

Technological characteristics and comparative quality assessment of local and Greek Oriental tobaccos in the Krumovgrad region

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Abstract. The study aimed to perform a comparative assessment of the quality characteristics of local and Greek Oriental tobaccos produced in the Krumovgrad region. Tobaccos of Krumovgrad (varieties “Krumovgrad 90” and “Krumovgrad 58”) and Basma (of Greek origin) ecotypes, grown during the 2019 harvest in five micro-regions, were analyzed. A complex methodology for tobacco quality assessment was applied, including chemical analysis, expert assessment of the leaves and tobacco smoking profile. The results showed a more balanced chemical composition in “Krumovgrad 58” variety (Krumovgrad ecotype) and the tobacco of Greek origin (Basma ecotype), produced in Krumovgrad micro-region. The expert assessment gave an advantage to the local tobaccos of Krumovgrad ecotype, with the exception of “Krumovgrad 58” sample from Zvezdel micro-region. The smoking analysis graded the Basma ecotype tobacco (Krumovgrad micro-region) with the best smoking qualities, followed by the samples representing “Krumovgrad 58” (Strandzhevo) and “Krumovgrad 90” (Baratsi) varieties. The complex assessment through the generalized quality index distinguished the “Krumovgrad 58” variety from Zvezdel, followed by the Basma ecotype tobaccos from Krumovgrad and Pashintsi micro-regions. The results emphasize the need for annual quality examination of Bulgarian Oriental tobaccos and provide valuable information for the strategic management of their varietal structure and market position.

1 Introduction

Despite the persistent efforts to reduce tobacco consumption over the last decades, tobacco has retained its position as one of the most important and extensively cultivated industrial crops worldwide [1-3]. According to FAOSTAT [4], the world production of unmanufactured tobacco in 2023 was 6,023,939 t, showing a slight increase from 5,772,379 t in 2022. Bulgaria is among the top producers of raw tobacco in the EU, with three of the world commercial tobacco types grown in the country – Oriental (Basma and Kabakulak variety groups), Virginia flue-cured and Burley. Oriental tobaccos, in particular, besides economic, have a very strong demographic and social importance for the country. Historically, they have formed as an individual tobacco type with specific morphological, chemical, technological and sensory characteristics precisely in the environmental conditions of the Balkan Peninsula. Moreover, the most recognized and highly aromatic Oriental tobacco varieties are grown in small, fragmented fields in mountainous and semi-mountainous areas, mainly on soils with low humus content and a high degree of erosion, for which there are practically no other suitable agricultural crops [5, 6]. The country has distinct and traditional tobacco-producing regions, each characterized by specific soil,

climate and terrain conditions, resulting in tobacco with certain technological qualities [6]. Oriental tobacco production in Bulgaria recently has been steadily dominated by Krumovgrad ecotype (approximately about 80% of annual production), accompanied by continued demand for the Greek ecotypes Basma and Katerini.

The concept of determining tobacco quality is extremely complex, as it involves technological and consumption-related characteristics (sensory, physical, and chemical), as well as various features in market demand mechanisms. Therefore, tobacco quality is a highly subjective phenomenon that varies depending on the type of product produced and the preferences of the consumers [7]. Sensory properties revealed during smoking (such as aroma and taste) are the crucial attributes that determine consumers' preferences for a particular type of tobacco or tobacco product [8, 9]. Oriental tobaccos are valued worldwide precisely for their outstanding flavour and smoking quality, which, however, strongly depend on the variety and the soil and climatic conditions in the region of production. The annual fluctuations in harvest conditions, i.e. the climatic indices during tobacco cultivation and curing, are also a very important factor in the formation and consistency of the quality level of Oriental tobacco ecotypes [2, 10-14]. Starting in 2008, our team has been

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conducting a comparative technological assessment of Bulgarian and foreign (mainly of Greek origin) tobaccos from each harvest. During this period, no trend for better overall quality of foreign tobaccos compared to those traditionally grown in our country has been found [15, 16]. It has been observed, however, that the difference in the quality of a given tobacco variety is more significant as a result of the harvest compared to the quality of the same variety grown in different regions from the same harvest, especially in higher quality harvests [17, 18].

