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Valuation of the Quality Level of Bulgarian Tobacco from the Market Sector of "Basmi" Variety Group

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Abstract. The aim of the current study was to assess the quality level of Oriental tobaccos from the market sector of the "Basmi" variety group from different production areas in Bulgaria. Tobaccos from Krumovgrad and Greek Basma ecotypes (varieties "Krumovgrad 90", "Krumovgrad 58", "Krumovgrad 78", and "Basma", respectively) were investigated, all farmer-produced (2019 crop year) in seven tobacco regions. The investigation followed a procedure validated for monitoring the quality of Bulgarian tobaccos, incorporating four evaluation steps – chemical indices of tobacco and tobacco smoke, expert and smoking assessment, and final rating by a complex quality index. Statistically significant differences were observed between the compared tobaccos (variety and region based) within the two ecotypes. For Krumovgrad ecotype, the final rating of the compared tobaccos revealed the best complex quality indicators in varieties "Krumovgrad 78" from Kardzhali (micro-region Patitza), "Krumovgrad 58" from Haskovo-Harmanli (Stambolovo) and "Krumovgrad 58" from Ivaylovgrad (Belopoltzi). With the best quality level within ecotype Basma were the tobaccos produced in Svilengrad (micro-region Raykova mogila) and Momchilgrad (Chorbadzhiysko) regions. The results from the study substantiate the annual monitoring of the quality level of Bulgarian Oriental tobaccos and provide data, which have potential importance for the national tobacco sector.

1 Introduction

The market for classic Oriental tobaccos is facing many challenges – but, as already stated [1], it is a tough business that has seen hard times before. About 60% of the global Oriental tobacco market nowadays are covered by Turkey, followed by North Macedonia, Greece and Bulgaria. The declining production and the commercialization of just a few ecotypes of Oriental tobacco in recent years endorse the necessity to create and implement high-yielding and high-quality varieties capable to satisfy producers' needs by providing high income and compliance with the requirements of the processing companies [2, 3]. In this respect, the development of new hybrids is recommended, which can, on the one hand, satisfy the needs of the market and, on the other hand, reduce the negative impact of production on the environment regarding the application of excessive irrigation and nitrogen fertilization for obtaining maximum yields.

It is well-known that the yield and quality of tobacco are determined by the genetic potential, the environmental conditions, the applied agrotechnical practices, and the specific leaf processing technology. Changes in any of these factors can result in significant differences in the chemical composition and, accordingly, in the smoking properties of tobacco. Therefore, plenty of research activity has been devoted to the analysis of these factors and their influence on tobacco quality, in order to steer them in the desired direction [4-9]. The inefficient resource use poses serious risks to the high-quality Oriental tobaccos. In the past, those tobaccos were usually grown in dry areas without irrigation or fertilization, while in recent years their production has shifted to flatter and irrigated fields. Correspondingly, the general quality, the contents of nicotine, reducing sugars and phenolics have been shown to increase periodically with the acceleration of water stress, and the highest values of those indices have been obtained in non-irrigated tobacco cultivation [10].

Tobacco leaf quality is a specific varietal characteristic arising from the interaction of genotype and environmental conditions [2]. The impact of the environment forces the plants to maintain a certain productivity dynamic through biochemical and morphological mechanisms, thus generating the specific quality characteristics of Oriental tobaccos, which distinguish them from other tobacco types [11]. Quality tobaccos of this type have developed superior defence mechanisms against the combined exposure to high temperature, and water and nutrient deficiency. Despite being highly adaptive, the Oriental tobaccos are capable

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to demonstrate their unique characteristics only in the traditional areas of production [12].

