



21st EDITION OF
THE L'ORÉAL-UNESCO INTERNATIONAL AWARD
FOR WOMEN IN SCIENCE

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Analytical and atmospheric chemistry

Laureate of Africa and the Arab States



Toxicant content, physical properties and **biological activity** of waterpipe tobacco smoke and its tobacco-free alternatives

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Outline

- ❖ Set of questions to undiscover the myths related to waterpipe
- ❖ Term definitions
- ❖ The description of the analytical procedure for chemical speciation
- ❖ Toxicant content in raw and smoked materials
- ❖ Research impact on regulations
- ❖ Recommendations

How old is waterpipe smoking?



What makes the waterpipe so popular?



Is waterpipe popular among AUB students?

Table 2. Frequency distribution of students by selected variables on practice of argileh smoking.

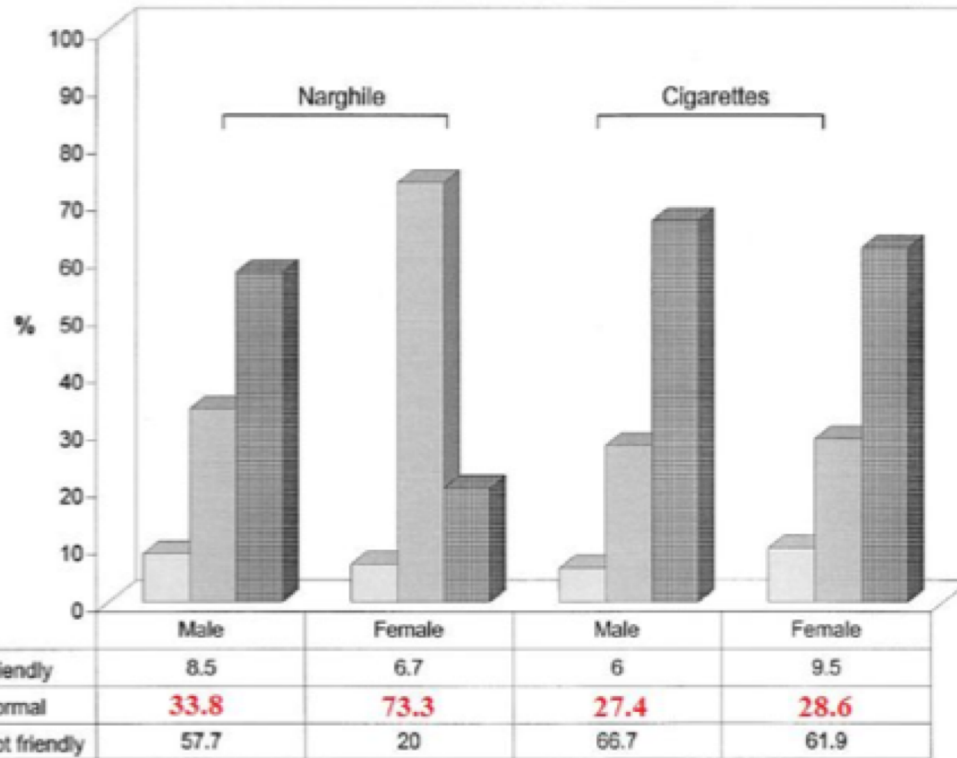
Practice variable	Unweighted (n)	Weighted (%)
Smoking status (n= 416)		
Never	250	57.2
Used to	54	14.5
Current	112	28.3
Frequency of smoking (n= 112)		
Daily	5	5.2
Weekly	36	33.0
Occasionally	70	61.0
Undetermined	1	0.8
Reason for smoking argileh (n= 41)		
Entertaining	41	94.4
Tasty	36	86.0
Relaxing	30	73.4
Gives time to think	12	30.5
Facilitates group communication	12	29.4
Trendy	8	19.2
Promotes family gathering	8	18.1
An inexpensive way to hang out with friends	6	15.8
Less harmful than cigarettes	3	6.3
Sharing argileh (n= 41)		
Inhaling the smoke (n=41)	37	89.8
Smoking in front of parents (n=41)	22	56.4
Smoking in front of parents (n=41)		
	35	83.2

Is waterpipe more popular among women?

French painter Eugène Delacroix (1798–1863)



Is waterpipe more popular among women?



Reponses of students (in %) about their family's attitude towards their smoking stratified by gender and method of smoking.

Maziak et al. 2004

Is waterpipe popular only in Lebanon?

Columbia University - US

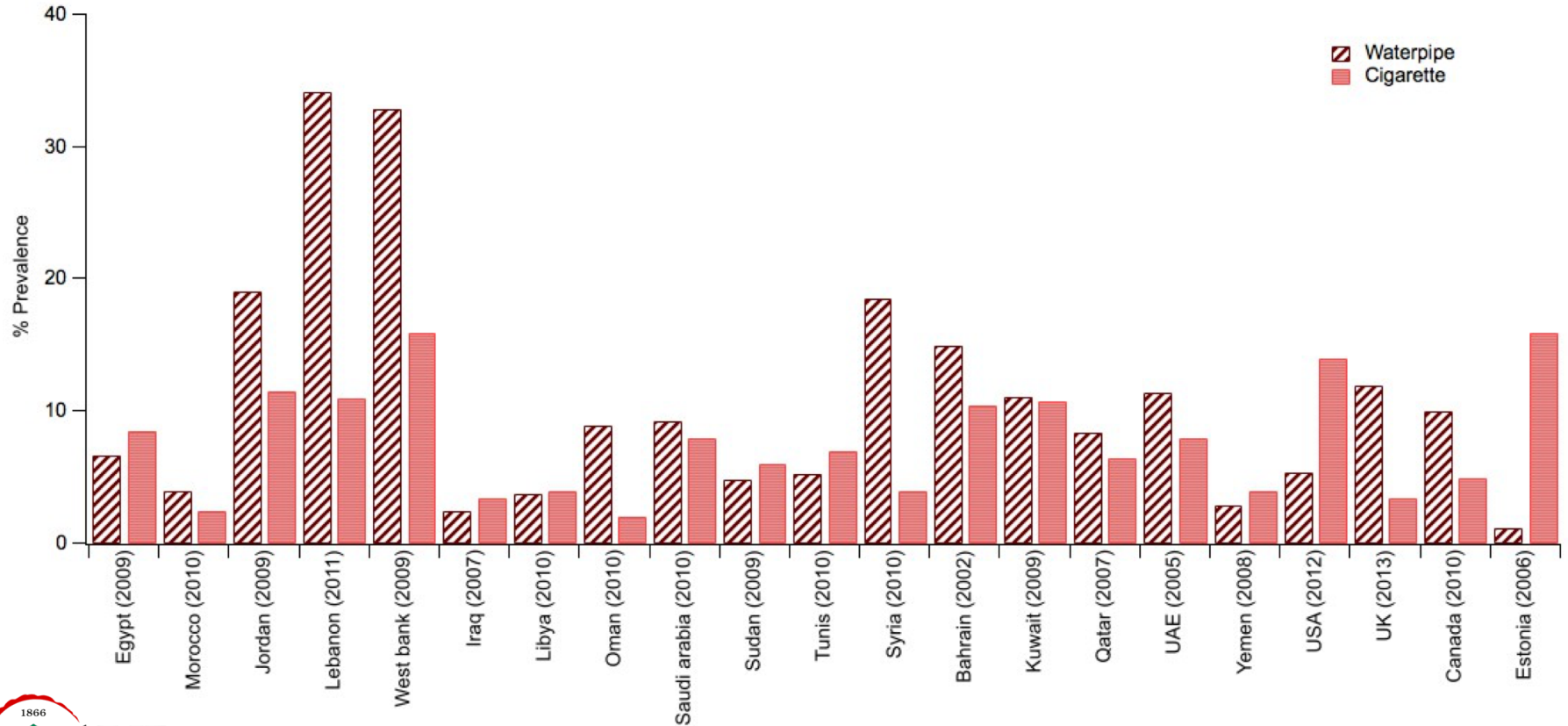


Are hookah lounges regulated in the US and EU?

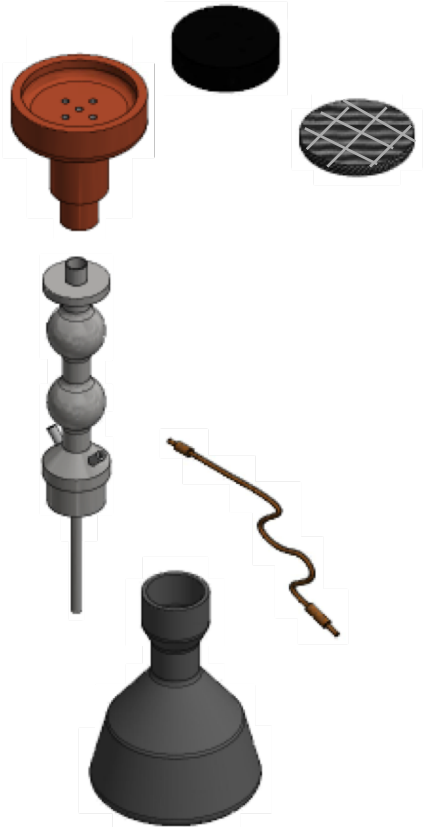
Redondo Beach - California



What country has the highest number of waterpipe smokers in the Arab world?



