Technological profile and quality level of tobaccos from Basmi variety group dominating the Bulgarian market

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Abstract. The dominance in the current Oriental tobacco market in Bulgaria is largely identified with the demand and supply of "Krumovgrad", "Basma" (GR) and "Katerini" (GR) ecotypes. The aim of the study was to characterize the technological profile and quality level of those tobaccos in two production regions, based on the complex assessment of chemical, visual, smoking and other properties. A comparative analysis and ranking of the ecotypes within each of the regions was carried out. The chemical analysis showed higher nicotine content in the tobaccos of Greek origin - "Basma" (GR) in region Nevrokop (0.75%) and "Katerini" in Gorna Dzhumaya (1.11%). All samples, regardless of ecotype and production area, had reducing sugars/nicotine ratio considerably higher than the optimal values for Oriental tobacco. The rest of the chemical indicators and the expert assessment of tobacco sensory properties revealed tobacco quality variations within each of the regions. The final ranking of the ecotypes in the respective regions, based on the complex evaluation of all quality indicators, suggested that in region Nevrokop the highest quality level was found in "Krumovgrad" ecotype tobacco from Bogolin and Ablanitsa, followed by "Basma"(GR) from Teplen, while in region Gorna Dzhumaya better was the tobacco of ecotype "Katerini".

1 Introduction

Tobacco (*Nicotiana tabacum* L.) is one of the most important industrial crops with a world production of about 4,900,000 tons. Raw (unprocessed) tobacco produced in the EU represents about 3.7% of the total world production and about 7.5% of world marketing [1]. The changes in the agricultural sector in recent years and the increased anti-smoking awareness have led to a decrease in tobacco consumption both globally and nationally [2]. Cultivated in over 100 countries around the world, tobacco exhibits high adaptability to a wide variety of environmental conditions. The key factors supporting tobacco cultivation in Bulgaria (and especially that of high quality Oriental tobacco) are the favorable soil and climatic conditions, the agricultural structure with many small farms, and the availability of experienced workforce in the agricultural sector. The dominance in the current Oriental tobacco market in Bulgaria is largely identified with the demand and supply of "Krumovgrad", "Basma" (GR) and "Katerini" (GR) ecotypes [3].

Oriental tobacco aroma and quality characteristics largely depend on the soil, climatic and other features of the region, which influence plant growth, productivity and the chemical composition of tobacco leaves. The genetics (variety), the applied agricultural practices, the leaf maturation processes, and curing and post-harvest processing technologies also have a significant influence [4]. During the growth and curing processes, tobacco plants undergo a series of physiological and metabolic processes that alter the chemical composition of the leaves [5]. Dynamic and temporal changes in tobacco leaf metabolites can have a huge impact on their composition, which is closely related to the quality and smoking properties of cured tobacco leaves [6]. Therefore, systematic and up-to-date information about the main chemical components of tobacco leaves - such as alkaloids, sugars, protein, mineral substances, etc., is important for many segments of the tobacco industry [7]. They contribute to the organoleptic properties and the physiological effects of cigarette smoke and the data for their content are traditionally used as important parameters in the evaluation of tobacco for marketing quality [8,9]. The quality of the cured tobacco leaves, determined by expert evaluation of their external sensory properties, is the other consideration that must be taken into account in the cultivation of tobaccos. The quality grade index of Turkish tobaccos (the percentage of high quality leaf in a grade), for instance, should be over 60% for satisfactory results [10].