The quality concept for Oriental tobaccos includes technological characteristics (sensory, physical, chemical) and different aspects of market demand, varying according to the type of product to be produced and consumer preferences [5, 12]. As stated in a recent study [13], *"Its [tobacco] grading is the key action that governs the direction of the product in all stages from processing, marketing and finally to the end-product"* [13]. Tobacco is and will remain the main source of flavor perceived by smokers, despite the use of additives (casings or top-flavorings) in blend composition or the influence of the auxiliary materials (e.g. filters) [12]. The systematic collection of data about the chemical composition of tobacco leaves is, in turn, important for the development of new blends or for maintaining the consistency of the existing ones. A three-year monitoring of Oriental tobaccos produced in four provinces of the Aegean region (Turkey) showed significant differences in chemical composition depending on crop years, regions, stalk positions, and farmers. Nicotine content varied between 0.42% and 0.83%, reducing sugars – 12.9-22.8%, and mineral matter (ash) – 9.7-2.0% [14]. A study on the quality of Oriental tobaccos produced in 2017 in the same region of Turkey determined the following ranges of variation: nicotine – from 0.19% to 0.86%; reducing sugars – from 12.9% to 32.48%; ash – from 12.2% to 23.1% [9]. Another study in Tavas district in the same region in 2021 reported nicotine content in "Saribaglar 407" variety ranging from 0.6% to 0.91%, and reducing sugars from 4.36% to 5.3% [15]. A study on 21 lines of tobacco from the Basma ecotype, one of the highest quality tobaccos produced in Turkey, indicated nicotine content from 0.31% to 3.15% and reducing sugars from 4.44% to 15.03% [12]. Two-year field experiments conducted with three varieties of Oriental tobacco ("Basma Xanthi 81", "Katerini S53" and "Mirodata 30A") on the experimental fields of the Agricultural University of Athens, showed nicotine and sugar contents of 2.53-4.22% and 2.39-3.17%, respectively, for crop-year 2017, and 2.34-3.34 % and 2.70-3.81%, receptively, for crop-year 2018 [8]. A study on the main indicators of the chemical composition of four tobacco varieties from the Prilep ecotype reported nicotine content of 0.88-0.94%, soluble sugars – 13.67-17.99%, ash – 14.29-16.66% [16]. The analysis of the chemical composition of five varieties of Oriental tobacco in Iraq, two local and three introduced, revealed the following ranges of indicators' variation: 1.16-3.67% for nicotine; 4.71-9.20% for reducing sugars; 1.57-2.45% for total nitrogen, and 17.15-24.56% for ash [17].

The production of Oriental tobaccos in Bulgaria, for the 2019 harvest, is dominated by the Krumovgrad ecotype (4,600 tons, mainly "Krumovgrad 90" and "Krumovgrad 58" varieties) and the Greek tobaccos of the Katerini (600 tons) and Basma (200 tons) ecotypes grown in single regions [1]. The transformations in the Bulgarian tobacco sector – combined with the established market trends in recent years – justify systematic, scientifically based investigations of the technological quality of the leaf material from the Oriental tobaccos produced in Bulgaria, which comprise an important segment of the national agricultural and economic reality. Based on these considerations, the aim of this study was to assess the quality level of tobaccos from the market sector of the "Basmi" variety group from different production areas in Bulgaria.

2 Materials and methods

2.1 Plant material

Oriental tobacco varieties (*Nicotiana tabacum* L.) from Krumovgrad and Basma ecotypes (varieties "Krumovgrad 90", "Krumovgrad 58", "Krumovgrad 78", and "Basma", respectively) were investigated. The tobaccos were produced under real production conditions in different micro-regions representing seven tobacco regions in Bulgaria for 2019 crop-year. The leaf material, in the form of stringed cured leaves, was farmer-provided on site in the respective micro-regions. Table 1 represents the sampling scheme for Krumovgrad and Basma ecotypes, respectively, specifying the regions, sub-regions and micro-regions of tobacco production.

