Investigation of the technological profile of illegally distributed tobacco derivatives and smoking products

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Abstract. The current investigation includes technological assessment and interpretation of the profile of tobaccos, tobacco derivatives and smoking products illegally distributed in Bulgaria, as officially provided for expertise in the Tobacco and Tobacco Products Institute (TTPI) by external contractors (legitimate state structures) in 2021. The physical and chemical properties of the tobacco objects, depending on their nature, were determined according to standardized methods. The biggest share in the analyses (139 in total) took the determination of tobacco cut width (39%) and particle size fractionation (37%), which supported the observation that the illicit tobacco market in Bulgaria is recently dominated by cut tobacco for hand-rolled cigarettes. In the cut tobacco predominated long and medium-sized strands, but in widely varying proportions (42.27-81.78% and 9.98-38.46%, respectively), with cut width in 0.59-1.06 mm range. The sieve analysis and the expert examination of the tobacco derivatives revealed that they were undoubtedly technological tobacco waste, and, respectively, that accentuated data must be communicated to consumers about the risks associated with the smoking of such tobacco articles. It was found that all illicitly traded fine-cut tobacco blends produced considerably higher tar (12.25-16.05 mg/cig) and CO (12.74-16.94 mg/cig) emissions than the limits set for conventional cigarettes.

1 Introduction

The illegal tobacco trade is a global issue, which causes significant revenue losses to the governments and the legal manufacturers, seriously undermines the objectives of tobacco policies by increasing the health risks, and is an important source of profits for the organized crime. It has been estimated that the elimination of illicit tobacco trade can save governments over $31 billion annually, and from 2030 onwards, more than 164,000 premature deaths would be avoided each year, the vast majority of which in middle- and low-income countries [1]. As analyzed by WHO, "*These illicit products are untaxed and unregulated, with no health warnings, packaging or labeling requirements; which makes them cheaper, more readily available and accessible, especially to young and poor people*" [1]. Thus, it is no surprise that the illicit tobacco trade, targeting vulnerable groups in society, undermines the strategies for tobacco control, and, accordingly, sets the vital necessity to both increase consumers' information about the social consequences of the purchase of illegal tobacco products and to put a stronger emphasis on the harmful effects of their consumption [2].

The determination of the scale of illegal cigarette trade usually covers markets with increased or steadily increasing excise duties, but a survey of adult cigarette smokers in California, under stable prices and taxes over years, shows that many smokers, knowingly or not, from all segments of society, participate in the illicit market for these products, complicating efforts to reduce illicit trade [3].

The EU member countries consume over 40 billion illicit cigarettes annually that originate from nearly 130 countries on five continents [4]. Most of them are smuggled from countries outside the EU, with low cigarette prices and weaknesses in law enforcement, control and regulation systems. Due to the undisputed harmful and negative consequences of the illicit tobacco trade, the EU and all member states has made the struggle against it a major priority [5]. A greater share of counterfeit cigarettes on the tobacco market is observed in the East European countries, mostly due to their low prices and affordability [6, 7]. The Balkan route is a historical contraband corridor, and the illicit tobacco trade has flourished in the period of transition and conflicts at the end of the 20th century [8]. A survey on the determinants of illegal tobacco consumption in the Western Balkans region concludes that the consumers of

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hand-made cigarettes are more willing to smoke illegal tobacco than those used to buy legally manufactured and sold cigarettes [9]. On the other hand, the analysis of consumer attitudes in the same region revealed good public awareness about the negative aspects of the grey tobacco market. The higher levels of illicit trade in Western Balkan countries compared to the more developed EU members are believed to be a consequence of underdeveloped institutional frameworks, suspended rule of law and heavy taxation of tobacco products [10]. According to a report, which analyzes the economic and other effects of the illegal market of roll-your-own tobacco in Bulgaria in the period 2007-2017, there is a startling dominance of the illicit trade, being about 75% of the RYO tobacco market in the country [11]. Bulk tobacco, mostly of local origin, dominates the illegal distribution, while legal trade in the period deals with fine-cut tobacco brands. Another analysis, based on a review of Bulgarian media materials published between 2010 and 2019 examines the reasons for the record decline in illegal cigarette sales in the country [12]. It indicates that the effective cooperation between the various interested parties in the country and abroad after the accession of Bulgaria to the EU and the implementation of the legal and economic measures has led to a significant reduction of losses from state taxes. The need for analysis based on elaborate data sources, a comprehensive research approach and activities carried out by independent research teams is also emphasized.