The Waterpipe System: Defining the parts of the waterpipe



Charcoal



Tobacco

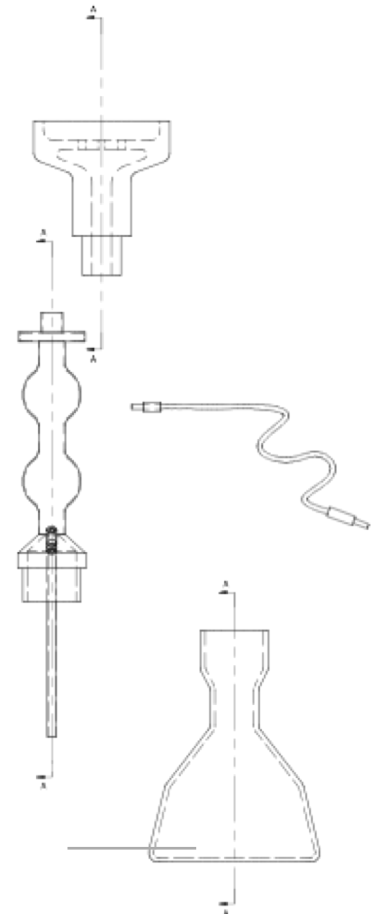


Head

Body

Hose

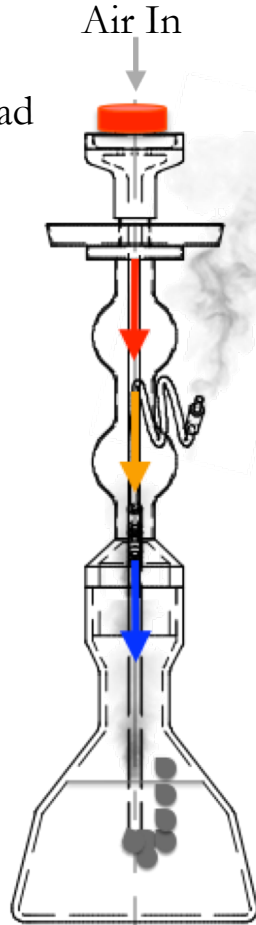
Bowl



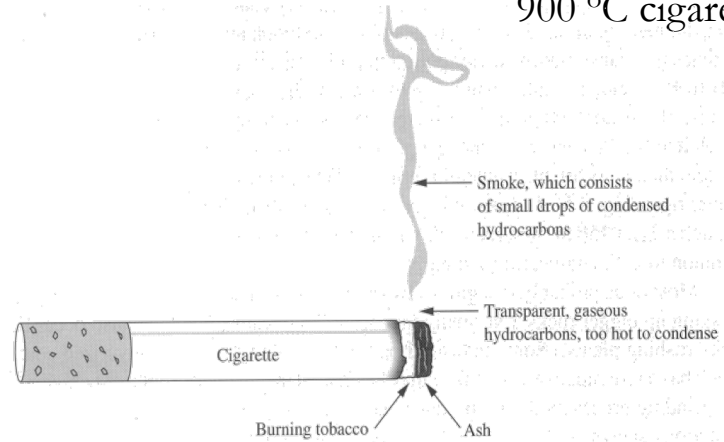
Water

The Waterpipe Smoking System: Combustion versus pyrolysis

Peak ~ 450 °C in head



900 °C cigarette



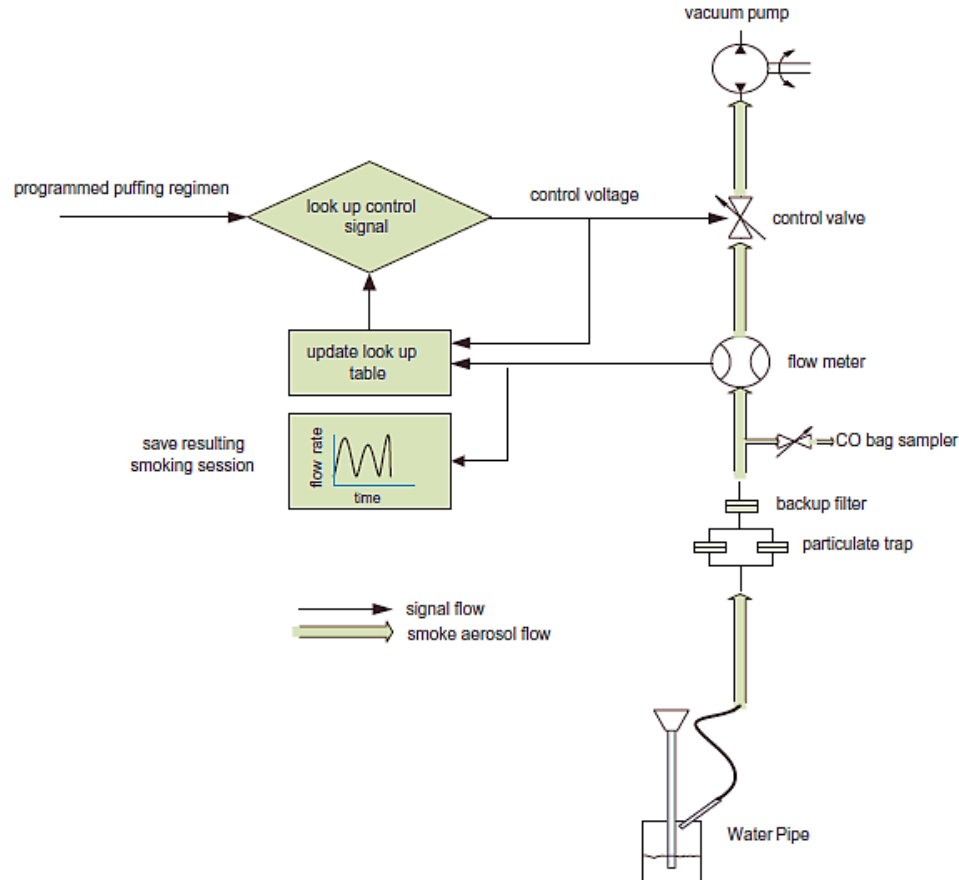
The Smoke Sample Collection: Mimicking the real life smoking scenarios

Waterpipe smoking regimen: The Beirut Method

Puffing parameter	Defined Value
Puff volume (ml)	530
Puff frequency (s)	17
Puff duration (s)	2.6
Session duration (min)	60
Number of puff cycles	171
Tobacco loaded (g)	10
Charcoal (g)	5.8

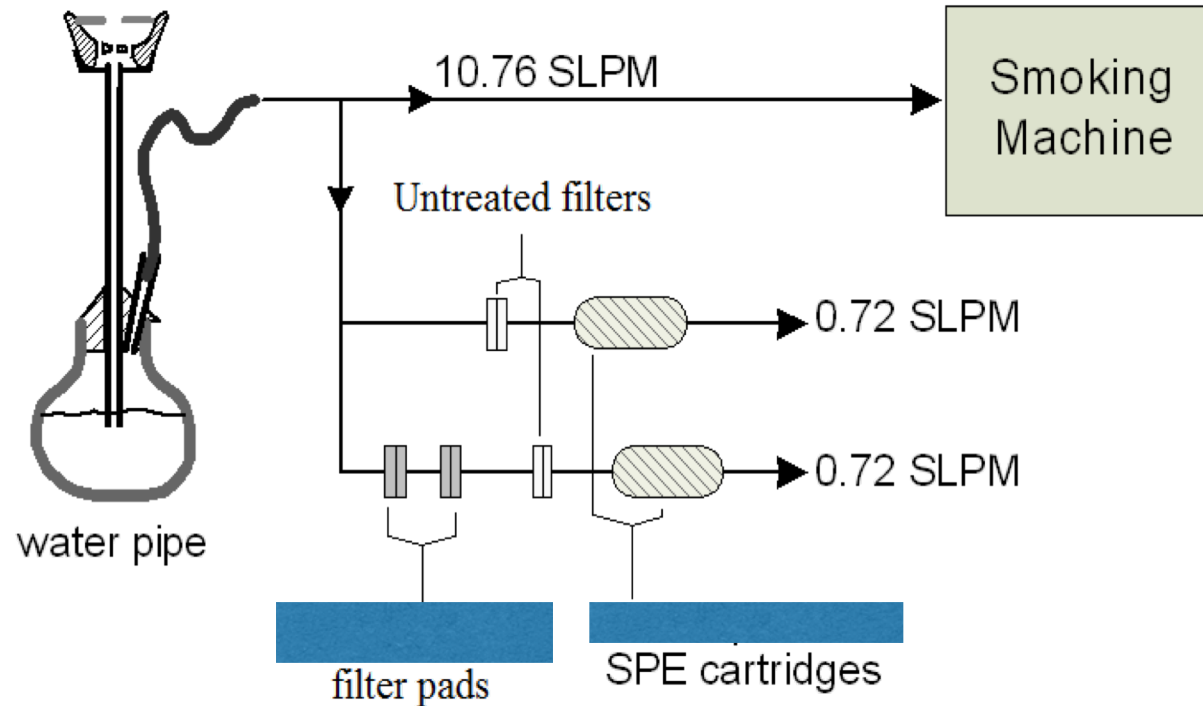
The Smoke Sample Collection: Automating the smoking process

Waterpipe digitally controlled smoking machine



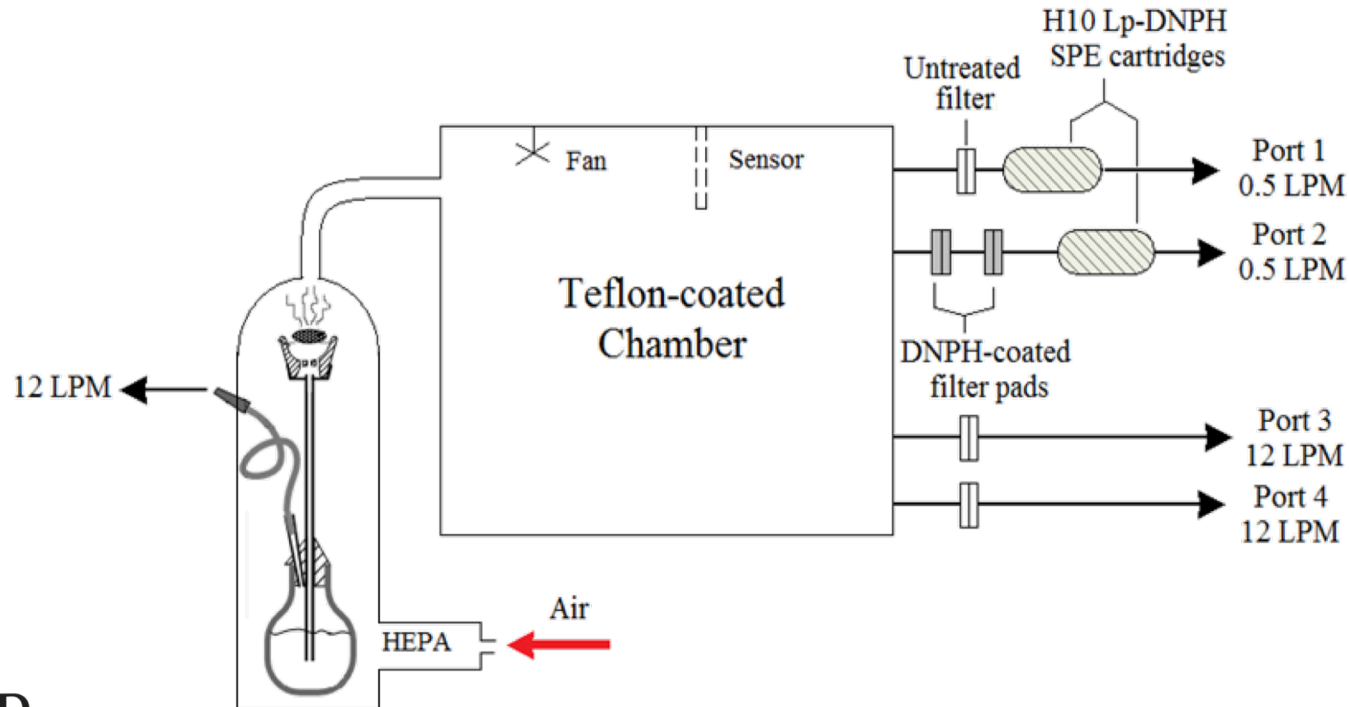
The Smoke Sample Collection: Collecting the mainstream smoke

Collection of filters and gases in the mainstream smoke



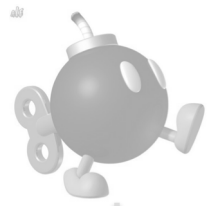
The Smoke Sample Collection: Collecting the sidestream smoke

Collection of filters and gases in the sidestream smoke



The Analytical Chemistry Process

Sample Collection



Sample Labeling and Data Logging



Sample Storage



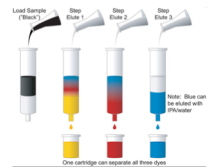
Sample Preparation and Identification



Sample Extraction



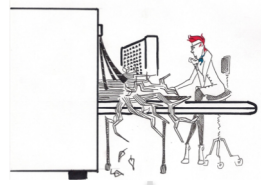
Sample Purification



Extraction Efficiency



Sample Separation



Chromatography type



Chemical Separation



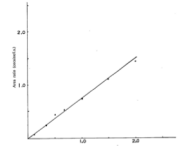
Separation Efficiency



Quality Control



Calibration Curve



Quality Assurance



Recovery



Sample Analysis



Sample comparison



Reporting



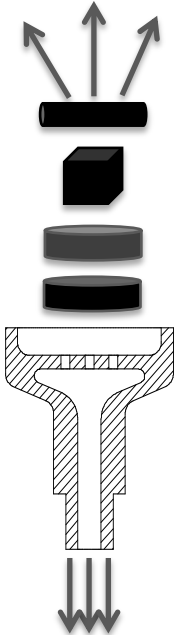
Standard Operating Procedure (SOP)



Sample Identification: starting with the content before the smoke

Physical and chemical properties of the raw material in the waterpipe system

Side Stream Smoke



Main Stream Smoke

I. Raw materials

- Tobacco
- Unburned herbal (tobacco-free) products
- Raw charcoal extract

Physical and chemical properties of Tobacco and herbal products:

- Type
- Mass
- Flavour
- Humectants (type and mass)
- Wettness
- Packing density
- Chemical composition (PAHs, metals, nicotine, and others)

Sample Identification: Content of the waterpipe system

Physical properties of the raw material in the waterpipe system

Tobacco type



Tobacco wettness and mass



Charcoal



Sample Identification: Chemical toxicants present in smoke

Chemical properties of the raw material in the waterpipe system:
Polycyclic Aromatic Hydrocarbons (PAHs) are toxic materials produced from
pyrolysis or incomplete combustion



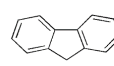
Naphthalene



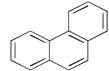
Acenaphthene



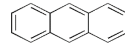
Acenaphthylene



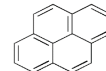
Fluorene



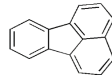
Phenanthrene



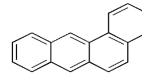
Anthracene



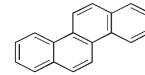
Pyrene



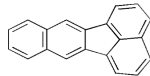
Fluoranthene



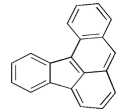
Benzo[a]anthracene



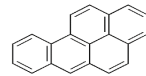
Chrysene



Benzo[k]fluoranthene

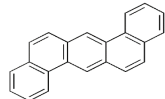


Benzo[b]fluoranthene

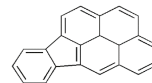


Benzo[a]pyrene

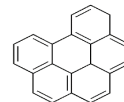
Benzo[a]pyrene is classified as
type IA carcinogen, *IARC-WHO*



Dibenz[a,h]anthracene

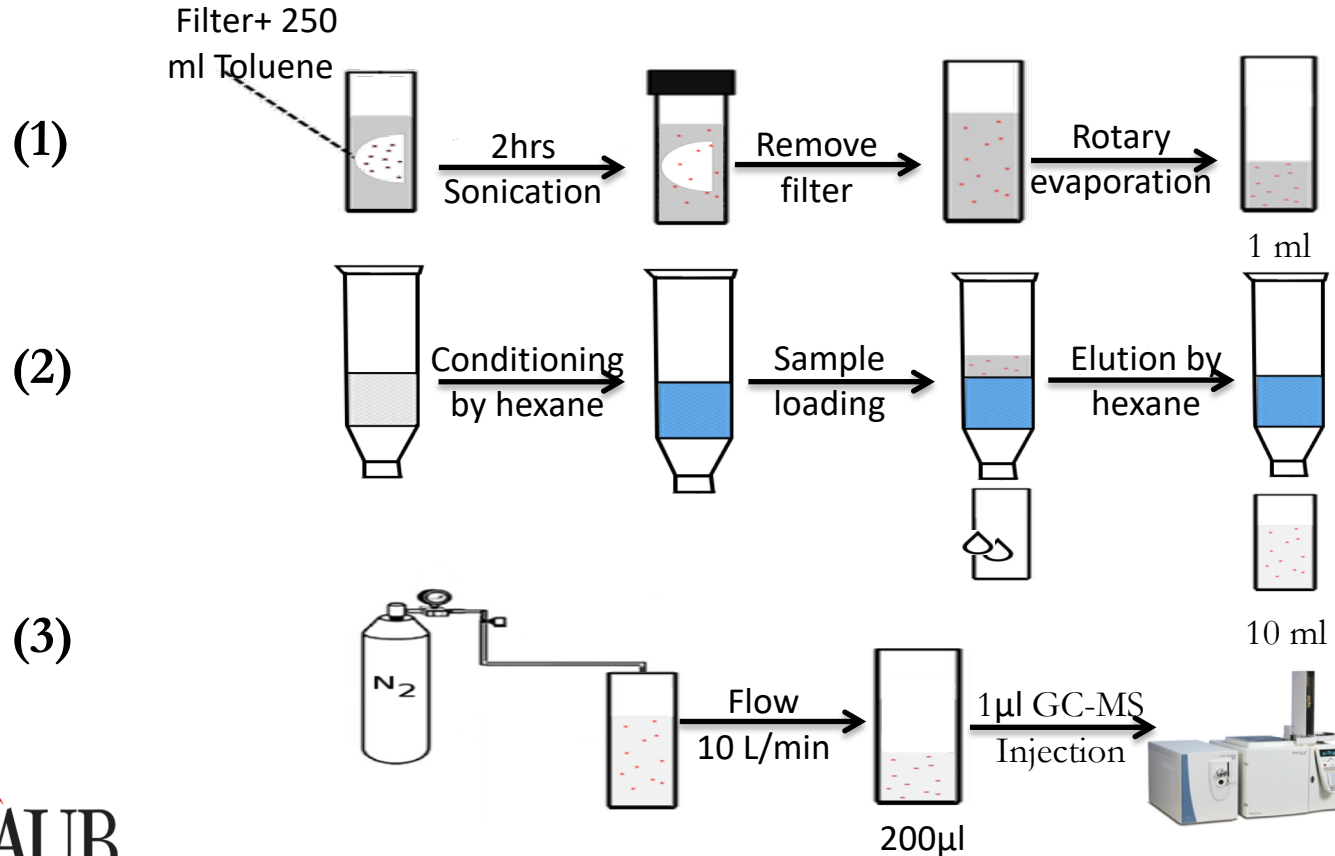


Indeno[1,2,3-cd]pyrene

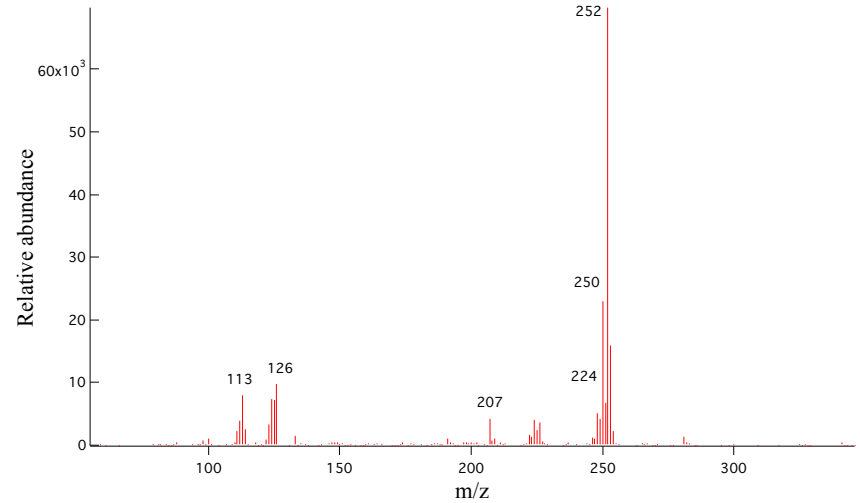
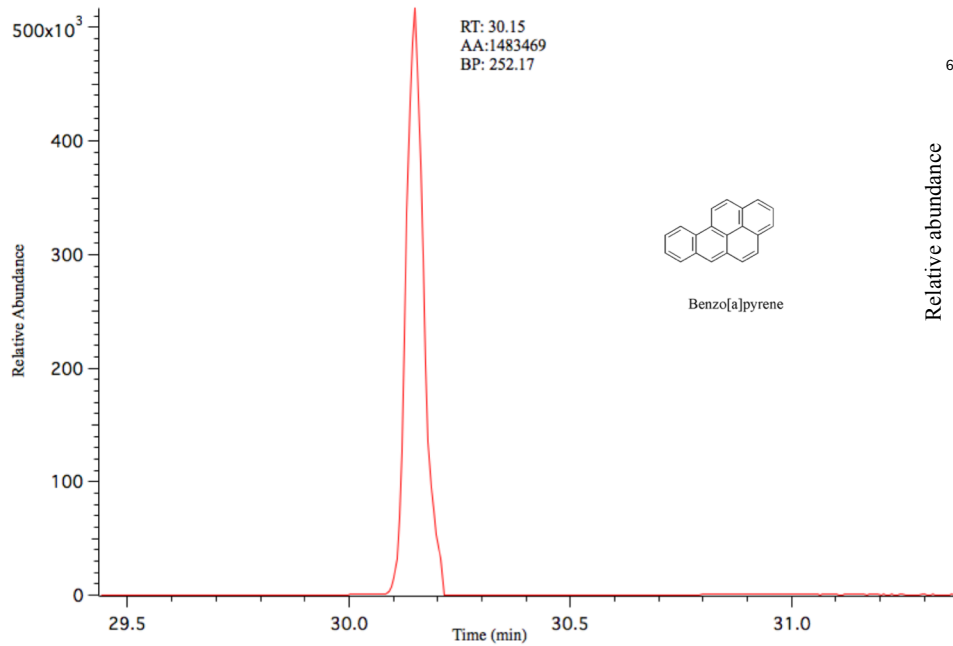


Benzo[ghi]perylene

The Sample Preparation Procedure: Extraction of PAHs



The Sample Analysis: Results as seen on the chromatographic system



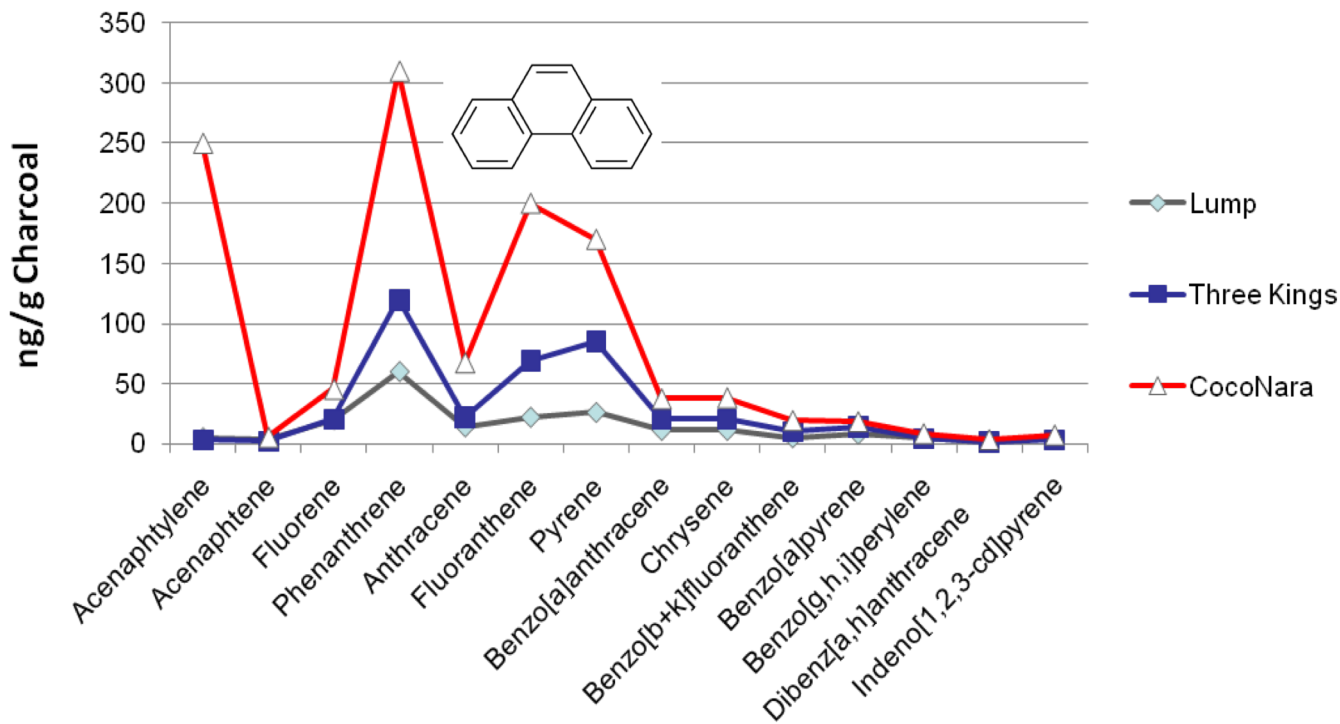
Examples of GC Chromatograms and MS spectra of the detected and quantified Benzo[a]pyrene