The analytical samples comprised of undamaged leaf material from upper stalk positions (upper middle leaves, kovalama, outch), which are the most characteristic and high-quality material in Oriental tobaccos, standardly corresponding to the A commercial grade. Leaves from the regarded stalk positions were proportionally mixed in each analytical sample. A portion (about 0.5 kg) of the so-prepared uniform leaf samples was ground for the chemical analyses; the remaining part was conditioned to 17% moisture content for the sensory assessment (expert rating), and then to 21% moisture content to obtain cut tobacco for the smoking tests (cut width 0.7-0.8 mm).

2.2 Evaluation procedure

The evaluation of the quality level of the Oriental tobaccos in the study followed a procedure previously validated for tobacco quality monitoring in Bulgaria [18]. In brief, it incorporated four basic steps of assessment including the consecutive determination of chemical indices, expert rating by sensory assessment of the external leaf properties (leaf size, color, texture, odor, body, integrity, *etc.*), rating by smoking properties, and the final rating by calculating the complex quality index [18].

In compliance with the objectives of the study, the evaluation procedure was carried out by comparison between the tobaccos from different production regions and micro-regions within the respective ecotype, Krumovgrad and Basma.

Table 1. Sampling scheme for Krumovgrad and Basma tobacco ecotypes in the study

Region	Sub-region	Micro-region	Variety	Sample code
Ecotype Krumovgrad				
Krumovgrad	Krumovgrad	Baratsi	Krumovgrad 90	**KR 01**
Krumovgrad	Potochnitsa	Strandzhevo	Krumovgrad 58	**KR 02**
Krumovgrad	Krumovgrad	Krumovgrad	Krumovgrad 58	**KR 03**
Krumovgrad	Zvezdel	Zvezdel	Krumovgrad 58	**KR 04**
Kardzhali	Chernoochene	Patitsa	Krumovgrad 78	**KR 05**
Momchilgrad	Momchilgrad	Chorbadzhiisko	Krumovgrad 58	**KR 06**
Svilengrad	Svilengrad - Yaka	Dimitrovche	Krumovgrad 58	**KR 07**
Svilengrad	Harmanli - Yaka	Shishmanovo	Krumovgrad 58	**KR 08**
Haskovo-Harmanli	Haskovo - Balkan	Stambolovo	Krumovgrad 58	**KR 09**
Ivaylovgrad	Ivaylovgrad - Pelevun	Belopoltsi	Krumovgrad 58	**KR 10**
Dzhebel	Benkovski	Fotinovo	Krumovgrad 58	**KR 11**
Dzhebel	Dzhebel	Dzhebel	Krumovgrad 58	**KR 12**
Ecotype Basma				
Krumovgrad	Krumovgrad	Krumovgrad	Basma	**BS 01**
Krumovgrad	Zvezdel	Pashintsi	Basma	**BS 02**
Momchilgrad	Momchilgrad	Chorbadzhiisko	Basma	**BS 03**
Svilengrad	Svilengrad - Yaka	Raykova Mogila	Basma	**BS 04**
Haskovo	Yaka	Haskovo	Basma	**BS 05**

2.2.1 Chemical analyses

Total alkaloids (as nicotine, %), reducing sugars (%), total nitrogen (%), and ash (%) contents were determined by continuous-flow analysis (AAIIC auto-analyzer, Technicon, USA), according to the standardized methods [19-22].

Smoke nicotine (mg/cig) and tar (mg/cig) concentrations were calculated following the regression model described earlier [23].

2.2.2 Expert rating by tobacco leaf properties

The procedure was conducted by six experts, who individually assessed and ranked coded samples of tobacco leaves. Expert decision in the rating procedure was based on the complex organoleptic assessment of all leaf properties, associated with tobacco quality, according to the standards for Oriental tobacco [24]. The rating by the expert panel was verified for unanimity at a confidence level *(α)* of 0.05, using the ranking coefficient, the coefficient of concordance (W), and the F-test calculation procedure [25].

