Abstract:

Investigating the chemical properties of PM2.5 and PM0.25 particles in the indoor air of Ardabil waterpipe coffees: heavy metals and polyaromatic hydrocarbons

Introduction:

Deaths due to waterpipe consumption due to its toxicity are estimated to be around 6 million people per year and this number is expected to exceed 8 million people per year by 2030. Previous studies on this topic have identified many compounds in waterpipe smoke. These compounds include polynuclear aromatic hydrocarbons (PAH), aldehydes, volatile organic substances, nicotine, carbon monoxide, phenolic groups, suspended particles, heavy metals, etc. that these compounds, in addition to the toxic and carcinogenic effects for humans, can cause various diseases and failures in humans.

One of these dangerous pollutants are heavy metals. Heavy metals are dangerous air pollutants that have many physiological effects on humans and due to their ability to accumulate in different tissues of the human body, they cause disturbances in body systems. Various studies have shown that tobacco smoke contains significant amounts of heavy metals such as lead, cadmium, nickel and arsenic.

Methodology:

This cross-sectional descriptive study was conducted in the indoor air of coffee houses in Ardabil city, in the fall season of 1402. 20 coffee houses were randomly selected for sampling. Before sampling, the sampling pump was first calibrated by a digital calibrator. to give us a flow rate of 9 liters per minute. A 5-stage cascade impactor was used to sample PM 2.5 and PM 0.25 particles in the air inside coffee houses. The type of filter used in the cascade impactor for sampling PM2.5 particles was PTFE 37 mm and pore diameter 1 micrometer, and for PM0.25 particles, PTFE type 25 mm and pore diameter 0.2 micrometer. In order to determine the mass concentration of PM2.5 and PM0.25 particles in the air inside the coffee houses, first, clean PTFE filters were placed in the laboratory at a temperature of 22-24 degrees Celsius and a relative humidity of 40-45% for 24 hours. Then each filter was weighed 5 times before sampling with a digital scale with an accuracy of 4 zeros and their average weight was recorded, and the filters were weighed, labeled and placed inside petri dishes. took, the sampling time of the air inside the coffee houses was 8 hours (3 pm to 11 pm) and the sampling pump was placed at a height of 1-1.5 meters (breathing height of sitting people), after sampling the filters They were immediately transported to the laboratory, the sampled filter was analyzed by GC/MS and ICP devices to determine PAHs and solid phase metals.

Results:

According to the results of the analysis, the mass concentrations of PM2.5 and PM0.25 in the air of fruit waterpipe supply coffee houses are 232.66 ± 77.33 and 17.75 ± 4.40 micrograms per cubic meter, respectively, and in the supply coffee houses Regulatory waterpipe was obtained as 124.55 ± 44.40 and 9.99 ± 3.19 micrograms per cubic meter, respectively, and the results indicate a high concentration of particles in the air of coffee

houses with fruit waterpipe compared to the air of the coffee house. It is the waterpipe of Regulatory. The average concentration of PM2.5 particles from this study in the indoor air of fruit waterpipe coffee shops is 232.66 ± 77.33 micrograms per cubic meter, and in the indoor air of Regulatory waterpipe coffee shops, it is 124.55 ± 44.40 micrograms per cubic meter. cubic meter was obtained, which is higher than the EPA standard (35 micrograms per cubic meter, 24-hour average) and the WHO guideline (15 micrograms per cubic meter, 24-hour average). In order, integrated ventilation, mechanical ventilation and natural ventilation have the greatest effect on the mass concentration of suspended particles. Regarding the type of waterpipe, Regulatory waterpipe coffee houses produce less particles than fruit waterpipe coffee houses. There is a very strong positive correlation between the number of lit waterpipes and the concentrations of particles ($p<0.001$, $R2=0.96$, PM0.25) and (PM2.5, $p<0.001$, $R2=0.97$). This analysis shows that Waterpipe smoking is the most important source of PM0.25 and PM2.5 particles in the air inside coffee houses. The results obtained in this study are with the results reported in the study by Gurangetal et al. and the study by Fazlzadeh et al. that the linear relationship between the concentration of PM2 particles 5. and the number of waterpipes obtained is consistent with the results reported by Shihadeh et al. . Aromatic hydrocarbons with low molecular weight accounted for about 65% of PAHs emissions in PM0.25 particles, these PAHs include dicyclic aromatic hydrocarbons such as naphthalene and tricyclic hydrocarbons, followed by PAHs with medium molecular weight, including 4-ringed PAHs, which are responsible for about 20-25% of the total PAHs emissions by all kinds of waterpipes in this study, and finally PAHs with high molecular weight include 5- and 6-ringed PAHs, and the lowest share of had total emissions of PAHs in our study. Regulatory waterpipes contributed more to the release of PAHs with high molecular weight than fruit waterpipes, but fruit waterpipes played a greater role in the release of PAHs with medium molecular weight, but they had almost the same performance in the production of PAHs with high molecular weight. The weight percentage of PAHs in PM0.25 particles is higher than its amount in PM2.5 particles, and fruit waterpipes have a greater share in the production of PAHs than Regulatory waterpipes. Also, the weight percentage of carcinogenic PAHs in PM0.25 particles is higher than its value in PM2.5 particles. For PM2.5, the equivalent concentration of PAHs based on benzopyrene was found to be equal to 29.17995 and 297.1969 ng/m3 for Regulatory and Fruity waterpipe coffee houses, respectively, which the measured concentrations are in accordance with the recommendations of the World Health Organization (1 nanograms per cubic meter) is much higher, Also, the average concentration obtained for fruit waterpipe is higher than the recommended limit of NIOSH (100 nanograms per ten working hours) and the equivalent concentrations obtained for PM0.25 particles in the case of waterpipe coffees with waterpipes in Regulatory are. 48.68732 and 90.91404 ng/m3 were obtained, which are much higher than the WHO recommended limit, which is 1 ng/m3 per year, and lower than the NIOSH recommendation (100 ng/10 working hours). According to the results, it can be seen that the share of fruit waterpipes in the production of PAHs is higher than that of Regulatory waterpipes. Among group 1 carcinogenic metals, the measured concentration for cadmium metal was higher than OSHA's 8-hour acceptable limit (0.005 µg/m3) for both PM2.5 and PM0.25. The share of

metals in PM0.25 particles is higher than the share of metals in PM2.5 particles, that is, as the particle size decreases, the percentage of metals increases relative to the total content of the particles, also the percentage of carcinogenic metals relative to the total metals in PM0.25 particles is higher than Its percentage in metal particles is PM2.5, also in the comparison of waterpipes, according to the above table, despite the fact that the percentage of metals in relation to the total particle content in fruit waterpipes is higher than the percentage mentioned in Regulatory waterpipes, but the percentage of carcinogenic metals The ratio of the total particle content as well as the percentage of carcinogenic metals to the total metals in the particles is higher for Regulatory waterpipes than for fruit waterpipes.

Keywords: Air, Air Pollution, Heavy Metal, Waterpipe Cofees, polyaromatic Hydrocarbons, PM2.5 , PM0.25