The Method Validation: PAH preparation and analysis

Validation parameters	16 PAH
Repeatability (%RSD)	4-8%
Recovery (%)	83-110%
Limit of detection ($\mu\text{g}/\text{mL}$)	0.01-0.05
Limit of quantification ($\mu\text{g}/\text{mL}$)	0.03-0.16
Correlation coefficient (R^2)	>0.995

The Sample Results and Data Analysis

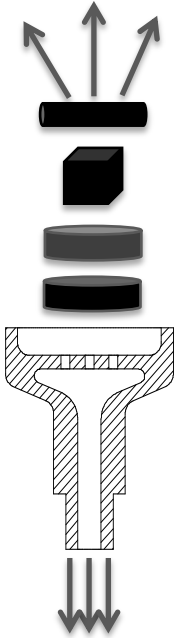
The difference in the PAH content among the common charcoal types that are available commercially in Lebanon



The Sample Preparation: Chemicals in the mainstream smoke

Polycyclic Aromatic Hydrocarbons (PAH) in the waterpipe system

Side Stream Smoke

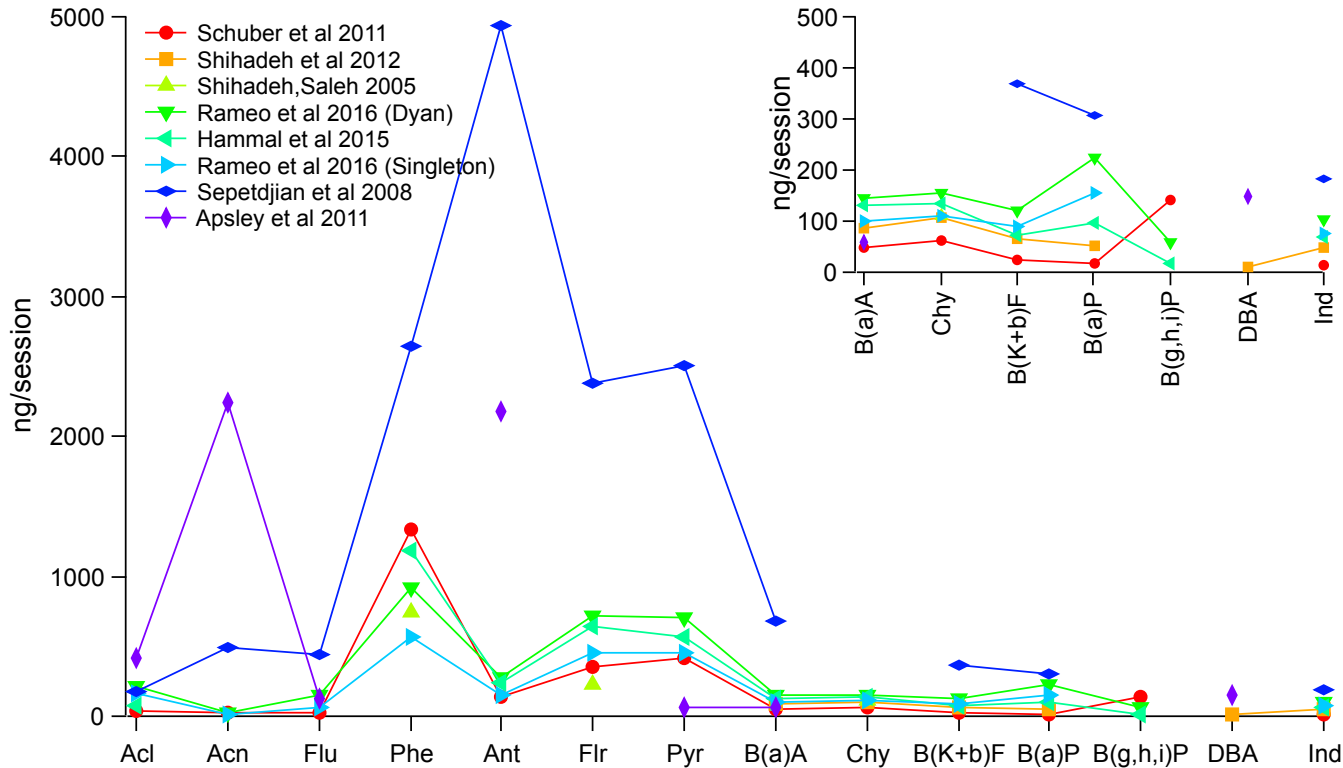


II. Mainstream PAHs in:

- Burned tobacco products
- Burned herbal (tobacco-free) products
- Burned charcoal

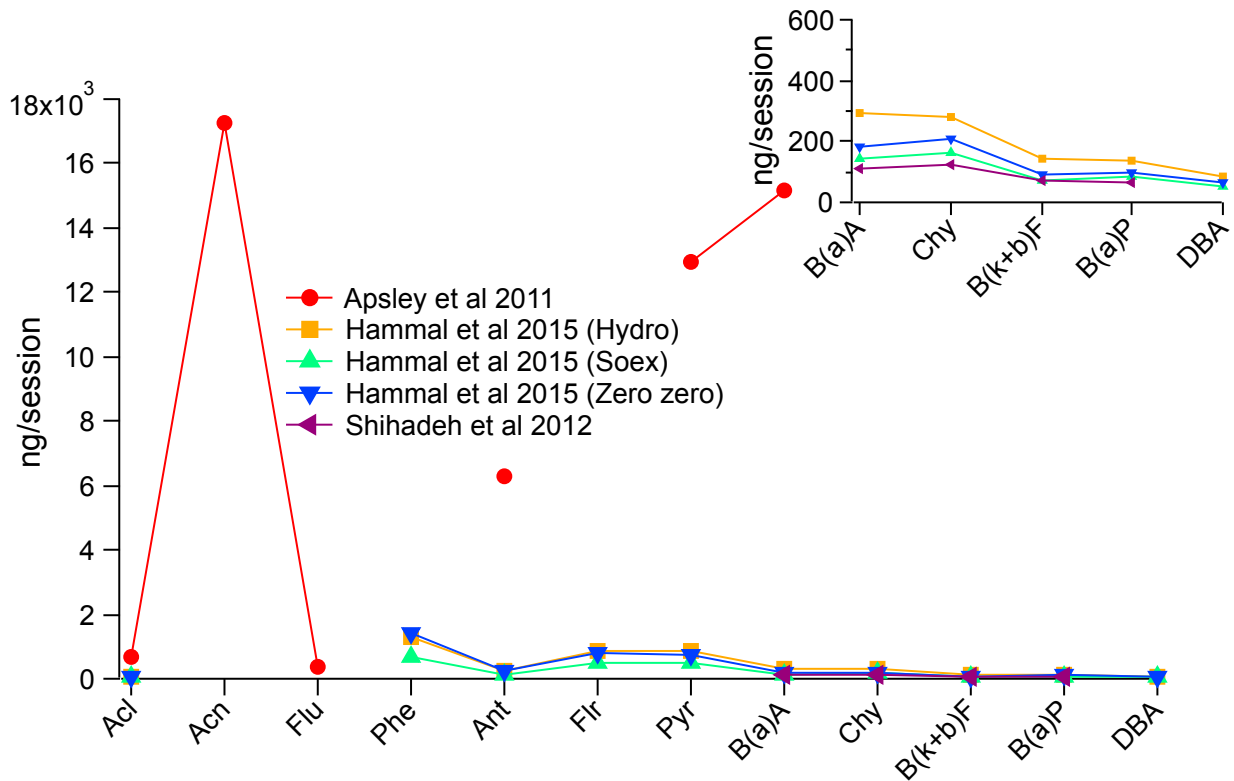
Main Stream Smoke

PAH analysis in the mainstream smoke of tobacco products

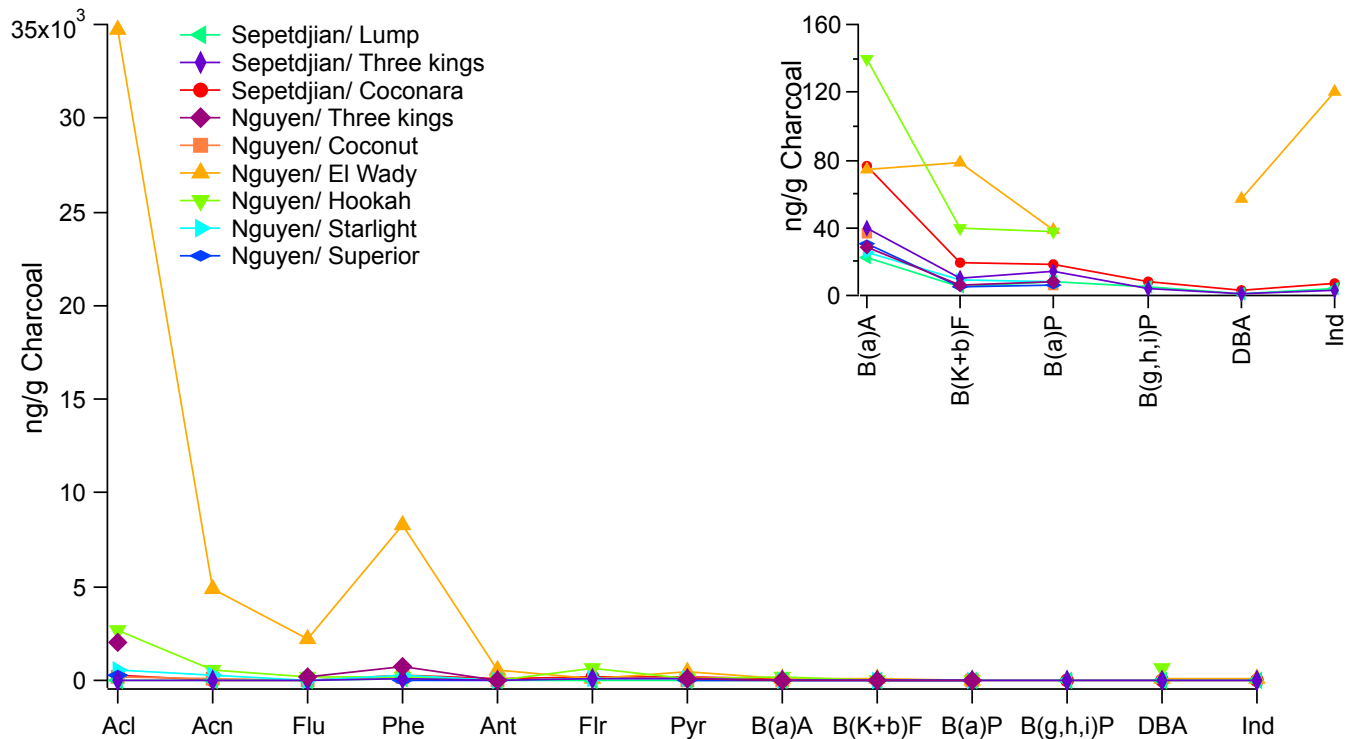


Shihadeh A. & Saleh R. 2005. *Food and Chemical Toxicology* 43 :655–661, Sepetdjian E. et al. 2008. *Food and Chemical Toxicology* 46 :1582–1590, Apsley A. et al. 2011. *Journal of Environmental Health Research* 11:93-104, Schubert J. et al. 2011. *Toxicology Letters* 205:279–284, Shihadeh A. et al. 2012. *Food and Chemical Toxicology* 50:1494–1498, Hammal F. et al. 2015. *Tob Control* 24:290–297, Ramoa C. et al. 2016. *Nicotine & Tobacco Research* 770–776