2.2.3 Rating by smoking properties of tobacco

The smoking tests were performed by a smoking panel consisting of five experts, in a direct comparison and rating mode. Each panel member assessed the overall perception of tobacco smoke attributes (aroma, strength, smoothness, desirability, *etc.*) of coded non-filtered cigarettes. The statistical verification of the results was the same as in the expert rating [25].

2.2.4 Complex rating of tobaccos

The final valuation of the quality level of the tobaccos regarded in the study was achieved by assigning individual ranks, resulting from their performance in the chemical analysis, the expert and the smoking rating steps, as described previously [18]. The calculation of the complex quality indices was done by multiplying the respective rank with its coefficient of importance (relative weight), defined by the expert panel. The final rating of tobacco samples was obtained considering the total of quality indices, in which the smallest value corresponded to the highest quality (rank 1), and vice versa.

3 Results and discussion

3.1 Chemical indices of tobaccos and tobacco smoke

The summarized data from the chemical analyses of the studied tobaccos are presented in Table 2.

As stated above, the comparison of tobaccos from different varieties, production regions and sub-regions was carried out within the respective tobacco ecotype – Krumovgrad and Basma.

3.1.1 Ecotype Krumovgrad

As seen from the data in Table 2, there were significant variations in the nicotine content of the studied tobaccos, region and variety defined – from 0.74% in "Krumovgrad 58" variety from Momchilgrad region (sample KR 06) to 2.28% in the same variety from region Krumovgrad (sub-region Zvezdel, sample KR 04).

Table 2. Chemical indices of the tobaccos in the study

Sample [1)]	Index							
	Tobacco						Smoke	
	Nicotine, %	Reducing sugars, %	Reducing sugars/ Nicotine	Total nitrogen, %	Ash, %	Reducing sugars /Ash	Nicotine, mg/cig	Tar, mg/cig
Ecotype Krumovgrad								
KR 01	1.03	16.30	15.83	2.28	10.12	1.61	0.88	19.52
KR 02	0.78	16.20	20.77	2.14	9.75	1.66	0.69	24.42
KR 03	1.90	17.80	9.37	2.04	7.58	2.35	1.72	27.39
KR 04	2.28	10.20	4.47	3.61	9.97	1.02	2.16	19.14
KR 05	2.09	12.60	6.03	2.96	11.52	1.09	1.93	23.19
KR 06	0.74	17.60	23.78	1.71	9.17	1.92	0.66	26.51
KR 07	0.87	14.60	16.78	2.29	9.75	1.50	0.76	24.28
KR 08	0.99	18.00	18.18	1.78	7.44	2.42	0.85	23.06
KR 09	2.21	11.20	5.07	2.90	10.57	1.06	2.08	22.05
KR 10	1.19	11.50	9.66	2.75	12.01	0.96	1.02	18.68
KR 11	1.36	17.10	12.57	1.68	10.52	1.63	1.17	26.67
KR 12	1.21	12.70	10.50	2.03	9.84	1.29	1.04	25.59
Ecotype Basma								
BS 01	1.21	12.20	10.08	3.63	13.51	0.90	1.04	17.28
BS 02	0.96	15.20	15.83	2.03	10.22	1.49	0.83	23.26
BS 03	2.10	9.53	4.54	3.43	12.56	0.76	1.95	17.41
BS 04	1.20	12.00	10.00	2.74	12.62	0.95	1.03	18.01
BS 05	1.49	10.80	7.25	3.42	10.67	1.01	1.29	29.16

[1)] Sample coding is as given in Table 1

Accordingly, nicotine concentrations approaching the maximum were found in "Krumovgrad 58" variety from Haskovo-Harmanli (2.21%, KR 09), "Krumovgrad 78" variety from Kardzhali (2.09%, KR 05) and "Krumovgrad 58" variety from Krumovgrad, micro-region Krumovgrad (1.90%, KR 04). Respectively, nicotine contents closer to the range minimum were found in "Krumovgrad 58" variety from regions Krumovgrad (sub-region Potochnitsa, KR 02) and Svilengrad (sub-regions Svilengrad-Yaka and Harmanli-Yaka, KR 07 and KR 08), as well as in "Krumovgrad 90" variety from Krumovgrad (micro-region Baratsi, KR 01). The registered nicotine levels were in compliance with other data [12, 17], being slightly higher than those reported in [9, 14-16], and lower than those in [8].