Tracking the variation of the main chemical and organoleptic quality indicators is important for tobacco production and trade, as it usually shows significant differences between production locations (countries, regions, etc.). Thus, for example, in the assessment of the effect of variety, region, and crop factors on yield and nicotine, sugar, and nitrate contents in five varieties

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of Oriental tobacco cultivated in Greece (Katerini 53, Xanthi 81, Xanthi 2A, Doxato, and Nigrita 34), a significant variation was found both in terms of chemical indicators (nicotine, 0.67-3.71%; sugars, 1.21-11.28%), and in terms of yield and quality. In particular, for Katerini 53 (KA 53) variety – a well-known aromatic Greek variety, which is used by the tobacco industry mainly to add flavor, the content of nicotine varied in the range 0.71-2.70%, and that of sugars 1.33-8.18% [1], although the variety is typically associated with about 1.5-2% nicotine and about 15% sugar content [2]. In a previous study of Oriental tobaccos from Turkey, it has been stated that new varieties and hybrids, providing both high yield and quality should have 8-12% sugar content and 2.2-2.7% nicotine content [10]. The comparison of 7 varieties of Oriental tobacco in the study showed that the nicotine content for Erbaa region varied in the range 0.80-2.52%, and for Bafra location – from 0.76 to 2.75%. A study of Oriental tobaccos in Vietnam found that they were better suited to the soil and climate conditions of Dak Lak province compared to Ninh Thuan province [11]. Based on the results for the chemical composition and smoking properties, it was stated that the tobacco from Dak Lak province is of good quality, similar to that of tobaccos imported from Bulgaria, Turkey and Greece. The study concluded that in 2022 the area under cultivation of Oriental tobacco in Dak Lak province should be expanded to limit the tobacco import from other countries [11]. Oriental tobacco is one of the important and strategic agricultural crops in the Republic of North Macedonia, as well, considered from economic, commercial, fiscal, social and demographic aspects [12]. An investigation of four varieties of the main ecotype, Prilep, reported the following chemical indices: nicotine, 0.87-0.94%; total nitrogen, 1.90-2.30%; soluble sugars, 13.67-17.99%; ash, 14.29-16.66% [13].

Based on these considerations, the aim of the study was to characterize the technological profile and quality level of tobaccos from “Krumovgrad”, “Basma” (GR) and “Katerini” (GR) ecotypes in two production regions in Bulgaria (Nevrokop and Gorna Dzhumaya), based on the complex assessment of their chemical, visual, smoking and other properties.

2 Materials and Methods

The study was carried out with Oriental tobaccos (crop year 2018) of three ecotypes, covering different sub-regions and micro-regions in two production regions in Bulgaria, as follows:

a) Region Nevrokop – ecotypes “Krumovgrad” and “Basma” (GR). The sampling sites covered two sub-regions: Yaka (micro-regions Teplen, Bogolin, Kornitsa, Valkosel, Ablanitsa, Godeshevo, Tuhovishte) and Balkan (micro-region Oreshe);

b) Region Gorna Dzhumaya – ecotypes “Krumovgrad” and “Katerini” (GR). The sampling sites covered sub-region Yaka, micro-regions Padesh and Dolno Osenovo.

Cured tobacco leaf was provided by farmers in the respective micro-region and taken directly from the curing premises. In order to obtain uniform samples for the analyses, the leaves were de-stringed and sorted to select undamaged material from the upper stalk positions (known to be the most characteristic and high-quality in Oriental tobaccos), corresponding to the A commercial grade. A part of each sample was dried (at 40°C) and ground for chemical analysis, and the remaining part was conditioned to conduct the sensory assessment tests (to 17% moisture for the expert assessment of tobacco leaf properties, and to 21% and 12% moisture for cutting and preparation of laboratory cigarettes for the smoking tests, respectively).

The technological profile and the quality level of the tobacco samples were evaluated in a four-step procedure [14], including:

a) Determination of the chemical indicators of tobacco. The following chemical indices of tobacco leaf were determined, applying standardized methods: nicotine (according to ISO 15152:2003 [15]), reducing sugars (according to ISO 15154:2003 [16]), total nitrogen (according to BDS 15836:1988 [17]), ash (according to ISO 2817:1999 [18]), and potassium (according to BDS 17365:1994 [19]). The chemical indicators of tobacco smoke – nicotine and tar content, were obtained by a calculation procedure, as previously described elsewhere [20].