Therefore, the current study aimed to perform a comparative analysis of the quality characteristics of local and Greek Oriental tobaccos produced in the Krumovgrad region, combining an assessment of tobacco chemical indicators, leaf quality properties and smoking profile.

2 Materials and methods

2.1 Plant material

Bulgarian and Greek Oriental tobaccos produced in the Krumovgrad region were selected as plant materials for the current study. Analysed were tobaccos of Krumovgrad (varieties “Krumovgrad 90” and “Krumovgrad 58”) and Basma (GR) ecotypes, grown during the 2019 harvest in five micro-regions, as follows:

- a) Ecotype Basma (GR) – sub-region Krumovgrad/ micro-region Krumovgrad; sub-region Zvezdel/ micro-region Pashintsi;
- b) Ecotype Krumovgrad – sub-region Krumovgrad/ micro-region Baratsi (variety “Krumovgrad 90”); sub-region Potochnitsa/ micro-region Strandzhevo; sub-region Krumovgrad/ micro-region Krumovgrad; sub-region Zvezdel/ micro-region Zvezdel (variety “Krumovgrad 58”).

The bulk samples of cured tobacco leaves were taken on site from the farmers in the respective micro-region. A subsequent expert grading was performed in order to obtain uniform representative samples, comprised of A-grade leaves from the upper stalk positions. The analytical samples were prepared, as follows: for chemical analysis – by oven-drying (at a temperature not exceeding 40°C) and grinding; for assessment of tobacco leaf properties – by conditioning to 17% moisture content; for cutting (0.7-0.8 mm cut width) and making laboratory cigarettes for the smoking tests – by conditioning to 21% and 12% moisture, respectively.

2.2 Methods

A complex methodology for tobacco quality assessment was applied, including chemical analysis, expert assessment of the leaves and tobacco smoking profile:

- a) *Chemical indicators of leaf tobacco.* Standardized methods were applied, as follows: nicotine, % (according to ISO 15152:2003 [19]); reducing sugars, % (according to ISO 15154:2003 [20]); total nitrogen, % (according to BDS 15836:1988 [21]); ash, % (according to ISO 2817:1999 [22]).

- b) *Chemical indicators of tobacco smoke.* Smoke nicotine and tar contents (mg/cig) were calculated, using the regression models proposed previously [23].

- c) *Tobacco leaf properties.* The assessment was conducted by a 6-member expert panel. The samples (blind) were ranked by each expert in a direct paired-comparison, based on the complex assessment of all leaf sensory properties, associated with Oriental tobacco quality [24]. The final rating from the expert panel was obtained from the ranking coefficient values, in descending order. The unanimity of the individual expert rating orders was evaluated by Kendall’s coefficient of concordance (W), with a limiting value set at 0.50, i.e. the experts’ opinions were considered agreed, at a probability level of 95%, if $W > 0.50$ [25].

- d) *Tobacco smoking profile.* The assessment was performed by degustation of coded non-filtered laboratory cigarettes, in a paired-comparison mode, by a 5-member smoking panel. Sample rating was based on the complex perception of all smoke attributes (aroma, strength, smoothness, desirability, etc.). The statistical processing of the individual results from the smoking tests was the same as the one described above.

- e) *Complex quality evaluation and rating of tobaccos.* Samples were ranked according to tobacco performance in each of the four assessment procedures, with regard to selected quality indicators – nicotine and reducing sugars content, and the ratio between them; tar content; leaf and smoke properties. The respective coefficients of importance were attributed to each indicator in consensus by the expert panel. The approach for obtaining the ranking orders for the chemical indicators was based on the relation to tobacco quality – positive or negative, as follows: *i)* nicotine – the sample with the highest nicotine content was ranked the first and the remaining samples were arranged in descending order; *ii)* reducing sugars – the ranks were assigned relative to the optimal range of 10-16%, accounting for the degree of deviation from that range; *iii)* reducing sugars/nicotine – the ranks, similarly, were assigned relative to the optimal interval of 6.0-10.0, and the degree of deviation from that range; *iv)* tar content – the sample with the minimal value was ranked the first. The ratings obtained by the expert assessment of tobacco leaf properties and tobacco smoking profile were applied as achieved in the respective step. If statistically significant differences were not proven between the samples, they shared the respective ranks (equal mean rank). The final complex quality evaluation and rating of the studied Oriental tobaccos in Krumovgrad region was achieved on the basis of the calculated quality index values.