In turn, the reducing sugars content varied in a relatively limited range, in which the sample with the lowest sugar level was "Krumovgrad 58" variety from Krumovgrad, sub-region Zvezdel (10.20%, KR 04) and that with the highest sugar level – the same variety from Svilengrad (sub-region Harmanli-Yaka, KR 08; 18.00%). The group of tobaccos with sugar contents insignificantly differing from the maximal included "Krumovgrad 58" variety from regions Krumovgrad (micro-region Krumovgrad), Momchilgrad and Dzhebel (Fotinovo); respectively, sugar contents close to the lower range end were found in the same variety from Haskovo-Harmanli and Ivaylovgrad regions. The rest of the samples had reducing sugars content falling within the typical range for Oriental tobaccos, from 12.60% (KR 05) to 16.30% (KR 01). Overall, the registered values for the reducing sugars content were very close to previous data [14, 16].

As seen from the data presented in Table 2, much more balanced reducing sugars-to-nicotine ratios were found in "Krumovgrad 78" variety from Kardzhali (KR 05) and "Krumovgrad 58" variety from the regions of Krumovgrad (KR 03), Ivaylovgrad (KR 10) and Dzhebel (KR 12). The "Krumovgrad 58" variety produced in Krumovgrad (Zvezdel) and Haskovo-Harmanli regions showed the highest nicotine and the lowest reducing sugars content within the studied tobaccos, and correspondingly – the lowest ratio values, with a distinctive misbalance in its smoking profile. The rest of the tobacco samples had reducing sugars-to-nicotine ratios considerably exceeding the optimal index values (6.00 – 10.00).

The total nitrogen content varied in the range from 1.68% in the sample from Dzhebel (Fotinovo; KR 11) to 3.61% in that from Krumovgrad (Zvezdel; KR 04). Those results were compliant with the data reported for Oriental tobacco in Iraq [17].

The highest mineral matter content was registered in "Krumovgrad 58" variety from region Ivaylovgrad (12.01%), and the lowest – in "Krumovgrad 58" from regions Svilengrad (Harmanli-Yaka) and Krumovgrad (sub-region Krumovgrad), 7.44% and 7.58%. The rest of the samples were practically undistinguishable in terms of the regarded indicator. The obtained data for the mineral matter (ash) content were very close to those cited for Oriental tobaccos of Prilep ecotype in the Republic of North Macedonia [16]. The ratio between reducing sugars and ash was the greatest in "Krumovgrad 58" variety from regions Svilengrad (Shishmanovo, KR 08) and Krumovgrad (KR 03), and the lowest – in the sample from region Ivaylovgrad (KR 10).

Smoke nicotine emissions followed the deviations in the nicotine content of the analyzed tobacco leaves, therefore the above observations for the alkaloid content in the tobacco samples were also valid for the nicotine levels in the produced smoke. The highest tar levels were found in “Krumovgrad 58” variety from regions Krumovgrad (27.39 mg/cig), Dzhebel (26.67 mg/cig) and Momchilgrad (26.51 mg/cig). The lowest tar producing potential was found for the same tobacco variety from Ivaylovgrad region (18.68 mg/cig).

3.1.2 Ecotype Basma

The tobacco characterized with the highest nicotine content was that produced in Momchilgrad region (2.10%), and the one with the lowest nicotine content – that from Krumovgrad region, Zvezdel sub-region (0.96%). The remaining three samples were with medium nicotine content (1.49-1.20%), without significant differences. The reducing sugars content varied from 9.53% in the tobacco from Momchilgrad to 15.20% in that from Krumovgrad (Zvezdel sub-region). The results obtained by the present study were lower concerning the nicotine content and higher with regard to reducing sugars than those reported for Greek tobaccos [8].