b) Assessment of tobacco leaf properties and rating of samples. The expert assessment was conducted by a 5-member panel, though direct comparison and rating of coded tobacco leaf samples. Sample rating was based on the complex assessment of all leaf properties associated with Oriental tobacco quality, according to the standards [21]. The unanimity of the obtained rating orders was verified, depending on the number of samples rated, by applying statistical tools, such as the critical ratio number (*CRN*), the ranking coefficient, the coefficient of concordance (*W*) and the *F*-test, at a confidence level of 0.05 [22].

c) Assessment of tobacco smoke quality and rating of samples. Smoking tests on coded non-filtered, non-ventilated laboratory-made cigarettes were conducted by a 5-member smoking panel, in a direct comparison mode. Each expert individually rated the samples in the series based on the complex perception of smoke attributes, and the criteria for the verification of the resultant rating orders were the same as in the tobacco leaf properties assessment.

d) Complex quality evaluation and rating of tobaccos. The samples were ranked according to the results from the previous steps of the procedure, with regard to selected quality indicators (chemical – nicotine, reducing sugars, RS/nicotine, and tar; tobacco leaf properties and smoke quality). Each of these indicators was given a coefficient of importance (relative weight), used for the calculation of the quality index value. The final rating of the samples was based on the achieved sum of quality indices, in which the minimal value was indicative of the highest quality level.

To achieve study objectives, the above-described evaluation and rating procedure was applied for the comparison of the tobacco ecotypes produced in one and

the same region (Nevrokop and Gorna Dzhumaya, respectively).

3 Results and Discussion

3.1 Chemical indicators of tobacco

Table 1 presents data for the chemical indicators of the studied Oriental tobaccos produced within each of the regions (Nevrokop and Gorna Dzhumaya).

Region Nevrokop (ecotypes "Basma" (GR) and "Krumovgrad"): The nicotine content in all of the studied tobaccos was below 1%, with the highest concentration found in the sample representing Basma (GR) ecotype (0.75%) and the lowest – in the sample from Tuhovishte micro-region (ecotype "Krumovgrad", 0.25%). The remaining samples did not show significant differences in leaf nicotine content. Accordingly, a similar distribution was found for smoke nicotine levels. Reducing sugars content was high, regardless of ecotype and micro-region, and varied in a relatively wide range, from 22.60% (Ablanitsa) to 32.70% (Tuhovishte). In all tobaccos from region Nevrokop the ratio between reducing sugars and nicotine was disturbed, with values considerably exceeding the typical range for bright tobaccos (6-10) [23]. Total nitrogen, ash and K contents were typical for quality Oriental tobacco, and did not show significant variation between the samples. The predicted tar content in the smoke of the compared tobaccos was practically identical in all samples, showing little variation in the range from 15.13 mg/cig (Valkosel) to 16.34 mg/cig (Ablanitsa).

Region Gorna Dzhumaya (ecotypes "Katerini" (GR) and "Krumovgrad"): The tobacco from Krumovgrad ecotype had lower nicotine, total nitrogen and ash content, and higher reducing sugars content than the sample from "Katerini" (GR) ecotype. The reducing sugars/nicotine ratio in both samples was higher than the optimal [2, 23]. No difference was observed in the tar content between the two ecotypes compared.

3.2 *Expert assessment of tobacco leaf properties and rating of samples*

The matrices for the rating of the studied Oriental tobaccos in regions Nevrokop and Gorna Dzhumaya by expert assessment of leaf quality are presented in Table 2 and Table 3.