The multidimensional negative effects and the factors influencing the unregulated trade in tobacco, as one of the greatest contemporary global challenges, are the subject of serious research interest [4, 8-10, 13-19].

Expertise and technological analysis related to the black market of tobacco, tobacco derivatives and smoking products in Bulgaria have been provided by the experts at the Tobacco and Tobacco Products Institute (TTPI), a research unit in the structure of the national Agricultural Academy, since 2007. Those expert opinions and assessments have been targeted mostly at the compliance of the respective illicit tobacco items with the current regulatory framework in the tobacco sector. However, very limited research data are available on the structure of illicit tobacco trade in the country and the specific properties of the distributed products, which could reveal better the potential health risks of their consumption. A study conducted in 2014 on different tobaccos for hand-rolled cigarettes (roll-your-own, RYO tobacco) distributed in Bulgaria concluded that such tobaccos are primarily constituted of the technological waste in tobacco processing, i.e. “small-size scrap” and “fines” fractions combined [20]. Another study [21] found alarmingly higher smoke emissions in illicit RYO tobacco blends in Bulgaria, compared to the threshold levels applied for legally manufactured and traded cigarettes: nicotine, 1.23-1.35 mg/cig; tar 19.12-20.54 mg/cig; carbon oxide (CO), 12.06-15.22 mg/cig. Furthermore, the study emphasized that a large part of the RYO tobaccos on the black market was not professionally prepared for human consumption and, thus, could pose extremely high risks to people’s health. A recent analysis of the microbiome status of illicit RYO tobaccos identified potential risk in terms of sanitation and health aspects from the presence of opportunistic and pathogenic microorganisms [22].

Therefore, the current investigation aims at the technological assessment and interpretation of the profile of tobacco derivatives and smoking products illegally distributed in Bulgaria.

2 Materials and methods

2.1 Tobacco materials

The study was performed on illicit tobacco derivatives and smoking products, as officially provided for expertise in the Tobacco and Tobacco Products Institute (TTPI) by external contractors (legitimate state structures) in 2021. The total number of the analyzed laboratory samples of illegal tobacco items in 2021 was 67, distributed as follows:

- Technological waste from tobacco processing (small-sized scrap and fines) – 7 samples;
- Fine-cut (shredded) tobacco – 52 samples;
- Cigarettes – 8 samples (one of them – hand-rolled).

The selected laboratory samples discussed below were coded as follows: from No 1 to No 10 – fine-cut tobaccos; from No 11 to No 7 – tobacco derivatives; and from No 18 to No 24 – machine-made cigarettes.

As “tobacco” derivatives” in this study are considered products made from tobacco leaf waste and by-products (small-sized scrap and fines), which are intended to be smoked.

2.2 Methods of analysis

Standardized methods (by the Bulgarian Institute for Standardization, BDS, and the International Organization for Standardization, ISO) were applied to determine the respective physical, chemical and sensory indices of the tobacco samples, as follows:

- Cut tobacco particle size (%) – BDS 8026:1988;
- Tobacco cut width (mm) – BDS 12973:1975;
- Sieve analysis (%) – BDS 8391:1985;
- Moisture content (%) – BDS 8025:1984;
- Nicotine (%) – ISO 15152:2003;
- Reducing sugars (%) – ISO 15154:2003;
- Total nitrogen (%) – BDS 15836:1988;
- Clorine (as chlorides, %) – SEAL Analytical Method No G-267-01, revision 4;
- Nicotine (mg/cig) – ISO 3400:1997;
- Tar (mg/cig) – ISO 4387:2000, ISO 10362-2:1994, and ISO 3308:2000;

- Carbon oxide, CO (mg/cig) – ISO 8454:2007;
- Smoking properties (by degustation) – BDS 8389:1985.

