04-0.17 | 0.10 | (Asim et al., 2017) |
| Pakistani | 2008 | 12 | 0.3-0.9 | 0.6 | (Kazi et al., 2009) |
| Pakistan | 2024 | 5 | 0.35-0.43 | 0.40 | (Hussain et al., 2024) |
| Palestina | 2015 | 25 | 0.8 - 2.1 | 1.2 | (Abu-Obaid et al., 2015) |
| Philippines | 2013 | 10 | 0.001-0.01 | 0.01 | (Solidum, 2013) |
| Poland | 2019 | 8 | 1.1-1.6 | N.A | (Tyka and Rusin, 2021) |
| Poland | 2008 | 10 | 0.6–1.4 | 0.8 | (Galażyn-Sidorczuk et al., 2008) |
| Portugal | 2014 | 20 | N.A | 0.8 | (Pinto et al., 2017) |
| Romanian | 2014 | 15 | 0.7-1.6 | 1.1 | (AGOROAEI et al., 2014) |
| Romania | 2018 | 8 | 0.4-1.4 | 0.7 | (Strungaru et al., 2018) |
| Saudi Arabia | 2021 | 20 | 0.2-306.1 | 37.4 | (Dahlawi et al., 2021) |
| Saudi Arabia | 2012 | 20 | 0.8-2.8 | 1.8 | (Ashraf, 2012) |
| Spain | 2015 | 33 | N.A | 0.8 | (Armendáriz et al., 2015) |
| Tanzania | 2024 | 8 | 0.4–0.66, | 0.53 | (Ntarisa, 2024) |
| Turkey | 2013 | 9 | 0.1-0.8 | 0.3 | (Pelit et al., 2013) |
| Turkey | 2012 | 15 | N.A | 1.1 | (Duran et al., 2012) |
| Turkey | 2012 | 20 | 1.0-5.5 | 2.0 | (KADIOĞLU et al., 2012) |
| Turkey | 2017 | 12 | N.A | N.A | (Söğüt and Uruş, 2017) |
| Turkey | 2001 | 9 | 0.5 - 2.6 | 1.7 | (Barlas et al., 2001) |
| U.S | 2013 | Several | N.A | 0.9 | (Caruso et al., 2013) |
| UK | 2005 | 11 | 0.7-2.3 | 1.3 | (Nnorom et al., 2005) |
| U.S | 2005 | 5 | 1.2-1.9 | 1.6 | (Nnorom et al., 2005) |
| U.S | 2007 | 21 | N.A | N.A | (Pappas, 2011) |