PAH analysis in the **mainstream** smoke of herbal (tobacco-free) products



PAH analysis in the mainstream smoke of burnt charcoal

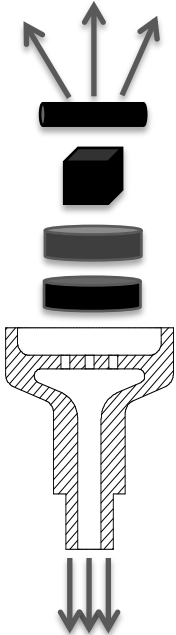


Sepetdjian E. et al.2010.Food and Chemical Toxicology 48 :3242–3245, Nguyen T.et al.2013.Journal of Environmental Science and Health, Part B (2013) 48, 1097–1102

The Sample Preparation: Chemicals in the **sidestream smoke**

Polycyclic Aromatic Hydrocarbons (PAH) in the waterpipe system

Side Stream Smoke

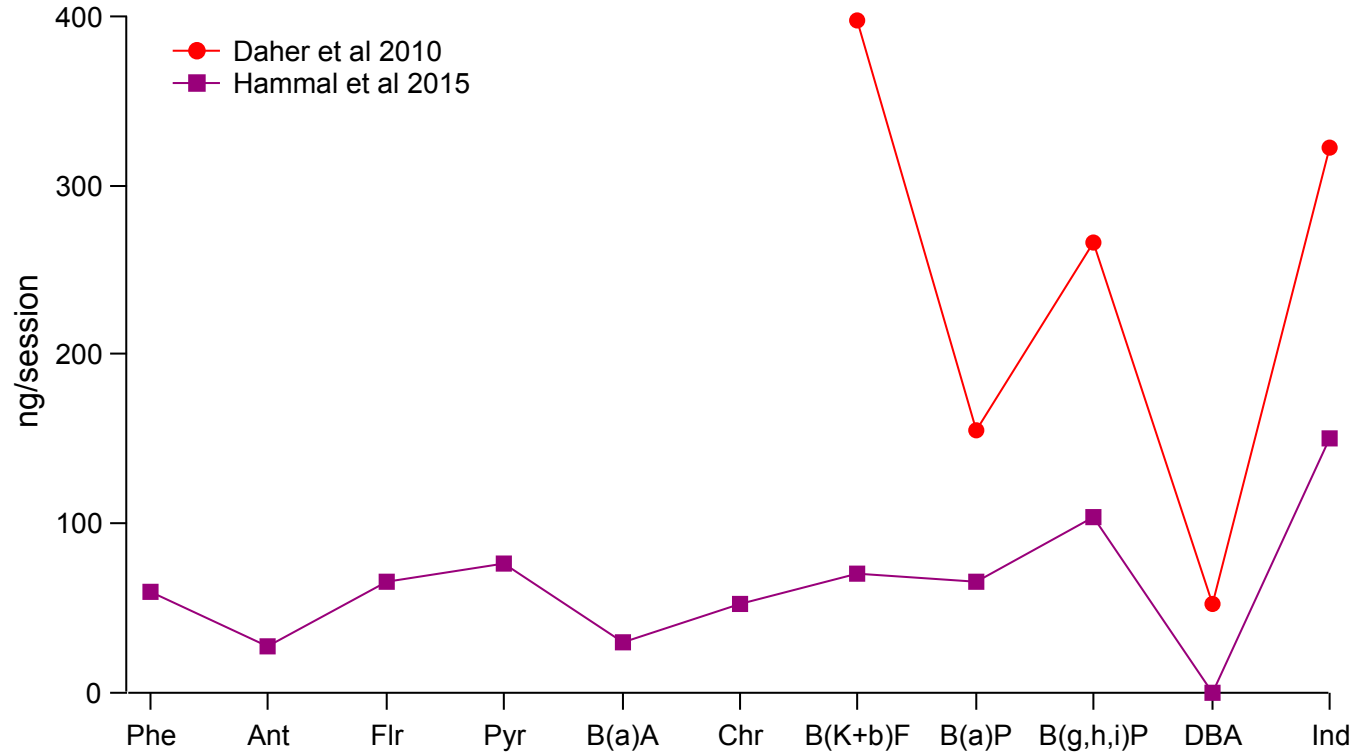


III. Sidestream PAHs in:

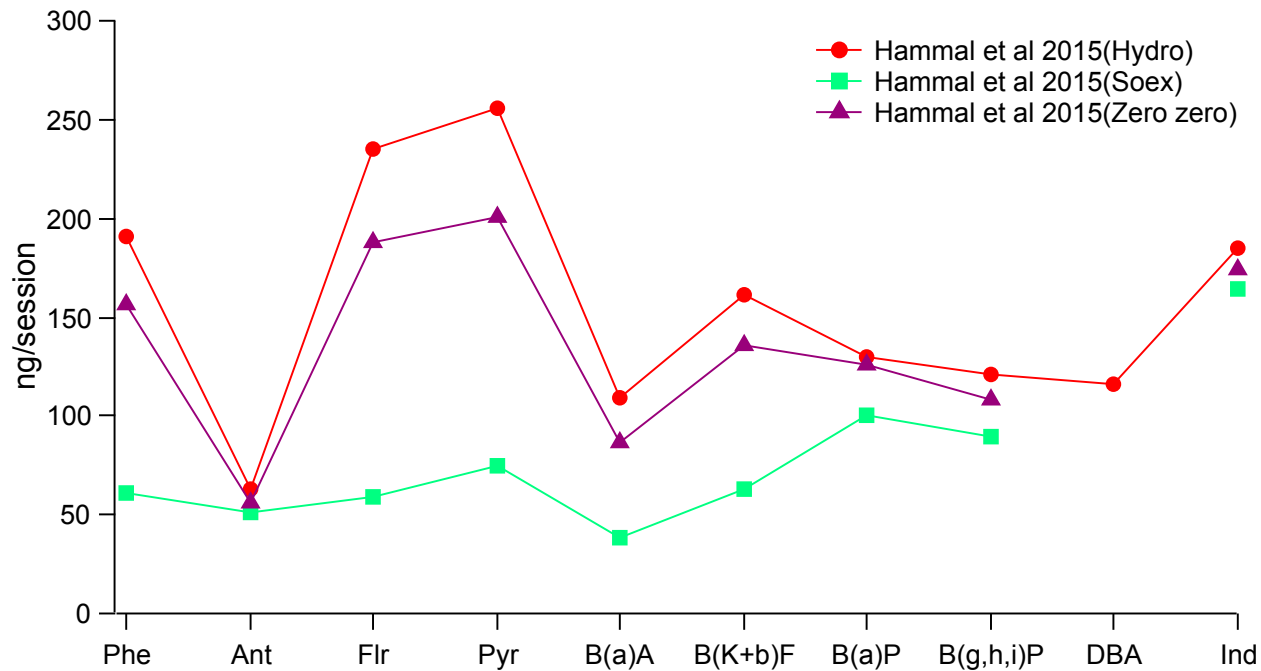
- Burned tobacco products
- Burned herbal (tobacco-free) products