3 Results and discussion

The illicit tobacco samples (n=67) constituting the pool of 2021 were analyzed in terms of those indices, which were considered adequate (applicable, informative, and decisive) according to the type of the tobacco material, as follows:

- *Small-sized scrap and fines* – sieve analysis;
- *Fine-cut (shredded) tobacco* – particle size fractionation, tobacco cut width, chemical composition of tobacco and tobacco smoke, and smoking properties;
- *Cigarettes* – moisture content, tobacco cut width, and smoking properties.

The total number of conducted analyses was 139 and their frequency, by type, is presented on Fig. 1.

Fig. 1. Frequency of analyses, by type, of illicit tobacco samples in 2021 (total number of samples – 67; total number of analyses – 139)

The summarized data demonstrated that tobacco cut width and particle size fractionation analysis took noticeably higher shares, 39% and 37%, respectively, compared to the rest of the relevant analyses. The higher frequency of those exact types of analysis confirmed the tendency already observed in 2020 [23] for an increasing distribution of fine-cut tobacco intended for hand-rolled or hand-filled cigarettes, preferred by the consumers as a cheaper and more affordable smoking product [23]. Moisture content (applied in the assessment of counterfeit cigarettes) and sieve analysis (applied in the assessment of tobacco derivatives; scrap and fines) had the lowest frequency among the required analyses. The continued, albeit reduced, detection of illicit tobaccos from the "small-size scrap/fines" category, illegally marketed as tobacco products, raises the question of consumer awareness about the risks related to smoking and exposure to such waste materials. It should be clearly emphasized that the discussions in this study are based only on the results obtained from the assessment of the illicit tobacco objects provided in the TTPI alone, and not in the other officially assigned national institutions. Still, they comply with previous observations that the illegal market of tobacco products in Bulgaria is dominated by fine-cut tobacco, at the expense of small-sized scrap and counterfeit cigarettes [12].

Fig. 2 illustrates the data acquired for the distribution of standard particle size fractions in the sieve analysis of the samples of illegally sold tobacco derivatives commissioned by different authorities (No 11 – No 17; n=7).

Fig. 2. Particle size distribution (%, by weight) in the sieve analysis of seven illicit tobacco derivatives

The conclusion from the expert examination of the contents of the tobacco objects was that they combined small pieces of leaf lamina, unprocessed tobacco stems, non-tobacco particles and inert materials.

The particle size distribution shown on Fig. 2 revealed that neither of the analyzed illicit tobacco samples contained the largest fraction retained on 10 × 10 mm mesh sieve (Fraction I). The share of particles collected on a 3.15 × 3.15 mm sieve (Fraction II) was also low, from 0.22% in sample No 13 to 16.64% in sample No 12. Smaller-size fractions varied more substantially between the tobacco samples: Fraction III (over 2 × 2 mm) from 15.75% in sample No 13 to 39.56% in sample No 12; Fraction IV (over 1.0 × 1.0 mm) from 38.33% to 63.58%, and Fraction V (over 0.4 × 0.4 mm) from 4.85% to 21.66%. The dust fraction (Fraction VI) comprised between 0.71% (sample No 11) and 16.63% (sample No 16) of tobacco weight. The results from the sieve fractionation suggested that every one of the illegally distributed tobacco derivatives contained mostly small-sized particles, with dimensions below 2 mm, which constituted over 80% of tobacco weight in sample No 12 and over 90% in the rest of the samples. The performance of the representative samples, No 11 – No 17, in the sieve analysis undoubtedly classified the regarded illicit tobacco objects as "small-sized scrap/fines/dust", being, respectively, a material not suitable for marketing as a "tobacco product" according to the legal definition.