As seen from Table 2, three of the tobaccos had a balanced reducing sugars-to-nicotine ratio – those produced in Haskovo, Svilengrad and Krumovgrad (sub-region Krumovgrad) regions. The respective balance was disturbed in the remaining two samples, having the minimal value of 4.54 in the tobacco from Momchilgrad and the maximal value of 15.83 in that from Krumovgrad (Zvezdel sub-region). The total nitrogen content varied in the range from 2.03% (Krumovgrad, sub-region Zvezdel) to 3.63% (sub-region Krumovgrad). The tobaccos from Momchilgrad and Haskovo regions approximated the upper nitrogen level, with no significant differences proved. The results about the ash content revealed no significant differentiation between the tobaccos, with values within the range 10.22-13.51%. The tar content was the highest in the smoke of the tobacco from Haskovo region (29.16 mg/cig) and the lowest – in the samples from Krumovgrad (Krumovgrad micro-region; 17.28 mg/cig) and Momchilgrad (17.41 mg/cig).

3.2 Expert rating

Table 3 presents the results from the expert rating of the tobaccos from Krumovgrad ecotype compiled on the basis of the individual preference matrix of each expert in the valuation of leaf quality properties.

The results proved the best expert quality valuation for the tobacco of “Krumovgrad 58” variety from Svilengrad (sub-region Harmanli-Yaka; KR 08), followed by the same variety from Dzhebel (sub-region Benkovski; KR 11) and two samples sharing the same rank, “Krumovgrad 78” from Kardzhali (KR 05) and “Krumovgrad 58” from sub-region Krumovgrad (KR 03). The last rank in the series was achieved by “Krumovgrad 58” variety from sub-region Zvezdel, region Krumovgrad (KR 04). Experts’ assessment was found unanimous and statistically reliable at a confidence level $\alpha=0.05$ ($W=0.57$), which validated the obtained rating order of the tobaccos.

Correspondingly, the summarized results from the expert rating of the tobaccos from Basma ecotype in the study are presented on Fig. 1.

The direct comparison of the tobaccos from the four regions representing ecotype Basma in the study concluded that the best manifestation of leaf quality elements was found in the sample from region Krumovgrad, sub-region Zvezdel (BS 02), followed by the tobaccos from regions Svilengrad (BS 04), Krumovgrad (BS 01), Momchilgrad (BS 03), and Haskovo (BS 05). The rating order was statistically validated at the applied confidence level $\alpha=0.05$ ($W=0.75$).

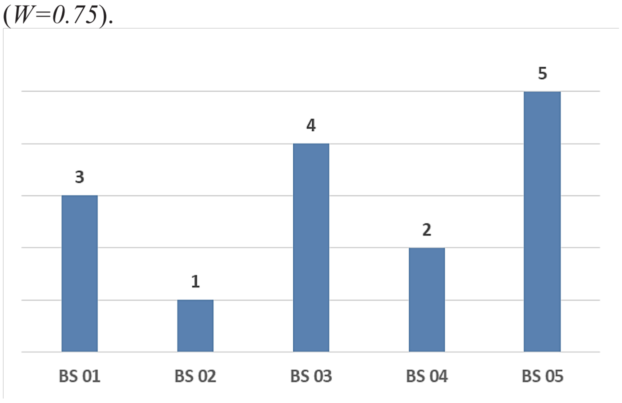

Fig. 1. Expert rating by leaf properties of tobaccos from Basma ecotype (Sample coding is as given in Table 1).