Main Stream Smoke

PAH sidestream smoke analysis from tobacco products

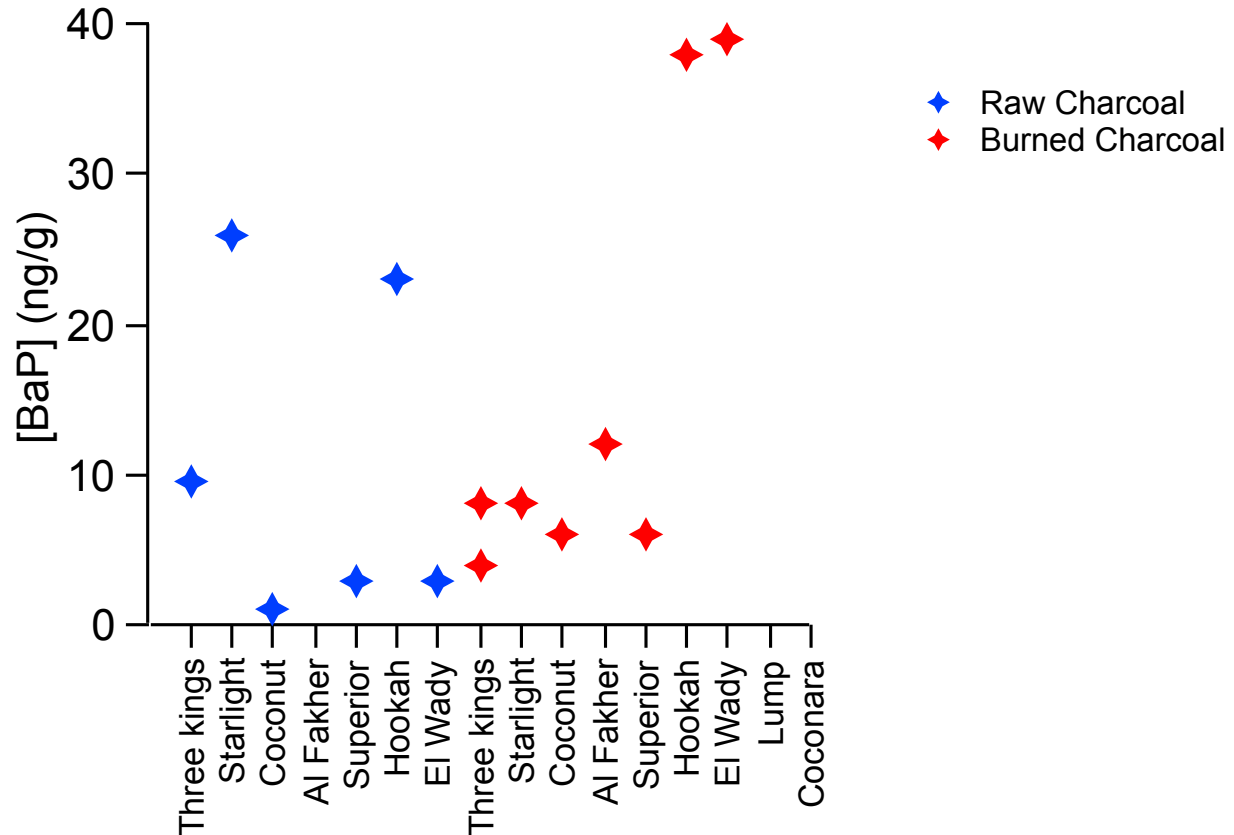


PAH sidestream smoke analysis from herbal (tobacco-free) products

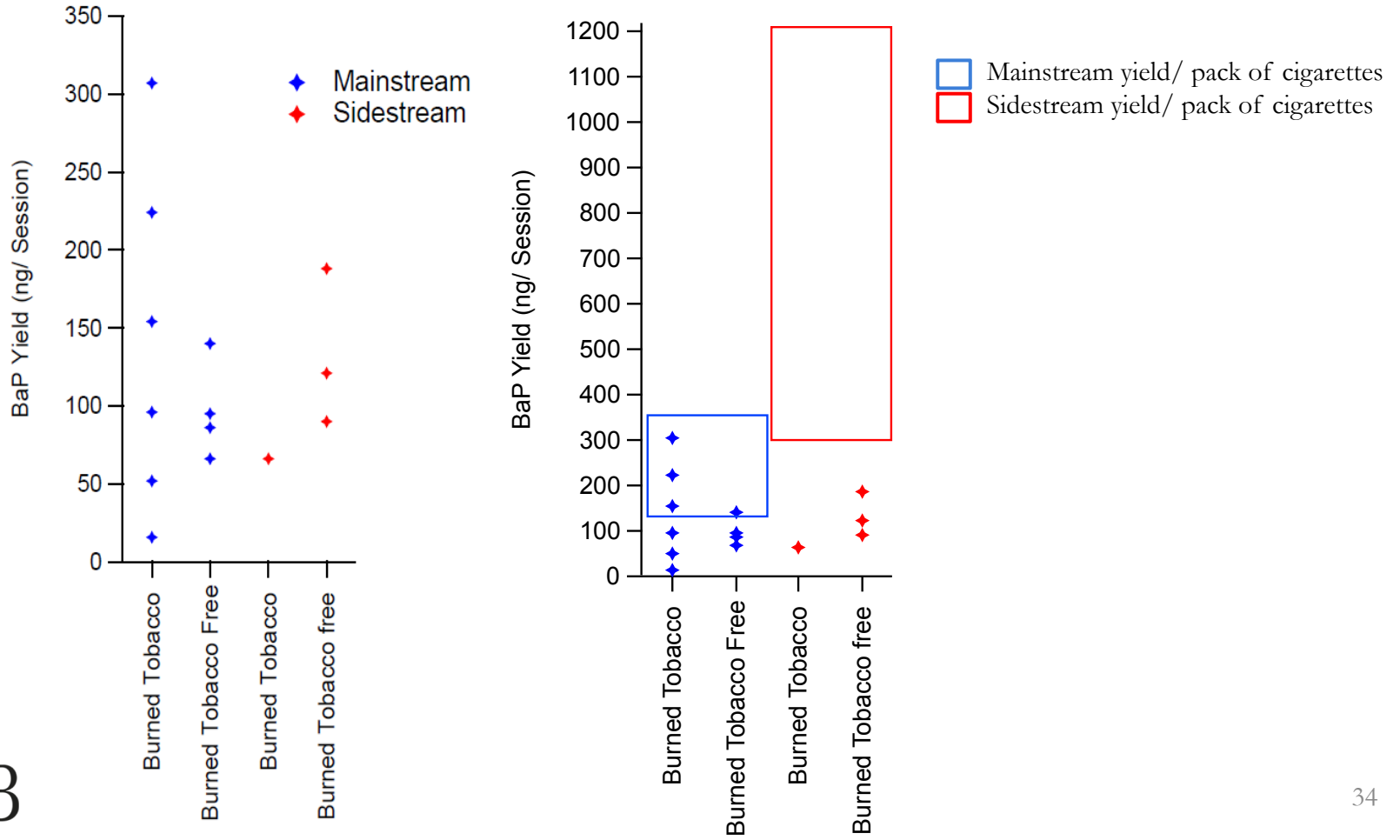


Hammal F et al. 2015. *Tob Control*. 24:290–297

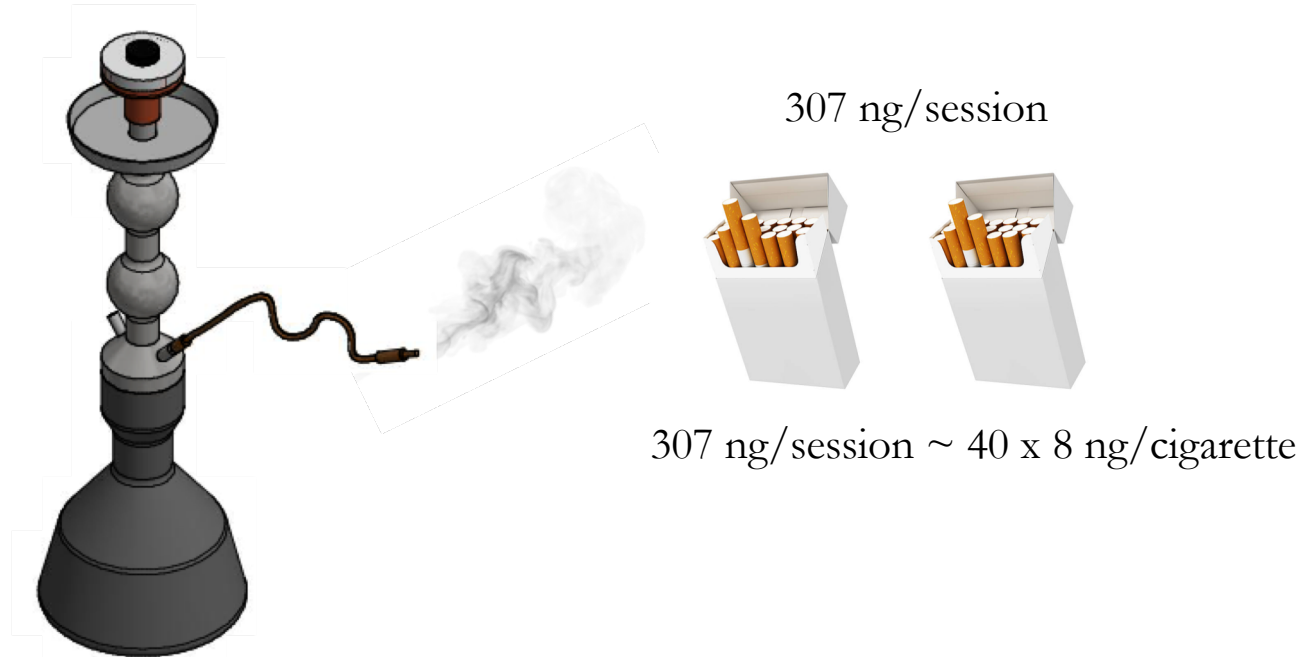
Benzo(a)pyrene yield in raw and burnt charcoal in waterpipe



Benzo(a)pyrene smoke yield in waterpipe



Equivalence of **mainstream** benzo[a]pyrene to cigarette smoke



Equivalence of sidestream benzo[a]pyrene to cigarette smoke

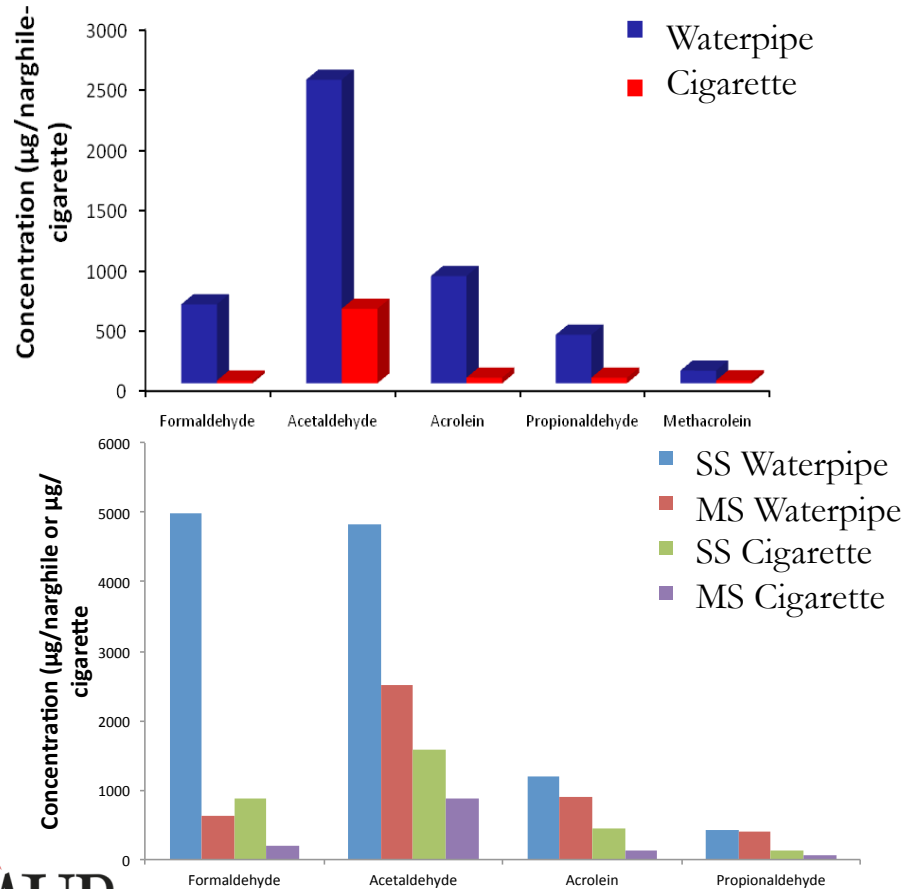


266 ng/session



266 ng/session \sim 4 x 57 ng/cigarette

Aldehyde content in mainstream and sidestream waterpipe smoke



Formaldehyde can make you feel sick if you breathe a lot of it.

People can have symptoms such as:

- sore throat
- cough
- scratchy eyes
- nosebleeds

Equivalence of mainstream TPM, CO, Tar and nicotine to cigarette smoke



Benzo[a]pyrene (BaP):



Aldehydes:



Carbon monoxide (CO):



Tar:



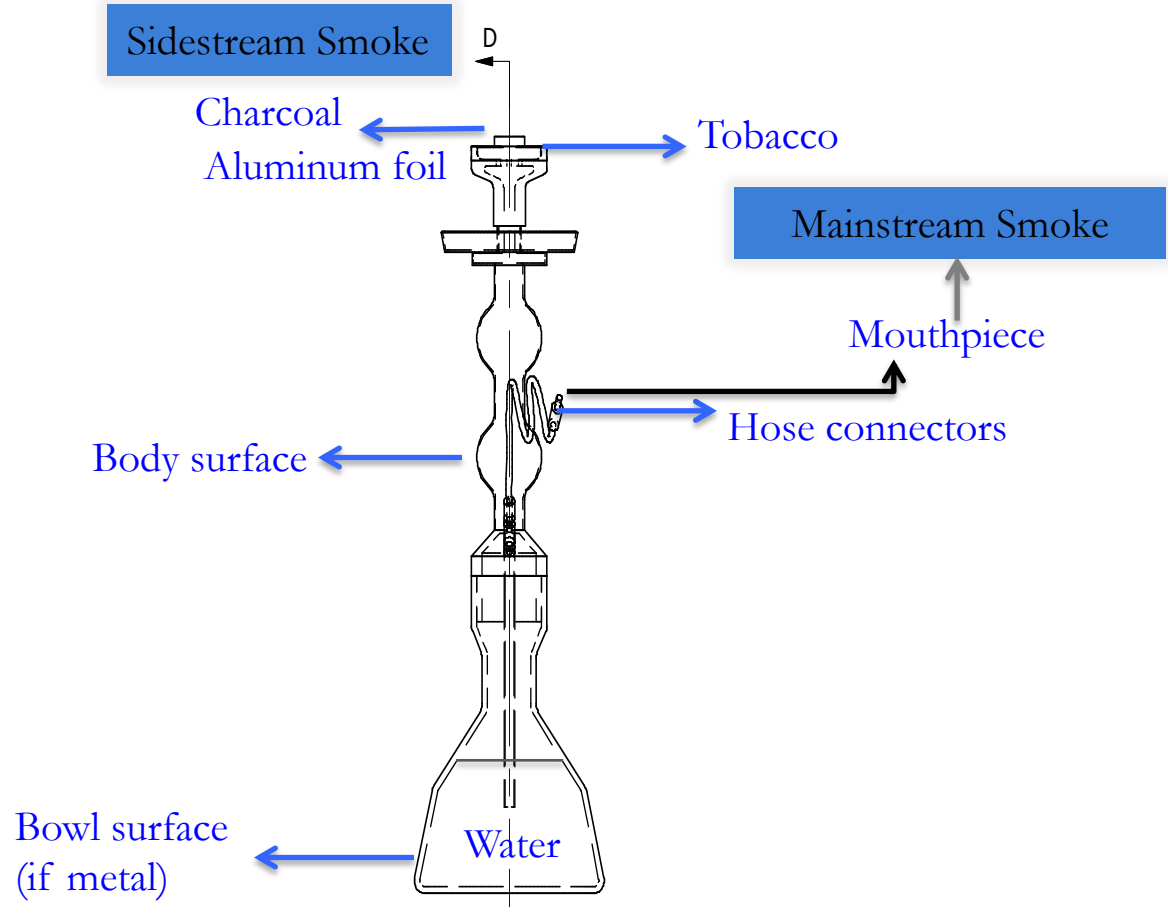
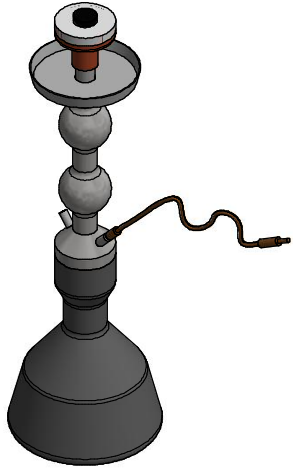
Nicotine:



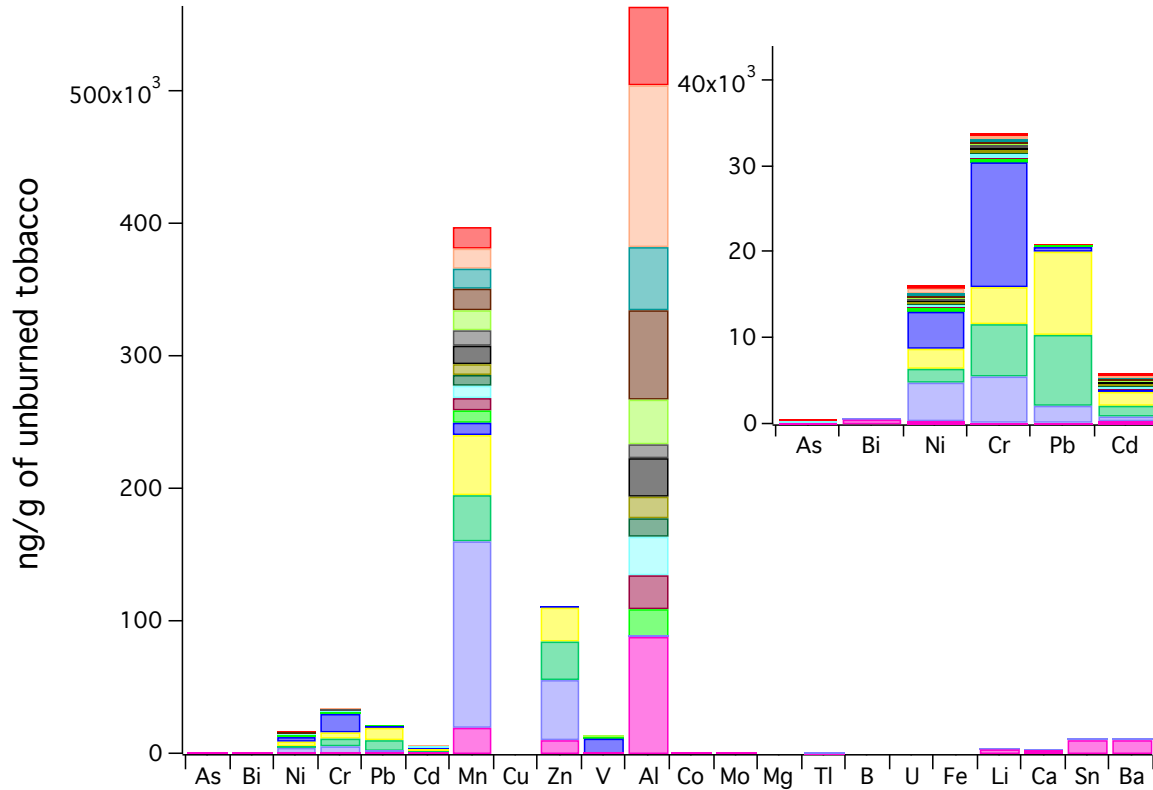
Total Particulate Matter (TPM):



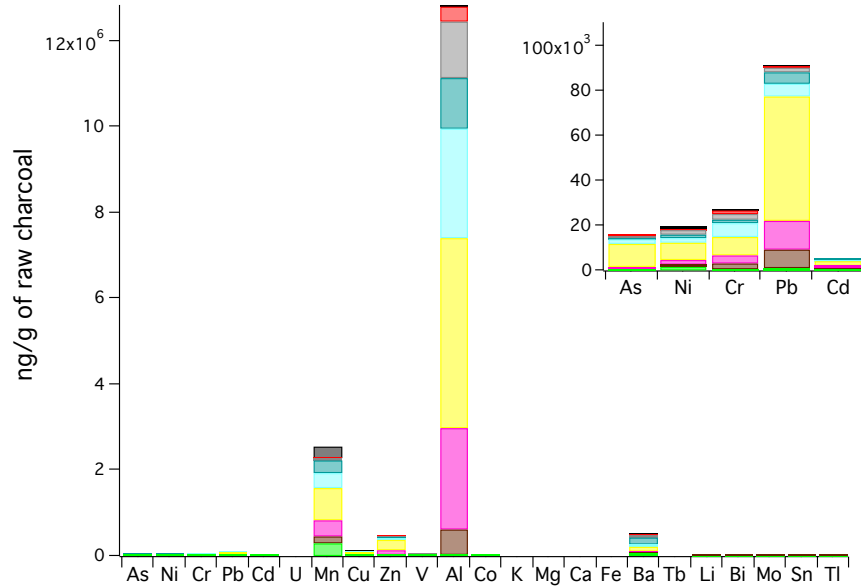
Sources of metals in the waterpipe system



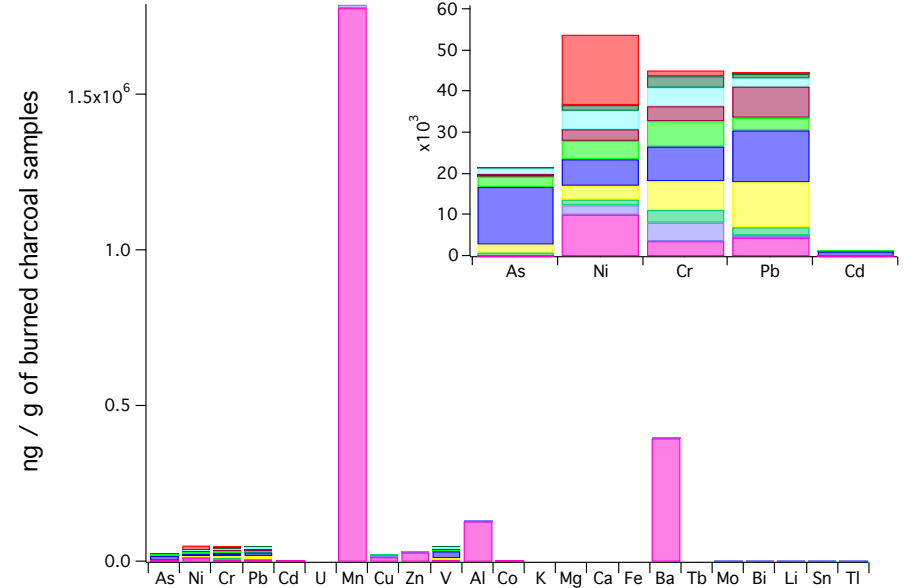
Heavy metals yields in waterpipe smoke: Unburned tobacco products



Heavy metals yields in waterpipe smoke: Raw and burnt charcoal extract

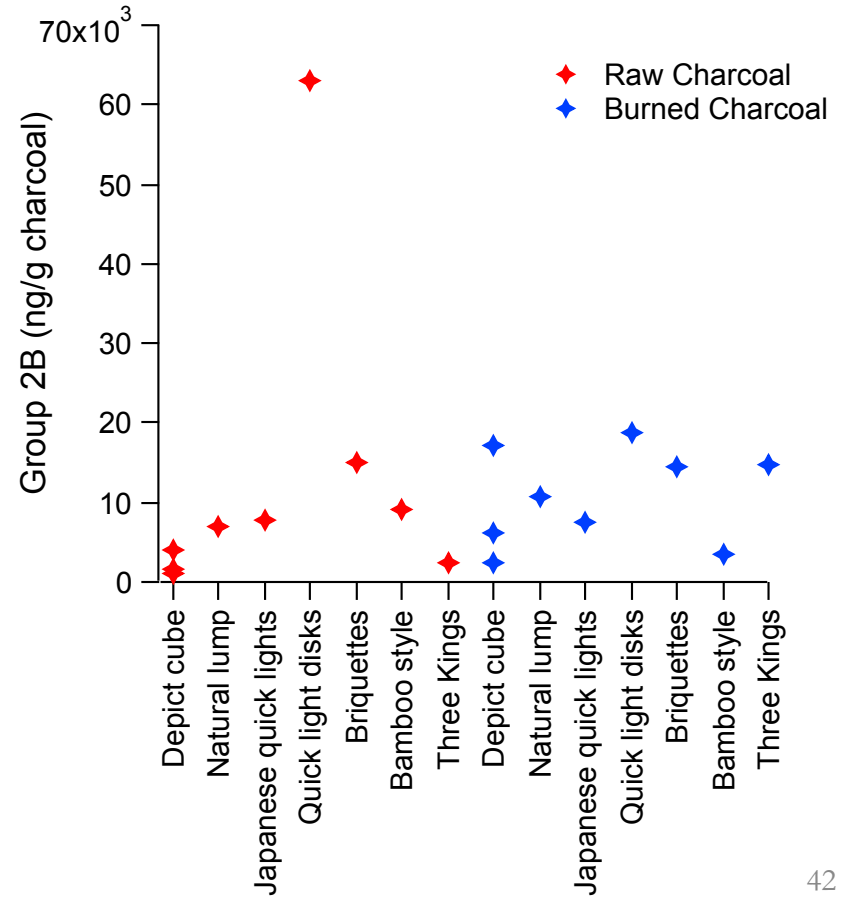
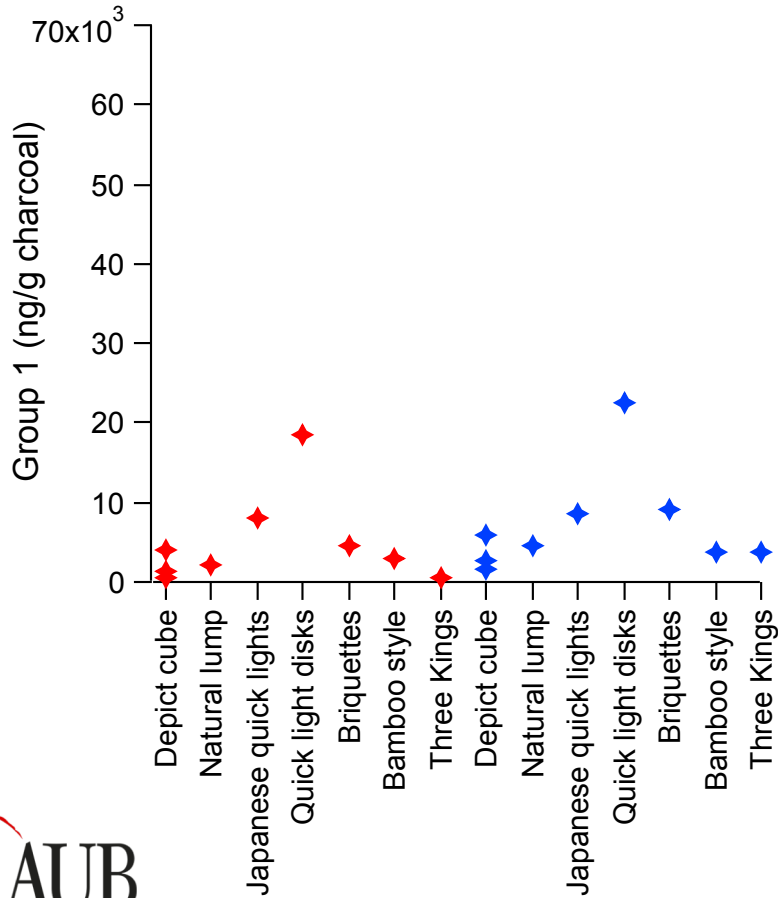