Table 1. Chemical indicators of the studied Oriental tobaccos

Sample	Sub-region	Micro-region	Ecotype	Variety	Indicators							
					Tobacco composition						Smoke composition	
					NC	RS	RS/NC	TN	Ash	K	NC	Tar
					%	%	-	%	%	%	mg/cig	mg/cig
Region Nevrokop												
A	Yaka	Teplen	Basma (GR)	-	0.75	28.00	37.33	1.25	7.87	4.72	0.67	15.53
B	Yaka	Bogolin	Krumovgrad	KR 90	0.59	29.60	50.17	1.40	8.06	3.39	0.56	15.88
C	Yaka	Kornitsa	Krumovgrad	KR 90	0.39	28.10	72.05	1.32	7.36	3.52	0.32	15.63
D	Yaka	Valkosel	Krumovgrad	KR 90	0.46	26.10	56.74	1.45	8.27	4.31	0.38	15.13
E	Balkan	Oreshe	Krumovgrad	KR 90	0.38	30.10	79.21	1.43	7.64	3.59	0.34	15.52
F	Yaka	Ablanitsa	Krumovgrad	KR 90	0.60	22.60	37.67	1.64	8.53	3.19	0.56	16.34
G	Yaka	Godeshevo	Krumovgrad	KR 90	0.49	26.40	53.88	1.14	7.58	3.63	0.42	15.46
H	Yaka	Tuhovishte	Krumovgrad	KR 90	0.25	32.70	130.80	1.14	7.11	3.85	0.22	15.22
Region Gorna Dzhumaya												
I	Yaka	Padesh	Katerini (GR)	KA 53	1.11	28.10	25.32	1.64	8.92	3.89	0.95	15.19
J	Yaka	Dolno Osenovo	Krumovgrad	KR 90	0.60	31.30	52.17	1.51	7.17	4.06	0.56	15.11

NC – Nicotine; RS – Reducing sugars; TN – Total nitrogen; K – Potassium (as K_2O)

Table 2. Rating of the studied Oriental tobaccos in region Nevrokop by expert assessment of leaf quality

Expert No	Sub-region/Micro-region							
	Yaka/ Teplen	Yaka/ Bogolin	Yaka/ Kornitsa	Yaka/ Valkosel	Balkan/ Oreshe	Yaka/ Ablanitsa	Yaka/ Godeshevo	Yaka/ Tuhovishte
1	8	1	2	5	6	4	3	7
2	8	1	2	6	5	3	4	7
3	8	2	1	5	6	4	3	7
4	8	1	2	6	5	4	3	7
5	8	1	3	5	4	6	2	7
∑Xij	*40*	*6*	*10*	*27*	*26*	*21*	*15*	*35*
Relative ranking factor	*0.22*	*0.03*	*0.06*	*0.15*	*0.14*	*0.12*	*0.08*	*0.19*
Ranking coefficient	*0.15*	*1*	*0.60*	*0.22*	*0.23*	*0.29*	*0.40*	*0.17*
Rating	**8**	**1**	**2**	**5.5**	**5.5**	**4**	**3**	**7**

Table 3. Rating of the studied Oriental tobaccos in region Gorna Dzhumaya by expert assessment of leaf quality

Expert No	Sub-region/Micro-region	
	Yaka/Padesh	Yaka/Dolno Osenovo
1	1	2
2	1	2
3	1	2
4	1	2
5	1	2
Rating	**1**	**2**

Region Nevrokop: The results proved statistically significant differences between the samples and good agreement in the rating of the tobaccos within the region, with coefficient of concordance (*W*) value 0.94 (confidence level 0.05). As seen from Table 2, the "Krumovgrad" ecotype tobaccos achieved higher ranks than "Basma" (GR) ecotype in the assessment of leaf quality properties. The best rated was the sample from Bogolin micro-region, followed by that from Kornitsa, after which in the corresponding order were found the tobaccos from Godeshevo, Ablanitsa, Valkosel, Oreshe (the latter two sharing the same rank), and Tuhovishte, while the sample from Teplen ("Basma" (GR) ecotype) took the last position.

Region Gorna Dzhumaya: The parallel between the tobaccos produced in region Gorna Dzhumaya (Table 3) defined better leaf quality properties for "Katerini" (GR) tobacco compared to "Krumovgrad" ecotype tobacco, with reliable difference between them (*CRN*=2.24, confidence level 0.05).

3.3 *Assessment of tobacco smoke quality and rating of samples*

The results from the smoke quality assessment for the tobaccos of ecotypes "Krumovgrad", "Basma" (GR) and "Katerini" (GR) produced in regions Nevrokop and Gorna Dzhumaya are presented in Table 4 and Table 5, respectively.