**Supplementary Table 3**: Heavy metals concentrations of Pb in the cigarettes brands

|  | Manufactures country | Year | N | Heavy metal concentration range () | Mean Heavy metal concentration () | Reference |
| --- | --- | --- | --- | --- | --- | --- |
|  | Bangladesh | 2023 | 10 | 0.5-1.1 | N.A | (Hasan et al., 2023) |
|  | Benin | 2012 | 5 | 1.2-3.9 | 2.0 | (Agbandji et al., 2013) |
|  | Brazil | 2011 | 20 | 0.2-0.4 | 0.3 | (Viana et al., 2011) |
|  | Bulgaria | 2023 | 5 | 0-3.0 | 1.6 | (Peeva et al., 2023) |
|  | China | 2017 | 11 | N.A | 0.2 | (Ren et al., 2016) |
|  | China | 2016 | 20 | 1.3-7.7 | N.A | (Li et al., 2020) |
|  | China | 2014 | Several | 1.2–6.5 | 2.5 | (O’Connor et al., 2014) |
|  | Ethiopia | 2016 | 11 | 0.5−12.5 | 6.2 | (Engida, 2017) |
|  | France | 2012 | 3 | 4.3-4.5 | 4.4 | (Agbandji et al., 2013) |
|  | Ghana | 2014 | 10 | 1.5-8.3 | 5.8 | (Etsey Sebiawu et al., 2014) |
|  | Hungary | 2002 | 30 | 0.3-0.8 | 0.5 | (Csalári and Szántai, 2002) |
|  | India | 2009 | 25 | 0.03-68 | 7.4 | (Dhaware et al., 2009) |
|  | India | 2022 | 3 | N.A | N.A | (Michael et al., 2022) |
|  | India | 2019 | 5 | 0.2-7.4 | 3.5 | (Özcan et al., 2019) |
|  | India | 2010 | 10 | 0.8-5.8 | 1.9 | (Verma et al., 2010) |
|  | Iran | 2016 | 10 | N.A | 34.4 | (Ziarati et al., 2016) |
|  | Iran | 2012 | 19 | 1.1-3.1 | 2.1 | (Pourkhabbaz and Pourkhabbaz, 2012) |
|  | Iran | 2015 | 10 | 16.6-33.5 | 22.3 | (Pashapour et al., 2015) |
|  | Iraq | 2021 | 25 | 1.2-9.3 | 4.6 | (M. Haleem and A. Amin, 2021) |
|  | Iraq | 2019 | 25 | 1.2-9.3 | 4.6 | (Haleem et al., 2020) |
|  | Iraq | 2014 | 20 | 2.3-11.7 | 5.9 | (Karbon et al., 2015) |
|  | Iraq | 2020 | 9 | 0.1-0.2 | N.A | (Khleif et al., 2020) |
|  | Iraq | 2015 | 17 | 0.1-0.4 | 0.2 | (Al-Jeboori et al., 2015) |
|  | Iraq | 2018 | 3 | <1 | <1 | (Al-Dahhan et al., 2018) |
|  | Ireland | 2015 | N.A | 0.378 - 1.16 | N.A | (Afridi et al., 2015a) |
|  | Ireland | 2015 | 7 | 0.2-0.5 | 0.4 | (Afridi et al., 2015b) |
|  | Japan | 2021 | 10 | N.A | 1.6 | (Dinh et al., 2021) |
|  | Jordan | 2005 | 19 | 2.1 - 3.2 | 2.7 | (Massadeh et al., 2005) |
|  | Jordan | 2003 | 4 | 0.2-0.3 | 0.3 | (Jaradat et al., 2003) |
|  | Jordan | 2004 | 19 | 2.1- 3.2 | 2.7 | (Massadeh et al., 2003) |
|  | kenya | 2015 | 3 | 6.6-7.1 | 6.8 | (Omari MO et al., 2015) |
|  | Kenya | 2020 | 5 | 0.1-0.3 | 0.2 | (Peter et al., 2020) |
|  | Malaysia | 2017 | 16 | 0-2.7 | 0.6 | (Ismail et al., 2017) |
|  | Malyasia | 2019 | 15 | N.A | 3.1 | (Janaydeh et al., 2019) |
|  | Nigeria | 2017 | 10 | 17.2– 74.7 | N.A | (Benson et al., 2017) |
|  | Nigeria | 2013 | 10 | 0.001-0.09 | 0.04 | (Eneji et al., 2013) |
|  | Nigeria | 2013 | 4 | 5.2-8.0 | 22.8 | (IWUOHA et al., 2013) |
|  | Nigeria | 2011 | 10 | 0.2-3.9 | 2.0 | (Anhwange and Yiase, 2011) |
|  | Nigeria | 2011 | 14 | 0.1-2.0 | 10.1 | (Yebpella et al., 2010) |
|  | Nigeria | 2009 | N.A | 0.013-0.63 | N.A | (Iwegbue, 2014) |
|  | Pakistan | 2008 | 10 | 10.2-27.3 | 14.4 | (Ajab et al., 2008) |
|  | Pakistan | 2019 | 19 | 0.6-1.4 | 1.0 | (Haleem et al., 2020) |
|  | Pakistani | 2008 | 12 | 0.1-0.6 | 0.3 | (Ren et al., 2016) |
| p | Pakistan | 2024 | 5 | 1.8-2.3 | 2.08 | (Hussain et al., 2024) |
|  | Palestina | 2015 | 25 | 2.2 - 5.1 | 3.1 | (Abu-Obaid et al., 2015) |
|  | Philippines | 2013 | 10 | 0.9-1.2 | 1.0 | (Solidum, 2013) |
|  | Portugal | 2014 | 20 | N.A | 0.5 | (Pinto et al., 2017) |
| Poland | 2008 | 10 | 0.7–0.9 | 0.8 | (Galażyn-Sidorczuk et al., 2008) |
|  | Romanian | 2014 | 15 | 2.3-5.2 | 4.2 | (AGOROAEI et al., 2014) |
|  | Roumania | 2018 | 8 | 0.2-0.7 | 0.4 | (Strungaru et al., 2018) |
|  | Saudi Arabia | 2021 | 20 | 0.2-4725.0 | 312.8 | (Dahlawi et al., 2021) |
|  | Saudi Arabia | 2011 | 20 | 1.3-3.6 | 2.5 | (Ashraf, 2012) |
|  | Serbia | 2012 | 20 | 0.02–8.56 | 0.9 | (Lazarević et al., 2012) |
|  | Spain | 2015 | 33 | N.A | 0.6 | (Armendáriz et al., 2015) |
|  | Turkey | 2012 | 15 | N.A | 3.7 | (Duran et al., 2012) |
|  | Turkey | 2017 | 12 | N.A | N.A | (Söğüt and Uruş, 2017) |
|  | Turkey | 2001 | 9 | 0.3- 2.3 | 1.0 | (Barlas et al., 2001) |
|  | U.S | 2013 | Several | N.A | 0.4 | (Caruso et al., 2013) |
|  | U.S | 2007 | 21 | N.A | N.A | (Pappas, 2011) |