Raw Charcoal

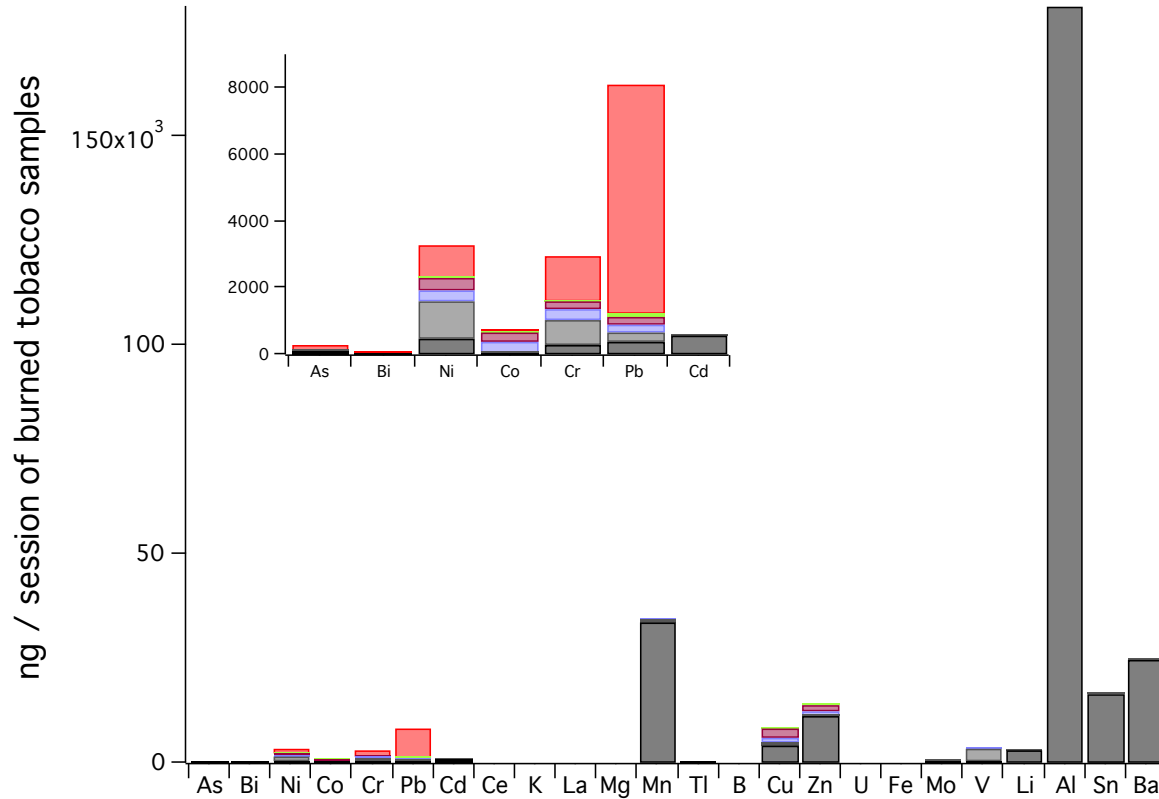


Bruned Charcoal

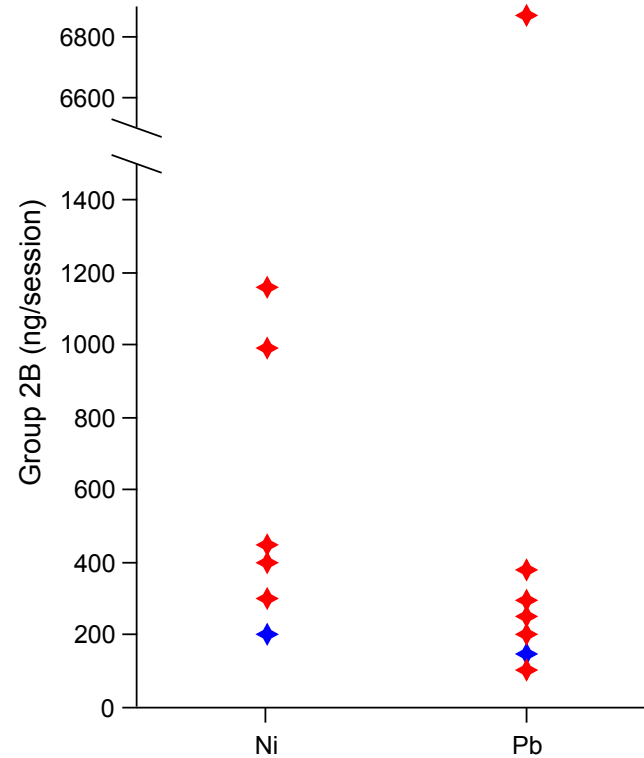
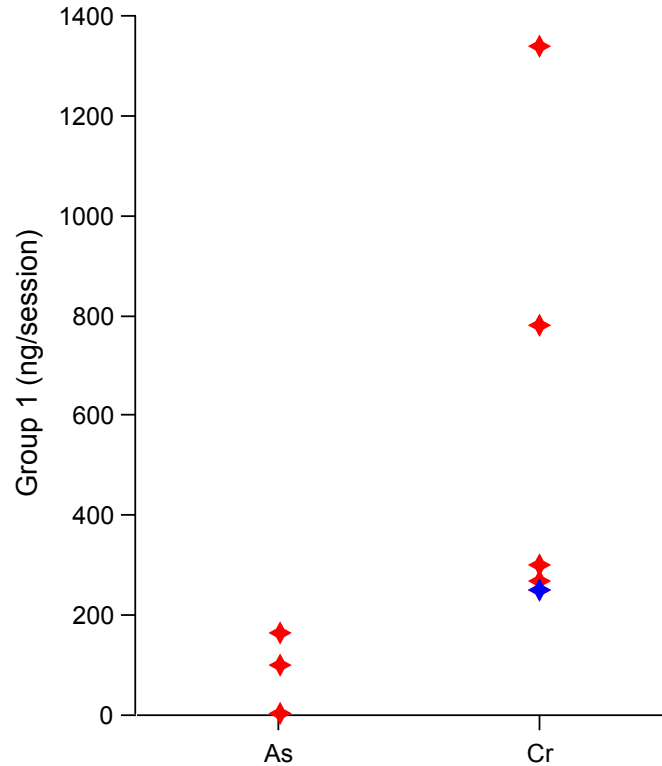
Arsenic, Nickel, Chromium, and Lead yields in waterpipe smoke



Heavy metals yields in mainstream waterpipe smoke: Burned tobacco products



Arsenic, Nickel, Chromium, and Lead yields in waterpipe smoke



PAH studies: feedback and recommendations

Validity of Laboratory Testing

Machine-based methods mimic to a certain extent human exposure. Hence, the laboratory evaluation of smoked tobacco products can be used for regulatory purposes

Hazardous emissions from tobacco and tobacco-free products

Mainstream and side-stream waterpipe tobacco smoke as well as smoke generated via herbal tobacco-free products are hazardous substances

Emissions of type 1A and 2B carcinogens

Hookah and El Wady Charcoals produced significant concentrations of Group 2B PAHs that are possibly carcinogenic to Humans
Public health agencies should regulate smoked charcoal products alongside tobacco

Heavy metals studies feedback and recommendations

Charcoal and metal content

Quick lighting charcoals appear to be the most contaminated with toxic metals

As, Ni, Pb, and Cr which are classified as **Group 1** and **Group 2B** carcinogens, are present in significant concentrations in mainstream water-pipe tobacco/tobacco-free products as well as burned charcoal samples

Future Studies

Further studies are needed regarding radiolabeled elements in water-pipe tobacco leaves, raw charcoal, and burned tobacco products

Advisory note from WHO

In 2005, the World Health Organization (WHO) issued an Advisory Note on Waterpipe Tobacco Smoking

This Advisory Note states:

"waterpipe smokers and second-hand smokers [are] at risks for the same kinds of disease as are caused by cigarette smoking, including cancer, heart disease, respiratory disease, and adverse effects during pregnancy."

And recommends that "waterpipes should be prohibited in public places consistent with bans on cigarette and other forms of tobacco smoking," and that "education...is urgently needed about the risks of waterpipe smoking, including high potential levels of secondhand exposure."



AMERICAN LUNG ASSOCIATION®

Tobacco Policy Trend Alert

AN EMERGING DEADLY TREND: WATERPIPE TOBACCO USE

February 2007

In the last few years, new popularity for an old form of tobacco use has been gaining ground within this already susceptible group. Waterpipes (also known as hookahs) are the first new tobacco trend of the 21st century.

This Trend Alert looks at the emerging waterpipe tobacco use trend and the widespread misperceptions that exist about its use.

Existing evidence on waterpipe smoking shows that it carries many of the same health risks and has been linked to many of the same diseases caused by cigarette smoking. Access to this “new” form of tobacco use continues to grow, especially in hookah cafes targeting 18-to-24-year olds.

The tobacco control community must educate the public about the potential dangers of the growing waterpipe trend.

Regulation on Indoor Smoking, Lebanon

الجريدة الرسمية - العدد ٤١ - ٢٠١١/٩/٣

٣٣٨٢

جدول رقم ٥

تحويل سلسلة رواتب القضاة المتخرجين

الراتب الجديد المحكوك	قيمة الدرجة الحالية	قيمة الدرجة الجديدة	الراتب الحالي	
١,٧٠٠,٠٠٠	١٥٠,٠٠٠	٥٣,٠٠٠	١,٠٠٠,٠٠٠	سنة أولى
١,٨٥٠,٠٠٠	١٥٠,٠٠٠	٥٣,٠٠٠	١,٠٥٣,٠٠٠	سنة ثانية
٢,٠٠٠,٠٠٠	١٥٠,٠٠٠	٥٣,٠٠٠	١,١٠٦,٠٠٠	سنة ثالثة

قانون رقم ١٧٤

الحد من التدخين وتنظيم صنع وتغليف وبيع منتجات التبغ

أقر مجلس النواب،

ويشتر رئيس الجمهورية القانون التالي نصه:

الفصل الأول، في التعريفات

المادة الأولى، في التعريفات والمصطلحات

تعتبر جميع التعريفات والمصطلحات التالية واجبة الاعتماد على وجه الحصر من أجل تفسير وتطبيق جميع أحكام هذا القانون.

اللولؤزم والمكملات، منتج يمكن أن يستعمل لاستهلاك أحد منتجات التبغ لا سيما قسيمة، غليون، نرجيلة، ميسم، أداة لقطع السجائر، كبريت أو قنادحة.

بائع بالمعقوف، شخص يستمر مؤسسة تعنى بشكل كامل أو جزئي ببيع منتجات التبغ الى المستهلك مباشرة.

المستورد، هو كل شخص يقوم باستيراد وتوزيع وبيع بالجملة أي منتج من التبغ.

تزويد، بيع، عرض للبيع، إعاره، تسليم، اعطاء، إرسال الى الغير مجاناً أو لقاء عرض، أو مقايضة بمنتج أو خدمة.

قاصر، هو الشخص الطبيعي الذي لم يبلغ الثامنة عشرة من عمره.

منتج التبغ، منتج مصنوع من التبغ أو التنباك وبدائل التبغ، ويشمل أيضاً الأوراق وخلصه الأوراق كالانابيب والورق ومرشح السجارة.

بدائل التبغ، الأدوات التي تعمل على الكهرياء وخالقها وغالباً ما تحوي على النيكوتين والمنكهات أو غيرها من المواد الكيميائية التي تتحول الى بخار يستنشقه المدخن، وجميع الأدوات التي توجي الى المنتجات التبغية، بما في ذلك النرجيلة الالكترونية.

الدعاية والإعلانات، الاعلان بصورة مباشرة أو