3 Results and discussion

3.1 Chemical composition of tobacco and tobacco smoke

The results from the determination of the chemical indicators of the studied tobaccos from the Krumovgrad region (ecotypes Basma (GR) and Krumovgrad) are presented in Table 1.

Table 1. Chemical indicators of Oriental tobaccos in Krumovgrad region

Sub-region	Micro-region	Ecotype	Tobacco leaf						Tobacco smoke	
			Nicotine (%)	Reducing sugars (%)	Reducing sugars/ Nicotine	Total N (%)	Total N/ Nic	Ash (%)	Nicotine (mg/cig)	Tar (mg/cig)
Zvezdel	Pashintsi	Basma (GR)	0.96	15.20	15.83	2.03	2.11	10.22	0.83	23.26
Krumovgrad	Krumovgrad	Basma (GR)	1.21	12.20	10.08	3.63	3.00	13.51	1.04	17.28
Krumovgrad	Baratsi	Krumovgrad	1.03	16.30	15.83	2.28	2.21	10.12	0.88	19.52
Potochnitsa	Strandzhevo	Krumovgrad	0.78	16.20	20.77	2.14	2.74	9.75	0.69	24.42
Krumovgrad	Krumovgrad	Krumovgrad	1.90	17.80	9.37	2.04	1.07	7.58	1.72	27.39
Zvezdel	Zvezdel	Krumovgrad	2.28	10.20	4.47	3.61	1.58	9.97	2.16	19.14

The highest nicotine content among the studied tobaccos characterized the “Krumovgrad 58” variety from Zvezdel sub-region – 2.28%, followed by the same variety from Krumovgrad sub-region – 1.90%, and the lowest – the one from Potochnitsa sub-region (0.78%). The tobaccos from the Basma (GR) ecotype showed a relatively low nicotine content, 0.96% and 1.21%, respectively.

The lowest content of reducing sugars was recorded in “Krumovgrad 58” variety from Zvezdel micro-region (10.20%), and the highest – in the same variety from the Krumovgrad micro-region, 17.80%. The remaining tobaccos tested had intermediate reducing sugar levels, in the range 15.20-16.30%. The results showed that the sugar content in all samples was compliant with the typical values referenced for high-quality Oriental tobacco, 10-18% [26].

The balance ratio between reducing sugars and nicotine is indicative of tobacco smoke strength, smoothness and flavor. Its optimal values for bright tobaccos should be within the range 6.0-10.0, while lower or higher ratio values result in either excessive harshness, strength and aggressiveness, or irritation, stinging and lack of flavor, respectively [26, 27]. The results indicated a more balanced reducing sugars/nicotine ratio only in “Krumovgrad 58” variety from Krumovgrad micro-region and the Greek Basma from the same micro-region (9.37 and 10.08, respectively). The lowest, highly imbalanced ratio value (4.47) was found in “Krumovgrad 58” variety from Zvezdel sub-region (the sample with the highest nicotine content and the lowest reducing sugars content). Respectively, the highest ratio value (20.77) was observed in Krumovgrad tobacco from Strandzhevo micro-region (the sample with the lowest nicotine content).

The lowest total content of nitrogenous compounds was found in the sample of Basma (GR) ecotype (from micro-region Pashintsi) - 2.03%, and the highest – in the tobacco of the same ecotype from micro-region Krumovgrad (3.63%) and in that of Krumovgrad ecotype from micro-region Zvezdel (3.61%). The remaining samples had total nitrogen levels insignificantly deviating from the lower limit of index variation (2.04-2.28%). The data showed that in all tobaccos the total nitrogen content was very balanced,

and consistent with the desired levels typical for quality Oriental tobacco (2-3%) [26]. Those findings corresponded very well with the second index applied for predictive evaluation of tobacco taste balance, the total nitrogen-to-nicotine ratio [27]. The data show that in two of the samples the values of the index corresponded to the most favourable range, about 1.5 (the samples representing Krumovgrad ecotype tobacco from micro-regions Krumovgrad and Zvezdel); nevertheless, in all other samples the taste balance number values were also within the usual range of index variation, 1.0-3.0.