**Supplementary Table 4**: Heavy metals concentrations of Cr in the cigarettes brands

|  | Manufactures country | Year | N | Heavy metal concentrations range () | Mean Heavy metal concentration () | Reference |
| --- | --- | --- | --- | --- | --- | --- |
|  | Bangladesh | 2023 | 10 | 0.8-1.2 | N.A | (Hasan et al., 2023) |
|  | Brazil | 2011 | 20 | 0.5-3.1 | 1.4 | (Viana et al., 2011) |
|  | Brazil | 2020 | 12 | 0.3-0.8 | 0.6 | (Lisboa et al., 2020) |
|  | China | 2017 | 11 | N.A | 0.1 | (Ren et al., 2016) |
|  | China | 2014 | Several | 0.0–1.0 | 0.6 | (O’Connor et al., 2014) |
|  | Ghana | 2014 | 10 | N.A | 4.3 | (Etsey Sebiawu et al., 2014) |
| Hungary | 2009 | 5 | 2.4-29.3 | 8.4 | (Hamidatou et al., 2009) |
|  | India | 2019 | 5 | 1.1-1.7 | 1.4 | (Özcan et al., 2019) |
|  | India | 2010 | 10 | 2.8-5.0 | 4.1 | (Verma et al., 2010) |
|  | Iraq | 2021 | 25 | N.A | 3.3 | (M. Haleem and A. Amin, 2021) |
|  | Iraq | 2020 | 25 | 0.0-6.7 | 3.3 | (Haleem et al., 2020) |
|  | Iraq | 2014 | 20 | 0.0-11.2 | 3.8 | (Karbon et al., 2015) |
|  | Iraq | 2018 | 3 | <1 | <1 | (Al-Dahhan et al., 2018) |
|  | Kenya | 2015 | 3 | 1.6-3.6 | 2.8 | (Peter et al., 2020) |
|  | Malaysia | 2017 | 16 | 12.1-50.9 | 22.1 | (Ismail et al., 2017) |
|  | Nigeria | 2013 | 10 | 0.02-0.3 | 0.12 | (Eneji et al., 2013) |
|  | Nigeria | 2013 | 4 | 16.9- 26.0 | 21.6 | (IWUOHA et al., 2013) |
|  | Nigeria | 2011 | 10 | 0.9-3-8 | 2.2 | (Anhwange and Yiase, 2011) |
|  | Nigeria | 2018 | 7 | 4.4-7.9 | 6.4 | (Azeez et al., 2019) |
|  | Nigeria | 2009 | N.A | 0.013-0.013 | N.A | (Iwegbue, 2014) |
|  | Pakistan | 2024 | 5 | 10-14 | 11.2 | (Hussain et al., 2024) |
|  | Romanian | 2014 | 15 | 1.9-7.0 | 3.8 | (AGOROAEI et al., 2014) |
|  | Romania | 2018 | 8 | 0.7-2.1 | 1.2 | (Strungaru et al., 2018) |
|  | Saudi Arabia | 2021 | 20 | 1.2-4.3 | 1.8 | (Dahlawi et al., 2021) |
|  | Spain | 2015 | 33 | N.A | 1.4 | (Armendáriz et al., 2015) |
|  | Tanzania | 2024 | 8 | 0.69–2.86 | 1.82 | (Ntarisa, 2024) |
|  | Turkey | 2012 | 15 | N.A | 5.0 | (Duran et al., 2012) |
|  | Turkey | 2017 | 12 | N.A | N.A | (Söğüt and Uruş, 2017) |
|  | Turkey | 2001 | 9 | 1.3- 2.2 | 1.6 | (Barlas et al., 2001) |
|  | U.S | 2013 | Several | 0.6-7.5 | 2.4 | (Caruso et al., 2013) |

**Supplementary Table 5**: Heavy metals concentrations of As in the cigarettes brands

| Manufactures country | Year | N | Heavy metal concentrations range () | Mean Heavy metal concentrations () | Reference |
| --- | --- | --- | --- | --- | --- |
| Benin | 2012 | 5 | 1.0-95.3 | 37.1 | (Agbandji et al., 2013) |
| Brazil | 2011 | 20 | 0.05-0.13 | 0.09 | (Viana et al., 2011) |
| China | 2014 | Several | 0.3–3.3 | 0.8 | (O’Connor et al., 2014) |
| France | 2012 | 3 | 1.01- 89.55 | 50 | (Agbandji et al., 2013) |
| Hungary | 2009 | 5 | 2.2-6.4 | 3.9 | (Hamidatou et al., 2009) |
| India | 2009 | 25 | 0.1-4.0 | 0.5 | (Dhaware et al., 2009) |
| Ireland | 2015 | N.A | 0.432 - 0.727 | N.A | (Afridi et al., 2015a) |
| Ireland | 2015 | 7 | 0.2-0.3 | 0.2 | (Afridi et al., 2015b) |
| Malaysia | 2017 | 16 | 0-0.2 | 0.03 | (Ismail et al., 2017) |
| Mexico | 2008 | 9 | N.A | 0.6 | (Martínez et al., 2008) |
| Serbia | 2012 | 20 | <0.02–2.04 | 0.2 | (Lazarević et al., 2012) |
| Turkey | 2017 | 12 | N.A | N.A | (Söğüt and Uruş, 2017) |
| Turkey | 2001 | 9 | 0.6- 1.0 | 0.9 | (Barlas et al., 2001) |
| U.S | 2013 | Several | N.A | 0.2 | (Caruso et al., 2013) |

