

Physical and chemical characteristics of water pipe tobaccos

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Abstract. The aim of the study is to determine the main physical and chemical characteristics of water pipe (hookah) tobacco mixtures sold on the Bulgarian market. The regarded type of tobacco product focuses researchers' interest due to its specific composition, consumption qualities and increasing popularity, especially among younger people, but the available information on the composition and indicators of hookah tobaccos in Bulgaria is too limited. The content of tobacco shreds (from 31.11% to 77.41%) and moisture (30-40%) in the hookah mixtures were analyzed, as well as the main chemical indicators of tobacco and smoke – total reducing sugars, ash, nicotine, total and dry particulate matter, etc. The nicotine content in three of the five samples tested was extremely low – below 0.12%. The amounts of total particulate matter, TPM (from 377.36 to 427.85 mg/g of burnt tobacco) and dry particulate matter, DPM (from 56.34 to 128.20 mg/g of burnt tobacco) were higher than those in cigarette smoke. The obtained results expand the knowledge about this non-traditional for Bulgaria, but increasingly popular tobacco product.

1 Introduction

One of the first documented ways of consuming tobacco is by using a water pipe. In different parts of the world it is also known as shisha, hookah, hubble-bubble, argilah, nargilah, goza, and other names. Hookah smoking is typical for the countries of the Middle East, India and North Africa, but, after 1990, an increase in the number of water pipe smokers has been reported in the countries of Europe and America, especially among the young population. The increase in the consumption of water pipe tobacco is due to several reasons. According to some authors, one of the main reasons is due to its attractiveness, pleasant taste and aroma [1, 2]. Another main reason for smoking hookah is the purely social aspect, as it is most often consumed in the company of family or friends, at home or in special "Hookah bars" [1, 2]. Many smokers believe that hookah smoking is more harmless than cigarette smoking because the smoke is passes through the water and filters it, and this also leads to an increase in hookah tobacco consumption. On the other hand, adolescents perceive the harm from hookah smoking to be smaller, as a result of the more pleasant smoking properties [1]. In Bulgaria, its use has also marked a serious growth because of the low price. It is more often consumed in public places than at home due to the absence of bans on indoor consumption.

The tobacco mixtures used for hookah smoking are three types: Ajami Tombak, Muassel and Jurak. The three types of water pipe tobaccos differ in their composition and method of consumption. The main component in water pipe mixtures is tobacco. When smoking traditional hookah 'Ajami' tobacco, smokers mix a small amount of water with cut and dried tobacco

to form a sticky mass. Shape into a ball and place in a shallow bowl. The burning charcoal is placed directly on the moist tobacco without the use of aluminum foil [3]. Muassel contains about 30% tobacco and up to 70% honey or molasses/cane sugar, in addition to glycerol and flavoring components. [4]. Jurak is finely ground tobacco leaves, with the addition of molasses and spices. When smoking, the bowl is usually filled completely and the charcoals are placed directly on top of this mixture without foil.

Another component in hookah mixtures is glycerin. It is used for its good moisture-retaining properties, as well as to enhance the flavor and add extra sweetness. In addition, glycerin participates in the production of the aerosol mixture, making it denser and increasing its volume.

In hookah mixtures, flavoring substances are very often added to improve the smoking properties and make the products more attractive to the end user. Various aromatic compositions are used, preferring fruit notes such as: peach, apricot, cherry, forest fruits (strawberry, raspberry, blueberry), citrus (lemon, lime, orange), some exotic fruits - dragon fruit, as well as tropical ones (mango, pineapple, coconut, banana, etc.). There is a wide variety of abstract aromas, such as candy, lemonade, coffee, vanilla, etc. Less common is the aroma of nuts - hazelnut, pistachio, etc.

Research on water pipe tobaccos has focused primarily on the composition of tobacco smoke, in terms of nicotine, tar and CO content and the data on the chemical composition of tobacco mixtures are too few. Mahboub et al [5] examine the amount of nicotine and tar in hookah smoke. The authors found that the amount of nicotine, in ranges from 0.8 to 20.52 mg/g, in the analyzed samples was higher compared to nicotine in

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cigarettes, chewing tobacco and e-cigarettes. Milanova et al. [6, 7] analyzed 5 samples of hookah tobacco regarding its chemical composition, as well as the composition of the produced tobacco smoke. In all five samples, the nicotine content in tobacco mixtures is below 0.1% and no nicotine content was detected in the smoke. Shihadeh studied the amount of tar, moisture and CO in the smoke produced by a single smoking session. The content of tar varies between 242 and 2350 mg per session, the values depending on the smoking method, the amount of moisture in the tar varies between 548 and 1760 mg per session and CO content is between 57,2 and 367 mg per session [8]. Polycyclic aromatic hydrocarbons (benz- α -pyrene, acenaphthylene, anthracene, phenanthrene, pyrene, dibenzo[α]anthracene, fluorene, fluaranthene, benzyl alcohol) [9], furan derivatives [8] and carbonyl compounds (acetaldehyde is the highest, followed by formaldehyde and acetone) [8] were also found in the tobacco smoke.