With regard to mineral matter, the lowest ash content was associated with “Krumovgrad 58” variety from micro-region Krumovgrad, and the highest – with the Greek Basma produced in the same micro-region (7.58% and 13.51%, respectively), while the rest of the samples had practically identical ash contents (9.75-10.22%). The data were fully compliant with the typical range of ash content in the leaves of quality Oriental tobacco, 9-14% [26].

The determined smoke nicotine levels in the samples changed similarly to the leaf nicotine content; therefore, the observations regarding the nicotine content in tobacco leaf were also valid for smoke nicotine variation, ranging from 0.69 mg/cig in the tobacco from Strandzhevo micro-region to 2.16 mg/cig in that from Zvezdel micro-region (both tobaccos representing Krumovgrad ecotype). The highest tar content was recorded for “Krumovgrad 58” variety from Krumovgrad micro-region (27.39 mg/cig), and the lowest – for the sample of Greek Basma ecotype from the same micro-region (17.28 mg/cig).

3.2 Rating of the Oriental tobaccos by expert assessment of tobacco leaf properties

The results obtained from the expert assessment of tobacco leaf visual and other sensory properties and the resultant rating order are presented in Table 2.

Table 2. Rating of the Oriental tobaccos by expert assessment of tobacco leaf properties

Expert No	Basma (GR)		Krumovgrad			
	Zvezdel	Krumovgrad	Krumovgrad	Potochnitsa	Krumovgrad	Zvezdel
	Pashintsi	Krumovgrad	Baratsi	Strandzhevo	Krumovgrad	Zvezdel
1	4	5	3	2	1	6
2	4	5	3	2	1	6
3	3	5	4	1	2	6
4	3	5	4	1	2	6
5	4	5	3	2	1	6
6	4	5	3	2	1	6
$\sum X_{ij}$	22	30	20	10	8	36
<i>Relative ranking coefficient</i>	0.17	0.24	0.16	0.08	0.06	0.29
<i>Ranking coefficient</i>	0.36	0.27	0.40	0.80	1.00	0.22
Rating	4	5	3	2	1	6

In the comparison of the tobaccos produced in the Krumovgrad region by leaf quality indicators (Table 2), the best assessment was awarded to the “Krumovgrad 58” variety produced in the Krumovgrad micro-region, followed by the same variety from Strandzhevo, and in the corresponding order – by “Krumovgrad 90” variety from Baratsi micro-region, the Greek Basma from Pashintsi and Krumovgrad micro-regions, and finally – “Krumovgrad 58” variety from Zvezdel.

The reliability of the assessment and expert rating was statistically proven ($W=0.95$; probability level 95%), thus indicating that experts’ decisions agreed well

and the differences between the samples were reliably distinguishable.

3.3 Rating of the Oriental tobaccos by expert assessment of tobacco smoking profile

The data from the smoking evaluation of the tobaccos from Greek Basma and Krumovgrad ecotypes produced in the Krumovgrad region (Table 3) also showed significant (reliable) differences between them ($W=0.80$; probability level 95%).

Table 3. Rating of the Oriental tobaccos by expert assessment of tobacco smoking profile

Expert No	Basma (GR)		Krumovgrad			
	Zvezdel	Krumovgrad	Krumovgrad	Potochnitsa	Krumovgrad	Zvezdel
	Pashintsi	Krumovgrad	Baratsi	Strandzhevo	Krumovgrad	Zvezdel
1	6	1	3	2	5	4
2	6	1	4	2	4	4
3	6	3	1	2	5	4
4	5.5	1	3.5	2	5.5	3.5
5	6	3	1	2	5	4
$\sum X_{ij}$	29.5	9	12.5	10	24.5	19.5
<i>Relative ranking coefficient</i>	0.28	0.09	0.12	0.10	0.23	0.19
<i>Ranking coefficient</i>	0.31	1	0.72	0.90	0.37	0.46
Rating	6	1	3	2	5	4

The sample with the best rating in terms of smoke perception was that representing Basma (GR) ecotype from Krumovgrad micro-region, followed by “Krumovgrad 58” (Strandzhevo) and “Krumovgrad 90” (Baratsi) varieties, after which, in the corresponding order, were rated the tobaccos of ecotype Krumovgrad (from Zvezdel and Krumovgrad micro-regions) and finally – the Greek Basma tobacco from Pashintsi micro-region.