**Supplementary Table 6**: Heavy metals concentrations of Hg in the cigarettes brands

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Manufactures country | Year | N | Heavy metal concentrations range () | Mean Heavy metal concentrations () | Reference |
| Ireland | 2015 | 7 | 3.5-5.1 | 4.4 | (Afridi et al., 2015b) |
| Japan | 2021 | 10 | N.A | 12.3 | (Dinh et al., 2021) |
| Malaysia | 2017 | 16 | 0-1.5 | 0.2 | (Ismail et al., 2017) |
| Pakistan | 2019 | 19 | N.A | 0.1 | (Haleem et al., 2020) |
| India | 2009 | 25 | N.A | N.A | (Dhaware et al., 2009) |
| India | 2022 | 3 | N.A | N.A | (Michael et al., 2022) |
| Turkey | 2017 | 12 | N.A | N.A | (Söğüt and Uruş, 2017) |
| Turkey | 2001 | 9 | 0.2 - 0.3 | 0.3 | (Barlas et al., 2001) |
| Poland | 2019 | 8 | 0.2-0.1 | N.A | (Tyka and Rusin, 2021) |

**References**

Abd El-Samad, M., Hanafi, H.A., 2017. Analysis of toxic heavy metals in cigarettes by Instrumental Neutron Activation Analysis. Journal of Taibah University for Science 11, 822–829. https://doi.org/10.1016/j.jtusci.2017.01.007

Abudu, K.A., Gbadamosi, M.R., Banjoko, O.O., Ogunbanjo, O.O., Osinaike Abiodun, 2015. Heavy metal content of different brands of cigarettes and local tobacco commonly smoked in Nigeria and its toxicological and Health implications. Conference: 1st Interdisciplinary Conference of University of Cape Coast and TASUED.At: University of Cape Coast, Ghana.

Abu-Obaid, A., Jodeh, S., Ahmad, O., Salghi, R., Warad, I., 2015. Determination and Assessment of Heavy Metals in Tobacco Sold and Smoked In Palestinian Market.

Afridi, H.I., Talpur, F., Kazi, T., Brabazon, D., 2015a. Estimation of Aluminum, Arsenic, Lead and Nickel Status in the Samples of Different Cigarettes and their Effect on Human Health of Irish Smoker Hypertensive Consumers. Clin Lab 61. https://doi.org/10.7754/Clin.Lab.2015.141120

Afridi, H.I., Talpur, F.N., Kazi, T.G., Brabazon, D., 2015b. Estimation of toxic elements in the samples of different cigarettes and their effect on the essential elemental status in the biological samples of Irish smoker rheumatoid arthritis consumers. Environ Monit Assess 187, 157. https://doi.org/10.1007/s10661-015-4353-5

Agbandji, L., Patrick, E.A., Gbago, G.B., Koumolou, L., Adisso, S., Guedenon, P., Ahodjide, S., Sinsin, B., Boko, M., 2013. Comparison of heavy metals contents for some cigarettes brands. Am J Pharmacol Toxicol 7, 149–153. https://doi.org/10.3844/ajptsp.2012.149.153

AGOROAEI, L., BIBIRE2, N., MIHAI APOSTU, M., STRUGARU, M., GRIGORIU, I., EBUTNARU, E., 2014. Content of Heavy Metals in Tobacco of Commonly Smoked Cigarettes in Romania.

Ahmad, S.A., Gulzar, A., Un Nisa, V., Hussain, A., Aslam Khan, W., Naeem Khan, M., Ullah Khokhar, Z., Abdul Qadir, M., 2011. STUDY OF TOXIC METALS IN DIFFERENT BRANDS OF STUDY OF TOXIC METALS IN DIFFERENT BRANDS OF CIGARETTES AVAILABLE IN LAHORE. Sci.Int. (Lahore) 23, 205–209.

Ajab, H., Yasmeen, S., Yaqub, A., Ajab, Z., Junaid, M., Siddique, M., Farooq, R., Malik, S.A., 2008. Evaluation of trace metals in tobacco of local and imported cigarette brands used in Pakistan by spectrophotometer through microwave digestion. J Toxicol Sci 33, 415–420. https://doi.org/10.2131/jts.33.415

Al-Dahhan, W., Hashim, H., Ibraheem, H., Hadi, H.M., Yousif, E., 2018. Determination of Toxic Elements in Tobacco, Tobacco Smoke and Ash from Selected Imported Cigarettes Brands. Al-Nahrain Journal of Science 21, 23–29. https://doi.org/10.22401/ANJS.21.4.04

Al-Jeboori, F.H.A., Hussain, K.I., Hammode, A.S., Znad, D.E., 2015. Analysis of Heavy Metals in Selected Cigarettes and Syrupy Tobacco (Mu՝assel) Brands Smoking in Baghdad Market Iraq, Online).