Table 4. Rating of the studied Oriental tobaccos in region Nevrokop by smoking assessment

Expert No	Sub-region/Micro-region							
	Yaka/ Teplen	Yaka/ Bogolin	Yaka/ Kornitsa	Yaka/ Valkosel	Balkan/ Oreshe	Yaka/ Ablanitsa	Yaka/ Godeshevo	Yaka/ Tuhovishte
1	3	1.5	6.5	6.5	5	4	8	1.5
2	3	5	6.5	6.5	3	3	8	1
3	4.5	1	7	4.5	2	4.5	8	4.5
4	3	1	7	5.5	5.5	3	8	3
5	6	1	7	2.5	4.5	2.5	8	4.5
∑Xij	19.5	9.5	34	25.5	20	17	40	14.5
Relative ranking factor	*0.11*	*0.05*	*0.19*	*0.14*	*0.11*	*0.09*	*0.22*	*0.08*
Ranking coefficient	*0.49*	*1*	*0.28*	*0.37*	*0.48*	*0.56*	*0.24*	*0.65*
Rating	**4**	**1**	**7**	**6**	**5**	**3**	**8**	**2**

Table 5. Rating of the studied Oriental tobaccos in region Gorna Dzhumaya by smoking assessment

Expert No	Sub-region/Micro-region	
	Yaka/Padesh	Yaka/Dolno Osenovo
1	2	1
2	2	1
3	1	2
4	2	1
5	2	1
Rating	**1.5**	**1.5**

Region Nevrokop: When comparing the tobaccos of ecotypes "Basma" (GR) and "Krumovgrad" produced in the respective micro-regions in terms of their smoking properties, consistency was found in the evaluations of the experts and proven reliability (*W*=0.69), which gives reason to accept the rating indicated in Table 4. In that gradation of the tobaccos, the sample from "Krumovgrad" ecotype (Bogolin micro-region) had the best rating, followed by the samples from Tuhovishte and Ablanitsa ("Krumovgrad" ecotype), and the Greek "Basma" ecotype sample (Teplen) in the fourth position. The remaining samples from "Krumovgrad" ecotype were placed in the corresponding order in the last positions, from fifth to eight. Based on these results, it can be summarized that the tobaccos from "Krumovgrad" ecotype have relatively more favorable smoking qualities compared to those from "Basma" (GR) ecotype in the Nevrokop region.

Region Gorna Dzhumaya: The results from the smoking tests (Table 5) showed the absence of statistically reliable difference in the smoking quality between the compared samples from "Katerini" (GR) and "Krumovgrad" ecotypes produced in region Gorna Dzhumaya (*CRN*=1.34).

3.4 *Complex quality evaluation and rating of tobaccos*

The approach to obtain the final rating of the regarded Oriental tobaccos, by their complex quality evaluation, was based on the gradation of the samples in the preceeding steps of the procedure. The indices, selected by the expert panel as the most important for the complex quality evaluation included: reducing sugars and nicotine content in tobacco leaf, as well as the ratio between them, the tar content in tobacco smoke, and the expert assessment of tobacco leaf properties and smoke quality. The ranking of the samples with regard to the

nicotine content was obtained considering its positive relation to quality, i.e. the maximal nicotine concentration (Table 1) took rank one, and so on. Reducing sugars were graded against the accepted 10-16% optimal interval, and moving away from that range gave the samples a lower rank. The same approach was applied for the reducing sugars/nicotine ratio, and the samples were rated accounting for the deviation from the optimal ratio value of 15.00. The ranking of the samples with regard to the tar content was from the minimal to the maximal value. The rating orders formulated in the assessment of tobacco leaf properties and smoke quality were transferred directly into the complex quality matrix. The quality indices obtained by considering the relative weight of each of these factors, thus, are complex indicators of tobacco quality.

The results from the complex evaluation of the studied tobaccos from ecotypes "Basma" (GR), "Katerini" (GR) and "Krumovgrad" produced in regions Nevrokop and Gorna Dzhumaya are presented in Table 6 and Table 7, respectively.