3.4 Complex quality evaluation and rating of Oriental tobaccos in Krumovgrad region

The approach to the final assessment of the quality level of the studied tobaccos from 2019 harvest in Krumovgrad region was based on the selection of the most characteristic for Oriental tobacco quality

indicators and taking into account their impact (relative weight) on the formation of the complex quality. As described in the Materials and Methods section, the single ranks concerning tobacco chemical indicators were obtained by assessing the respective indicator value relative to the optimal value range and, accordingly, the degree of deviation from it. The results of the direct comparison and rating of tobaccos through expert assessment of tobacco leaf visual and smoking properties were directly applied. Based on this, the values of the quality index for the respective tobacco were obtained, which can be accepted as a reliable complex expression of tobacco quality level.

The results of the complex quality evaluation and rating of the studied Oriental tobaccos of the ecotypes Basma (GR) and Krumovgrad, produced in Krumovgrad region, are presented in Table 4.

Table 4. Complex quality evaluation and rating of Oriental tobaccos in Krumovgrad region

Index	Rating						CI	Quality index					
	Ecotype Basma (GR)			Ecotype Krumovgrad				Ecotype Basma (GR)			Ecotype Krumovgrad		
	S1	S2	S3	S4	S5	S6		S1	S2	S3	S4	S5	S6
Nicotine, %	5	3	4	6	2	1	0.20	1.00	0.60	0.80	1.20	0.40	0.20
RS, %	2	2	4.5	4.5	6	2	0.12	0.24	0.24	0.54	0.54	1.20	0.24
RS/Nicotine	4.5	1.5	4.5	6	1.5	3	0.18	0.81	0.27	0.81	1.08	0.27	0.54
Tar, mg/cig	4	1	3	5	6	2	0.10	0.40	0.10	0.30	0.50	0.60	0.20
EA	5	4	3	2	1	6	0.15	0.75	0.60	0.45	0.30	0.15	0.90
SA	1	6	3	2	5	4	0.25	0.25	1.50	0.75	0.50	1.25	1.00
Sum of quality indices								3.45	3.31	3.65	4.12	3.87	3.07
Rating								3	2	4	6	5	1

RS – Reducing sugars; EA – expert assessment; SA – smoking assessment; CI – coefficient of importance.

Sample designation, by sub-region/micro-region: S1 - Zvezdel/Pashintsi; S2 - Krumovgrad/Krumovgrad; S3 - Krumovgrad/Baratsi; S4 - Potochnitsa/Strandzhevo; S5 - Krumovgrad/Krumovgrad; S6 - Zvezdel/Zvezdel.

Based on the obtained quality index values (Table 4), the better quality characteristics were established for the tobacco of the Krumovgrad ecotype from Zvezdel micro-region, followed by those from Basma (GR) ecotype (Krumovgrad and Pashintsi micro-regions). The last three positions in the complex quality evaluation rating were occupied by the rest of the tobaccos of Krumovgrad ecotype (from Baratsi, Krumovgrad and Strandzhevo micro-regions, respectively).

4 Conclusions

A complex methodology for the assessment of the quality of local and Greek Oriental tobaccos produced in the Krumovgrad region was applied, including chemical analysis and expert assessment of leaf properties and tobacco smoking profile.

The results showed a more balanced chemical composition in “Krumovgrad 58” variety (Krumovgrad ecotype) and in the tobacco of Greek origin (Basma ecotype), produced in Krumovgrad micro-region.

The expert assessment gave an advantage to the local tobaccos of Krumovgrad ecotype, with the exception of “Krumovgrad 58” sample from Zvezdel micro-region.

The smoking analysis graded the Basma ecotype tobacco (Krumovgrad micro-region) with the best smoking qualities, followed by the samples representing “Krumovgrad 58” (Strandzhevo) and “Krumovgrad 90” (Baratsi) varieties.

The complex assessment through the generalized quality index distinguished the “Krumovgrad 58” variety from Zvezdel, followed by the Basma ecotype tobaccos from Krumovgrad and Pashintsi micro-regions.

The results emphasize the need for annual quality examination of Bulgarian Oriental tobaccos and provide valuable information for the strategic management of their varietal structure and market position.

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