Different types of hookah mixtures have been studied for heavy metal content [10, 11]. 11 heavy metals were identified in Jurak mixtures, and the results showed that their content was higher than in cigarettes [11].

The available information on the composition and indicators of hookah tobaccos in Bulgaria is too limited.

Therefore, the aim of the study was to determine the main physical and chemical characteristics of water pipe (hookah) tobacco mixtures sold on the Bulgarian market.

2 Materials and methods

2.1 Materials

Five brands of water pipe tobaccos sold legally on the Bulgarian market, in particular "Franklin", "Quiwi Punch", "Grape and Mint", "Bono", and "Yellow Punch" (Holster Tobacco GmbH, Germany), were studied.

2.2. Methods

Water pipe tobaccos were characterized in terms of the following indices:

Physical parameters. Content of tobacco shreds was defined by washing with distilled water, until the glycerin was visibly removed. The mass of the obtained tobacco samples was determined after drying at room temperature and the amount of tobacco was expressed as a percentage of the original sample (%); moisture - by drying at a temperature of 103 ± 2 °C, to a constant mass; particle size of tobacco shreds - by fractional analysis, using sieves with size 2 mm, 1.25 mm and 0.25 mm. [12].

Chemical composition of water pipe tobaccos. The samples were not further processed for the chemical analyses. The main chemical indicators influencing the quality of tobacco are determined: ash - by burning at 550 °C, %; total alkaloids (as nicotine) – by a spectrophotometric method for the determination of

total alkaloids as nicotine, %; total reducing sugars – by Schoorl method, %, proteins - by Lowry method, %; cellulose - by burning with acetic and nitric acid, %; hexane extracts – by double extraction with n-hexane lasting 1 hour and 30 minutes at a temperature of 40°C, % [12].

Amounts of total particulate matter (TPM) and dry particulate matter (DPM) in the smoke. The mass of the sample was 10 g and the volume of water in the body of the water pipe was 600 ml. After smoking, the amount of tobacco burned averaged 4.3 g. TPM was collected on Cambridge filters, with up to 12 filters used for each sample. TPM from 10 puffs was collected on each filter. Smoking was carried out under the following parameters: for 1 min, 3 puffs were made every 20 s, at a puff flow rate of 14.87 cm³ [13], mg/g of burnt tobacco. Moisture in the TPM was determined by drying for 72 hours over silica gel [12].

3 Result and discussion

3.1 Physical characteristics of water pipe tobaccos

The results from the measurements of the physical indices of the studied water pipe tobaccos were presented in Table 1.

Table 1. Physical indices of five brands of water pipe tobaccos

Brands	Index		
	Content of tobacco shreds, %	Content of tobacco shreds > 2 mm, %	Moisture, %
Franklin	77,41	90,66	32,24
Quiwi Punch	73,96	92,51	38,47
Grape & Mint	52,67	83,59	33,84
Bono	44,69	89,5	35,36
Yellow Punch	31,11	92,81	29,08

There were no significant differences between the analyzed brands, with the exception of the tobacco content in the samples. The amount of tobacco was highest in "Franklin" sample - 77.41%, and lowest in the "Yellow Punch" sample - only 31.11%. The obtained values are higher than those cited in the literature for Moassel and Jurak type mixtures [4].

The five samples are characterized by the largest amount of tobacco shreds with sizes > 2 mm, over 80%. Only one of the samples was found to contain dust - 0.15%. From the obtained results, it can be stated that the samples are relatively uniform due to the significantly high percentage of large fraction and the insignificant amount of small fraction, as well as dust, which occurs only in traces.

Unlike most tobacco products on the market, this type is characterized by relatively high moisture (29,08-38,47%), which is partly due to the high percentage of humectants, solvents and flavoring agents. As indicated in the literature [2], the high values of moisture are also

due to the content of glycerin in the samples, which is volatile at temperatures above 92°C.