Anhwange, B., Yiase, S.G., 2011. Trace metals content of some Brands of Cigarette found within Makurdi Metropolis.

Armendáriz, C.R., Garcia, T., Soler, A., Gutiérrez Fernández, Á.J., Glez-Weller, D., Luis González, G., de la Torre, A.H., Revert Gironés, C., 2015. Heavy metals in cigarettes for sale in Spain. Environ Res 143, 162–169. https://doi.org/10.1016/j.envres.2015.10.003

Ashraf, M.W., 2012. Levels of Heavy Metals in Popular Cigarette Brands and Exposure to These Metals via Smoking. The Scientific World Journal 2012, 1–5. https://doi.org/10.1100/2012/729430

Asim, M., Bano, H., Ahmed, K., Arif Aziz, A., 2017. DETERMINATION OF CADMIUM AND ZINC CONTENTS IN DIFFERENT BRANDS OF CIGARETTES AND CHEWING TOBACCOS, INT. J. BIOL. BIOTCH.

Asubiojo, O.I., Adebiyi, F.M., Ayenimo, J.G., Olukoko, O.O., Oyekunle, J.A.O., 2009. Chemical analysis of tobacco cigarette for organochlorine insecticides and heavy metal composition. Toxicol Environ Chem 91, 611–618. https://doi.org/10.1080/02772240802343123

Azeez, S.O., Saheed, I.O., Ashiyanbola, I.O., 2019. Assessment of Cr, Cd and Pb levels in tobacco leaves and selected cigarette samples from Ilorin Metropolis Kwara State, Nigeria. Journal of Applied Sciences and Environmental Management 22, 1937. https://doi.org/10.4314/jasem.v22i12.11

Barlas, H., Ubay, G., Soyhan, B., Bayat, C., 2001. Heavy metal concentrations of cigarettes in Turkey. Fresenius environmental bulletin 10, 80–83.

Benson, N.U., Anake, W.U., Adedapo, A.E., Fred-Ahmadu, O.H., Ayejuyo, O.O., 2017. Toxic metals in cigarettes and human health risk assessment associated with inhalation exposure. Environ Monit Assess 189. https://doi.org/10.1007/s10661-017-6348-x

Caruso, R. V., O’Connor, R.J., Stephens, W.E., Cummings, K.M., Fong, G.T., 2013. Toxic metal concentrations in cigarettes obtained from U.S. smokers in 2009: Results from the International Tobacco Control (ITC) United States survey cohort. Int J Environ Res Public Health 11, 202–217. https://doi.org/10.3390/ijerph110100202

CRISPINO, C.C., FERNANDES, K.G., KAMOGAWA, M.Y., NÓBREGA, J.A., NOGUEIRA, A.R.A., FERREIRA, M.M.C., 2007. Multivariate Classification of Cigarettes According to Their Elemental Content Determined by Inductively Coupled Plasma Optical Emission Spectrometry 23, 435–438.

Csalári, J., Szántai, K., 2002. TRANSFER RATE OF CADMIUM, LEAD, ZINC AND IRON FROM THE TOBACCO-CUT OF THE MOST POPULAR HUNGARIAN CIGARETTE BRANDS TO THE COMBUSTION PRODUCTS, Acta Alimentaria.

Dahlawi, S., Abdulrahman Al Mulla, A., Saifullah, Salama, K., Ahmed Labib, O., Tawfiq Aljassim, M., Akhtar, A., Asghar, W., Kh. Faraj, T., Khalid, N., 2021. Assessment of different heavy metals in cigarette filler and ash from multiple brands retailed in Saudi Arabia. J King Saud Univ Sci 33. https://doi.org/10.1016/j.jksus.2021.101521

Dhaware, D., Deshpande, A., Khandekar, R.N., Chowgule, R., 2009. Determination of toxic metals in Indian smokeless tobacco products. ScientificWorldJournal 9, 1140–1147. https://doi.org/10.1100/tsw.2009.132

Dinh, Q.P., Novirsa, R., Jeong, H., Cahya Nugraha, W., Addai-Arhin, S., Viet, P.H., Tominaga, N., Ishibashi, Y., Arizono, K., 2021. Mercury, cadmium, and lead in cigarettes from international markets: concentrations, distributions and absorption ability of filters.

Duran, A., Tuzen, M., Soylak, M., 2012. Trace metal concentrations in cigarette brands commonly available in Turkey: relation with human health. Toxicol Environ Chem 94, 1893–1901. https://doi.org/10.1080/02772248.2012.737795

Eneji, Ishaq Shaibu, Olalekan, S., Sha’ato, R., Eneji, Ishaq S, Salawu, O.W., 2013. Analysis of Heavy Metals in Selected Cigarettes and Tobacco Leaves in Benue State, Nigeria. Journal of Science (JOS) 244.