The results from the determination of tobacco particle size fractionation (Fractions I – IV) in 10 representative

samples of fine-cut tobacco blends from different contractors are presented on Fig. 3.

By visual assessment, the tobacco blends were found to combine tobacco strands of different length, non-expanded cut stems and single small pieces of leaf lamina, and were further characterized as approximating flue-cured Virginia tobacco blends.

Fig. 3. Cut tobacco particle size fractions (%, by weight) in ten illicit fine-cut tobacco blends

The results showed that the long strand fraction (Fraction I, retained over 2 × 2 mm mesh screen) predominated in all fine-cut tobacco blends analyzed, with the partial exception of samples No 2 and No 5, in which the differentiation from the next particle size fraction (Fraction II) was not as pronounced. The variation in the content of the largest strands between the blends, however, was in a very wide range – from 42.27% (sample No 2) to over 81% (samples No 1 and No 9). The portion of middle-sized strands (retained on a 1.0 mm screen, Fraction II) varied from 9.98% (sample No 1) to 38.46% (sample No 5). The short strands fraction (over 0.4 × 0.4 mm screen size; Fraction III) constituted between 1.81% (Sample No 9) and 17.46% (sample No 2) of blends' weight. The smallest share in all samples took the fraction defined as dust/fines (Fraction IV), from 1.00% in sample No 10 to 2.28% in sample No 3. The results from the particle size fractionation analysis substantiated the assumption that it would be possible, from a technological point of view, to complete a machine-rolled or a hand-rolled cigarette with consumer-acceptable design from the material contained in the illicit fine-cut tobacco blends.

The data for tobacco cut width (mm) in the same samples of fine-cut tobacco blends are presented on Fig. 4.

As seen from Fig. 4, the analyzed illicit objects had tobacco cut width from 0.59 mm in sample No 5 to 1.05 mm and 1.06 mm, respectively, in samples No 9 and No 7. The registered value range could be accepted as close enough to the typical tobacco cut width in legally marketed blends for make-your-own or roll-your-own cigarettes.

Fig. 4. Tobacco cut width (mm) in ten illicit fine-cut tobacco blends

Table 1 presents the data about the chemical indices of six fine-cut tobacco blends for hand-rolled cigarettes, selected from the 2021 pool of illicit tobacco products.

Nicotine content in the examined fine-cut tobacco blends varied in a relatively narrow range, between 0.89% in sample No 3 and 1.34% in sample No 5. Regarding the specific index, the results suggested a greater uniformity in the illicit tobacco category when compared to the very wide deviations in the nicotine contents found in similar fine-cut tobacco blends in 2020 (1.18-3.02%) [23]. More significant variations between the samples were found in the content of reducing sugars – from 13.40% in samples No 2 and No 5 to 19.40% in sample No 3. Differences in a comparatively narrow

range were found with regard to the content of total nitrogen (1.22-1.63%) and chlorine (0.75-0.95%).

Table 1. Indices of the chemical composition of tobacco and tobacco smoke in six illicit fine-cut tobacco blends

No	Index						
	Tobacco, %				Tobacco smoke, mg/cig		
	Nic[1)]	RS[2)]	TN[3)]	Cl	Nic	Tar	CO
1	1.08	16.00	1.48	0.95	1.00	12.25	12.74
2	1.15	13.40	1.63	0.84	1.08	14.09	13.24
3	0.89	19.40	1.57	0.87	0.90	14.22	12.90
4	0.94	18.13	1.22	0.76	0.93	16.05	16.03
5	1.34	13.40	1.57	0.75	1.23	15.19	15.27
6	1.08	15.30	1.57	0.75	1.21	15.70	16.94