3.2 Chemical composition of water pipe tobaccos.

The results of chemical composition of the studied water pipe tobaccos are presented in Table 2.

The "Yellow Punch" sample has the highest ash percentage 4.26%, which can be explained by the fact that different types of tobacco are used with different percentages in each individual blend. In the other four samples the ash content was below 3.04 %. The obtained results are lower compared to those reported in the literature [6].

The five analyzed samples were characterized by a low content of total reducing sugars (up to 10%) compared to the typical hookah mixtures in which a high content of honey, molasses, glucose-fructose syrups [4] is indicated. This is most likely due to the lack of added sugars in the mixtures.

Protein content was significantly higher, up to 7.09% in sample "Bono". There was a lack of data on the protein content of hookah tobacco in the literature.

The highest percentage of cellulose was found in the sample "Grape & Mint" -2.03%. It is followed by

Table 2. Chemical composition of five brands of water pipe tobaccos

Index	Brand				
	Franklin	Quiwi Punch	Grape & Mint	Bono	Yellow Punch
Ash %	2,01	3,04	1,95	2,01	4,26
Total reducing sugars, %	6,94	6,26	10,72	8,43	8,32
Proteins, %	4,65	3,51	4,13	7,09	3,89
Cellulose, %	1,83	1,75	2,03	1,78	1,41
Hexane extract, %	0,46	0,21	0,67	0,96	0,84
Nicotine, %	0,12	1,3	0,91	0,01	0,06

Samples show trace amounts of nicotine, namely below 0.1%. The results are also confirmed by the data in the literature [7].

3.3 Amounts of total particulate matter and dry particulate matter.

The amounts of TPM and DPM are presented in Table 3.

Table 3. Amounts of TPM and DPM

Brands	Index	
	TPM, mg/g burnt tobacco	DPM, mg/g burnt tobacco
Franklin	377.36	92.72
Quiwi Punch	404.14	63.60
Grape & Mint	385.43	56.34
Bono	421.69	93.98
Yellow Punch	427.85	128.20

"Franklin" with 1.83%, "Bono" with 1.78%, and "Quiwi Punch" with 1.75%. The lowest content was found in the "Yellow Punch" sample - 1.41%.

The extracted aromatics and other non-polar compounds obtained by the hexane extraction were in relatively low amounts compared to yields from other tobacco products. The highest share is occupied by the "Bono" sample with a content of 0.96%. The content is lower in "Yellow Punch" - 0.84%, "Grape & Mint" - 0.67% and "Franklin" - 0.46%. The lowest yield was found in sample "Quiwi Punch", 0.21%.

Nicotine content was the highest in a sample "Quiwi Punch" - 1.3%, followed by "Grape & Mint" with 0.91%. The nicotine content was extremely low, being below 0.12% in three of the samples, respectively 0.12% in sample "Franklin", 0.06%, in "Yellow Punch" and the sample with the smallest amount was "Bono" - 0.01%. Tobaccos used in water pipe smoking products are characterized by a high nicotine content, but in the samples used, its amount is low. This may be due to blend processing and purposeful reduction of its content. The results confirm the data from previous studies, which also indicated low nicotine levels in water pipe tobaccos [6, 7].

The nicotine content in the tobacco obtained after washing the samples with water was also determined.

The amounts of TPM and DPM were considerably higher than that in cigarette smoke. The highest were the TPM and DPM content in a sample "Yellow Punch" (427.85 mg/g burnt tobacco and 128.20 mg/g burnt tobacco) and the lowest in samples "Franklin" and "Grape & Mint" (385.43 mg/g burnt tobacco and 56.34 mg/g burnt tobacco). The significant difference between the amount of TPM and DPM was due to the high moisture content and the use of humectants in the mixture. High levels of TPM are due to the specific way of consuming the product, but also to the humectants used.

4 Conclusion

The results from the study of five water pipe tobacco brands sold on the Bulgarian market provide grounds for making the following conclusions: i) The physical parameters of the studied hookah tobaccos showed insignificant differences between the brands, with the exception of the tobacco content, which was the biggest

for “Quiwi punch”; ii) There were no significant differences in most of the chemical indicators, but the nicotine content varied from 0.01% (“Bono”) to 1.30% (“Quiwi punch”); iii) Hookah tobaccos produce a smoke with much higher TPM and

DPM concentrations than those in the smoke of conventional cigarettes, which are strictly regulated.

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