Engida, A., 2017. Assessment of heavy metals in tobacco of cigarettes commonly sold in Ethiopia. https://doi.org/10.13140/RG.2.2.29974.80962

Etsey Sebiawu, G., Jackson Mensah, N., Ayiah-Mensah, F., 2014. Analysis of Heavy Metals Content of Tobacco and Cigarettes sold in Wa Municipality of Upper West Region, Ghana. Online.

Galażyn-Sidorczuk, M., Brzóska, M.M., Moniuszko-Jakoniuk, J., 2008. Estimation of Polish cigarettes contamination with cadmium and lead, and exposure to these metals via smoking. Environ Monit Assess 137, 481–493. https://doi.org/10.1007/s10661-007-9783-2

Haleem, A.M., Amin, S., Mahmood, U.H., 2020. Heavy metal and polycyclic aromatic hydrocarbons in cigarettes: An analytical assessment. Popul Med 2, 1–4. https://doi.org/10.18332/popmed/122558

Hamidatou, L.A., Khaled, S., Akhal, T., Ramdhane, M., 2009. Determination of trace elements in cigarette tobacco with the k 0-based NAA method using Es-Salam research reactor. J Radioanal Nucl Chem 281, 535–540. https://doi.org/10.1007/s10967-009-0011-0

Hasan, M., Hossain, M.M., Abrarin, S., Kormoker, T., Billah, M.M., Bhuiyan, M.K.A., Akbor, M.A., Salam, S.M.A., Khan, R., Naher, K., Salam, M.A., Ali, M.M., Rahman, M.M., Emran, T. Bin, Mahmoud, Z., Khandaker, M.U., Siddique, M.A.B., 2023. Heavy metals in popularly sold branded cigarettes in Bangladesh and associated health hazards from inhalation exposure. Environmental Science and Pollution Research 30, 100828–100844. https://doi.org/10.1007/s11356-023-29491-9

Hussain, A., Ahmad, U., Zafar Iqbal khan, Kafeel Ahmad, 2024. Evaluation of Heavy Metals in Various Brands of Tobacco Cigarettes Marketed in Pakistan and Their Implications in Public Health. Journal of Health and Rehabilitation Research 4, 1–8. https://doi.org/10.61919/jhrr.v4i3.1294

Ismail, S.N.S., Ladius, C., Abidin, E.Z., Samah, M.A.A., Sulaiman, F.R., 2017. Heavy Metals Content and Health Risk Assessment of the Processed Tobacco From Malaysian Cigarettes, Article in Indian Journal of Environmental Protection.

Iwegbue, C.M.A., 2014. Impact of land use types on the concentrations of metals in soils of urban environment in Nigeria. Environ Earth Sci 72, 4567–4585. https://doi.org/10.1007/s12665-014-3355-x

IWUOHA, G.N., OGHU, E.I., ONWUACHU, U.I., 2013. Levels of selected heavy metals in some brands of Cigarettes marketed in University of Port Harcourt, Rivers State. J. Appl. Sci. Environ. Manage. 17, 561–564.

Janaydeh, M., Ismail, A., Zulkifli, S.Z., Omar, H., 2019. Toxic heavy metal (Pb and Cd) content in tobacco cigarette brands in Selangor state, Peninsular Malaysia. Environ Monit Assess 191, 637. https://doi.org/10.1007/s10661-019-7755-y

Jaradat, Q.M., Momani, K.A., Mutair, A., 2003. Heavy Metal Content of Some Jordanian and American Cigarettes. ABHATH AL-YARMOUK: "Basic Sci. & Eng 12, 231–243.

Joda, B.A., Alheloo, H.S., 2022. Determination of Major, Minor and Trace Elements in Cigarette Tobacco Samples from Karbala, Iraq, Journal of University of Kerbala.

KADIOĞLU, B., NALTEKIN, E., CHAREHSAZ, M., SIPAHI, H., SOYKUT, B., AYDIN, A., 2012. The Relationship Between Cadmium Contents of Tobacco and Their Ash in Cigarettes Marketed Under Different Brands. FABAD J.Pharm. Sci., 37, 129–132.

Karbon, M.H., Ali, F.H., Hasan, E.J., Znad, D.E., Zamil, S.K., Lafi, A.F., 2015. Evaluation of the level of Some Heavy Metals in Tobacco of Domestic and Imported Cigarette Brands Used in Iraq, Baghdad Science Journal Vol.

Kazi, T.G., Jalbani, N., Arain, M.B., Jamali, M.K., Afridi, H.I., Sarfraz, R.A., Shah, A.Q., 2009. Toxic metals distribution in different components of Pakistani and imported cigarettes by electrothermal atomic absorption spectrometer. J Hazard Mater 163, 302–307. https://doi.org/10.1016/j.jhazmat.2008.06.088

Khleif, A.T., Ammar, Q., Al-Janabi, A., Ibraheem, A.K., 2020. IDENTIFICATION OF QUANTITY OF HEAVY METALS IN DIFFERENT TYPES OF TOBACCO IN SHISHA AND CIGARETTE BRANDS. Plant Archives V 20, 214–216.