Table 6. Complex quality evaluation and rating of Oriental tobaccos in region Nevrokop

Index	Rating								Coefficient of importance	Quality index							
	A	B	C	D	E	F	G	H		A	B	C	D	E	F	G	H
NC, %	1	2.5	6.5	4.5	6.5	2.5	4.5	8	0.20	0.20	0.50	1.30	0.90	1.30	0.50	0.90	1.60
RS, %	4	6	5	2	7	1	3	8	0.12	0.48	0.72	0.60	0.24	0.84	0.12	0.36	0.96
RS/NC	1	3	6	5	7	2	4	8	0.18	0.18	0.54	1.08	0.90	1.26	0.36	0.72	1.44
Tar, mg/cig	4.5	7	6	1	4.5	8	3	2	0.10	0.45	0.70	0.60	0.10	0.45	0.80	0.30	0.20
Expert assessment	8	1	2	5.5	5.5	4	3	7	0.15	1.20	0.15	0.30	0.83	0.83	0.60	0.45	1.05
Smoking assessment	4	1	7	6	5	3	8	2	0.25	1.00	0.25	1.75	1.50	1.25	0.75	2.00	0.50
Sum of quality indices										***3.51***	***2.86***	***5.63***	***4.47***	***5.93***	***3.13***	***4.73***	***5.75***
Rating										**3**	**1**	**6**	**4**	**8**	**2**	**5**	**7**

NC – Nicotine; RS – Reducing sugars; A-H – sample designation is the same as in Table 1.

Table 7. Complex quality evaluation and rating of Oriental tobaccos in region Gorna Dzhumaya

Index	Rating		Coefficient of importance	Quality index	
	I	J		I	J
NC, %	1	2	0.20	0.20	0.40
RS, %	1	2	0.12	0.12	0.24
RS/NC	1	2	0.18	0.18	0.36
Tar, mg/cig	2	1	0.10	0.20	0.10
Expert assessment	1	2	0.15	0.15	0.30
Smoking assessment	1.5	1.5	0.25	0.38	0.38
Sum of quality indices				***1.23***	***1.78***
Rating				**1**	**2**

NC – Nicotine; RS – Reducing sugars; I-J – sample designation is the same as in Table 1.

Region Nevrokop: The final rating of tobaccos from the two ecotypes for the Nevrokop region based on the complex quality evaluation (Table 6) was as follows: the tobaccos from "Krumovgrad" ecotype (Bogolin micro-region) had the best rating, followed by "Krumovgrad" (Ablanitsa) and "Basma" (GR) (Teplen), after which were rated the "Krumovgrad" ecotype tobaccos from the remaining five micro-regions (Valkosel, Godeshevo, Kornitsa, Tuhovishte, and Oreshe).

Region Gorna Dzhumaya: The tobaccos from ecotype "Katerini" (GR) appeared to have a better complex quality assessment for region of Gorna Dzhumaya compared to those from "Krumovgrad" ecotype (Table 7).

4 Conclusions

The complex assessment of chemical, visual, smoking and other technological properties of the studied Oriental tobacco ecotypes from Basmi variety group in regions Nevrokop and Gorna Dzhumaya led to the following conclusions:

- Higher nicotine content was found in the tobaccos of Greek origin – "Basma" (GR) in region Nevrokop (0.75%) and "Katerini" (GR) in Gorna Dzhumaya (1.11%);
- All tobaccos, regardless of ecotype and production area, had reducing sugars/nicotine ratio considerably higher than the optimal values;
- The final rating of the ecotypes in the respective regions, based on the complex evaluation of all quality indicators, suggested that in ***region Nevrokop*** the highest quality level was found for "Krumovgrad" ecotype tobacco from Bogolin and Ablanitsa, followed by "Basma" (GR) from Teplen and "Krumovgrad" from Valkosel. In ***region Gorna Dzhumaya*** with better complex quality was the tobacco of ecotype "Katerini" (GR).

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