[1)] Nicotine content; [2)] Reducing sugars content; [3)] Total nitrogen content

The highest nicotine level was registered in the smoke of samples No 5 and No 6 (1.23 mg/cig and 1.21 mg/cig, respectively), and the lowest – in samples No 3 and No 4 (0.90-0.93 mg/cig). Tar content in cigarette smoke took values from 12.25 mg/cig (sample No 1) to 16.05 mg/cig (sample No 4), while the remaining samples were with medium tar concentrations. Carbon oxide (CO) smoke emissions varied more substantially between the blends – from 12.74 mg/cig (sample No 1) to 16.94 mg/cig (sample No 6). The analysis of the results for the tar and CO contents in the smoke of all tested samples showed significantly higher values than the normatively accepted limits (10 mg/cig) for these indicators in factory-manufactured cigarettes. With regard to nicotine, higher than the standard content (1 mg/cig) was recorded only in samples No 5 and No 6. The results obtained in the present study for the smoke emissions of fine-cut tobacco illicitly distributed in Bulgaria in 2021 support the findings in [21], showing slightly lower levels of tar, and comparable – in terms of nicotine and CO.

The same samples of fine-cut tobacco blends (No 1 – No 10), in the form of laboratory-made non-filtered cigarettes), as well as the counterfeit cigarette brands (with acceptable moisture content, 11-14%; No 19 – No 24), were subjected to smoking analysis (degustation tests), carried out by a five-member smoking panel, who assessed each sample individually in terms of its smoking properties (aroma, taste, strength), using a standard 10-rate scale. The ultimate goal of the expert rating of smoke perceptions was to determine the type of the respective blend (cased, top-flavored or not) and most of all – its overall smoking suitability. As a result from the conducted degustation tests, positive replies to the latter question were obtained for all of the analyzed illicit tobacco products (i.e. the conclusion was that they were suitable for consumption by smoking). All fine-cut tobaccos smoked in the tests were characterized as "non-flavored flue-cured Virginia type". In general, the objects had a sub-average to average level of smoking properties, as follows: aroma – pure, of Virginia tobacco (with sub-medium typicity), pleasant, intensive, dense (from sub-medium to medium expression); taste – associated with sub-medium to medium fullness and richness, sub-medium mouth coating and aftertaste, sub-medium to medium stinging, and mild irritation; strength - sub-medium to medium.

The results from the determination of the moisture content of the counterfeit cigarette brands traded in the regarded time period are presented on Fig. 5.

Fig. 5. Moisture content (%) in seven brands of illicit cigarettes

Six of the analyzed cigarette samples (No 19 to No 24) complied with the standard requirements for the moisture content in commercial cigarettes, from 11% to 14%, while only one of the samples was characterized with a lower moisture value (No 18; 9.57%). As a general observation, the examined samples of illicit cigarettes had moisture contents rather close to the lower end of the acceptable range, thus suggesting a probability of accelerated combustion, irritation and other negative effects at smoking. In addition, the inappropriate storage of illegally distributed cigarettes, as well as their untimely presentation for analysis, obviously changes their condition and prevents the correct reference to the regulatory framework in force in the sector.

4 Conclusions

An expert assessment of the technological profile of tobacco derivatives and smoking products illegally distributed in Bulgaria has been conducted in the study, based on the characteristics of samples appointed for expertise in the Tobacco and Tobacco Products Institute by legitimate state structures in 2021.

The analysis supported the observations that the illicit tobacco market in Bulgaria is recently dominated by fine-cut tobacco for hand-rolled cigarettes.

All illicitly traded fine-cut tobacco blends produced considerably higher tar (12.25-16.05 mg/cig) and CO (12.74-16.94 mg/cig) emissions than the limits set for conventional cigarettes. At the same time, the results from the study suggested the continued, although decreased, illegal marketing of tobacco derivatives from

the "small-sized scrap/fines" category as tobacco products.

Based on the data obtained, it can be concluded that accentuated and evidence-based data must be communicated to consumers about the health risks associated with the smoking of illicit tobacco articles.

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