Lazarević, K., Nikolić, D., Stošić, L., Milutinović, S., Videnović, J., Bogdanović, D.C., 2012. Determination of Lead and Arsenic in Tobacco and Cigarettes: an Important Issue of Public Health. Cent Eur J Public Health 20, 62–66. https://doi.org/10.21101/cejph.a3728

Li, F., Wang, Y., Zhang, J., Lu, Y., Zhu, X., Chen, X., Yan, J., 2020. Toxic metals in top selling cigarettes sold in China: Pulmonary bioaccessibility using simulated lung fluids and fuzzy health risk assessment. J Clean Prod 275, 124131. https://doi.org/10.1016/j.jclepro.2020.124131

Lisboa, T.P., Mimura, A.M.S., da Silva, J.C.J., de Sousa, R.A., 2021. Chromium levels in tobacco, filter and ash of illicit brands cigarettes marketed in Brazil. J Anal Toxicol 44, 514–520. https://doi.org/10.1093/JAT/BKZ106

Lisboa, T.P., Mimura, A.M.S., da Silva, J.C.J., de Sousa, R.A., 2020. Chromium Levels in Tobacco, Filter and Ash of Illicit Brands Cigarettes Marketed in Brazil. J Anal Toxicol 44, 514–520. https://doi.org/10.1093/jat/bkz106

M. Haleem, A., A. Amin, S., 2021. Concentrations and health risks assessment of heavy metals in cigarettes within Baghdad city. International Journal of Physical Research 9, 56–59. https://doi.org/10.14419/ijpr.v9i1.31470

Mahmood, I., Khan, S., Akram, W., M. Obodo, R., Mehmood, T., Ahmad, I., Zhao, T., 2020. Investigation of Toxic Metals in the Tobacco of Pakistani Cigarettes Using Proton-Induced X-Ray Emission, in: Ion Beam Techniques and Applications. IntechOpen. https://doi.org/10.5772/intechopen.84723

Martínez, T., Aguilar, F., Lartigue, J., Navarrete, M., Cuapio, L.A., López, C., Morales, O.Y., 2008. Analysis of Mexican cigarettes by INAA. J Radioanal Nucl Chem 278, 365–370. https://doi.org/10.1007/s10967-008-0801-9

Massadeh, A., Alali, F., Jaradat, Q.M., 2003. Determination of Copper and Zinc in different brands of cigarettes in.

Massadeh, A.M., Alali, F.Q., Jaradat, Q.M., 2005. Determination of cadmium and lead in different cigarette brands in Jordan. Environ Monit Assess 104, 163–170. https://doi.org/10.1007/s10661-005-1609-5

Michael, M., Meyyazhagan, A., Velayudhannair, K., Pappuswamy, M., Maria, A., Xavier, V., Balasubramanian, B., Baskaran, R., Kamyab, H., Vasseghian, Y., Chelliapan, S., Safa, M., Moradi, Z., Khadimallah, M.A., 2022. The Content of Heavy Metals in Cigarettes and the Impact of Their Leachates on the Aquatic Ecosystem. Sustainability (Switzerland) 14. https://doi.org/10.3390/su14084752

Nnorom, I.C., OSIBANJO, O., Oji-nnorom, C., 2005. Cadmium determination in cigarettes available in Nigeria. Afr J Biotechnol 4, 1128–1132.

Ntarisa, A.V., 2024. Heavy metals concentration and human health risk assessment in tobacco cigarette products from Tanzania. Chinese Journal of Analytical Chemistry 52, 100428. https://doi.org/10.1016/j.cjac.2024.100428

O’Connor, R.J., Schneller, L.M., Caruso, R. V., Stephens, W.E., Li, Q., Yuan, J., Fong, G.T., 2014. Toxic metal and nicotine content of cigarettes sold in China, 2009 and 2012. Tob Control 24, iv55–iv59. https://doi.org/10.1136/tobaccocontrol-2014-051804

Omari MO, Kibet JK, Cherutoi JK, Bosire JO, Rono NK, 2015. Heavy Metal Content in Mainstream Cigarette Smoke of Common Cigarettes Sold in Kenya, and their Toxicological Consequences, Int. Res. J. Environment Sci. International Science Congress Association.

Onojah, P.K., Daluba, N.E., Odin, 2019. Investigation of Heavy Metals in Selected Samples of Cigarette Randomly Purchased from Local Markets in Anyigba and its Environment and Tobacco Leaves Grown in Kogi State, International Journal of Innovative Research in Technology & Science.

Özcan, M.M., Aljuhaimi, F., Uslu, N., Ghafoor, K., Mohamed Ahmed, I.A., Babiker, E.E., 2019. Distribution of heavy metal and macroelements of Indian and imported cigarette brands in Turkey. Environmental Science and Pollution Research 26, 28210–28215. https://doi.org/10.1007/s11356-019-05978-2

Pappas, R.S., 2011. Toxic elements in tobacco and in cigarette smoke: Inflammation and sensitization. Metallomics. https://doi.org/10.1039/c1mt00066g

Pashapour, S., Mousavi, Z., Ziarati, P., Najafabadi, K.E., 2015. Comparison of the Level of Cadmium and Lead between the Cigarette Filters of Different Iranian and non-Iranian Brands, Iranian Journal of Toxicology.

Peeva, S., Nikolova, V., Nikolov, N., Popova, V., 2023. Assessment of heavy metal levels in roll-your-own cigarette and water pipe tobacco blends. BIO Web Conf 58, 01021. https://doi.org/10.1051/bioconf/20235801021

Pelit, F.O., Demirdöğen, R.E., Henden, E., 2013. Investigation of heavy metal content of Turkish tobacco leaves, cigarette butt, ash, and smoke. Environ Monit Assess 185, 9471–9479. https://doi.org/10.1007/s10661-013-3266-4

Peter, O.M., Micah, O., Abraham, S., Timothy, O., 2020. Evaluation of Heavy Metal Content in Main Stream Smoked Cigarettes and Non-smoked Tobacco in Kenya. IOSR Journal of Applied Chemistry (IOSR-JAC 13, 39–45. https://doi.org/10.9790/5736-1312023945

Pinto, E., Cruz, M., Ramos, P., Santos, A., Almeida, A., 2017. Metals transfer from tobacco to cigarette smoke: Evidences in smokers’ lung tissue. J Hazard Mater 325, 31–35. https://doi.org/10.1016/j.jhazmat.2016.11.069

Pourkhabbaz, A., Pourkhabbaz, H., 2012. Investigation of Toxic Metals in the Tobacco of Different Iranian Cigarette Brands and Related Health Issues, Toxic Metals in the Tobacco of Cigarette Brands Iran J Basic Med Sci.

Ren, T., Zhao, L.J., Zhong, W.S., 2016. Determination of Pb (Lead), Cd (Cadmium), Cr (Chromium), Cu (Copper), and Ni (Nickel) in Chinese tea with high-resolution continuum source graphite furnace atomic absorption spectrometry. J Food Drug Anal 24, 46–55. https://doi.org/10.1016/j.jfda.2015.04.010

Siddiqui, I., Rais Hashmi, D., Ahmad Khan, F., Shareef, A., Hussain Shaikh, G., Bano Munshi, A., 2009. Determination of Copper, Manganese, Nickel and Zinc in Different Cigarette Brands Available in Pakistan, Pak. J. Sci. Ind. Res.

Söğüt, Ö., Uruş, S., 2017. Analysis of Metal Contents in Maraş Powder and Different Cigarette Brands in Turkey, El-CezerîJournal of Science and Engineering.

Solidum, J., 2013. Lead, Cadmium and Chromium in Selected Local Cigarettes Available in the Philippines, International Journal of Chemical and Environmental Engineering.

Strungaru, S.-A., Nicoara, M., Dacia PETROAIE, A., Plavan, G., 2018. HEAVY METALS IN COMMON TOBACCO BRANDS FROM LEGAL MARKET AND BLACK MARKET OF IAŞI-ROUMANIA, Rev. Roum. Chim.

Tyka, A., Rusin, M., 2021. Heavy metals content in various types of tobacco and tobacco smoke. Environmental Medicine. https://doi.org/10.26444/ms/133102

Verma, S., Yadav, S., Singh, I., 2010. Trace metal concentration in different Indian tobacco products and related health implications. Food and Chemical Toxicology 48, 2291–2297. https://doi.org/10.1016/j.fct.2010.05.062

Viana, G.F.D.S., Garcia, K.S., Menezes-Filho, J.A., 2011. Assessment of carcinogenic heavy metal levels in Brazilian cigarettes. Environ Monit Assess 181, 255–265. https://doi.org/10.1007/s10661-010-1827-3

Yebpella, G.G., Oladipo, M.O.A., Magomya, A.M., Abechi, S.E., Udiba, U.U., Kamba, E.A., 2013. Multi-element analysis of selected brands of cigarettes in Nigerian market, Scholars Research Library Archives of Applied Science Research.

Yebpella, G.G., Oladipo, M.O.A., Saidu, S.A., Mohammed, A., Achi, S.S., Nok, A.J., Bonire, J.J., 2010. Neutron Activation Analysis of Trace Metals in Cigarette, Nigerian Journal of Chemical Research.

Yebpella, G.G., Shallangwa, G.A., 2015. Heavy Metal Content of Different Brands of Cigarettes Commonly Smoked in Nigeria and its Toxicological Implications.

Ziarati, P., Mousavi, Z., Pashapour, S., 2016. Analysis of Heavy Metals in Cigarette Tobacco. Journal of Medical Discovery 2. https://doi.org/10.24262/jmd.2.1.16006

Ziyae Aldin Samsam Shariat, S., Rastqar, A., Jabbari, M., Taheri, M., Keshvari, M., 2019. Cadmium Concentration in Cigarette Brands, Tobacco Leaves, and Smokers’ Blood Samples. Herbal Medicines Journal 4, 11–18. https://doi.org/10.22087/herb%20med%20j.v1i1.736