Table 3. Expert rating by leaf properties of tobaccos from Krumovgrad ecotype

Expert No	Sample [1)]											
	KR 01	**KR 02**	**KR 03**	**KR 04**	**KR 05**	**KR 06**	**KR 07**	**KR 08**	**KR 09**	**KR 10**	**KR 11**	**KR 12**
1	7	10	2.5	12	2.5	11	8.5	1	5.5	4	5.5	8.5
2	6	4	7.5	12	10	4	4	1	11	9	2	7.5
3	11	7.5	4.5	9.5	1.5	9.5	12	1.5	7.5	3	4.5	6
4	11	3	5	12	7.5	2	5	1	9.5	9.5	5	7.5
5	9.5	6	5	12	2	7.5	9.5	1	7.5	4	3	11
6	7	7	7	12	7	2	7	1	10.5	4	3	10.5
$\sum X_{ij}$	*51.5*	*37.5*	*31.5*	*69.5*	*30.5*	*36.0*	*46.0*	*6.5*	*51.5*	*33.5*	*23.0*	*51.0*
Rating	**10**	**7**	**3.5**	**12**	**3.5**	**6**	**8**	**1**	**10**	**5**	**2**	**10**

[1)] Sample coding is as given in Table 1

3.3 Rating by smoking properties

Similar to the approach applied above, the individual preference matrix of each panelist reflecting the ranking of the twelve samples of Krumovgrad ecotype tobacco, in a full paired-comparison scheme, were used to complete the summarized rating in the smoking assessment test (Table 4). The comparison of the smoking properties of the tobaccos within the regarded ecotype provided individual ranking orders, which were found unanimous and, therefore, the rating of tobacco samples shown in Table 4 could be assumed as statistically valid. In the final rating by smoking properties the highest rank was achieved by "Krumovgrad 58" variety from Haskovo-Harmanli region (KR 09), followed by "Krumovgrad 90" variety from Krumovgrad region (micro-region Baratsi; KR 01) and "Krumovgrad 78" variety from Kardzhali region (KR 05). The last three places in the descending ranking order were occupied by "Krumovgrad 58" variety from Krumovgrad region (micro-region Zvezdel; KR 04) and the same variety from the two sub-regions of Dzhebel region (KR 11 and KR 12, sharing the same rank). The rating of the tobaccos was statistically validated in the *F*-test ($W=0.94$).

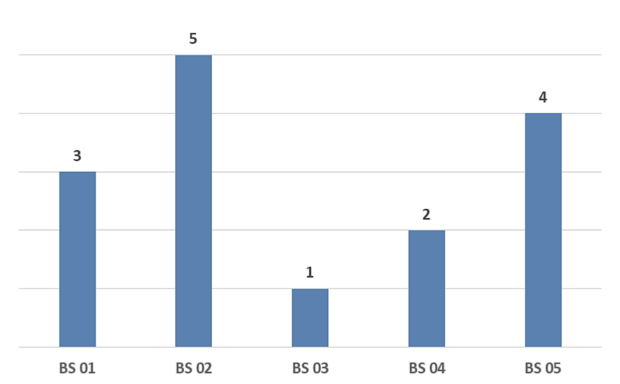

Fig. 2. Rating by smoking properties of tobaccos from Basma ecotype (Sample coding is as given in Table 1)

Accordingly, the results from the valuation of the smoking properties of the tobaccos from Basma ecotype produced in the four regions included in the study (Fig. 2) also revealed statistically significant (reliable) differences between them ($W=0.60$; $\alpha=0.05$). In the rating order of Basma ecotype tobaccos the best graded by its smoking performance was the sample from region Momchilgrad (BS 03), followed by those produced in regions Svilengrad (BS 04) and Krumovgrad (sub-region Krumovgrad; BS 05), while the lowest rank was attributed to the tobacco from Krumovgrad region (sub-region Zvezdel; BS 02).

3.4 Complex quality rating

As stated earlier, the final complex quality rating of the tobaccos within the respective ecotypes was based on the results achieved in each of the above-described steps of the evaluation procedure, namely those in regard with selected chemical indicators of tobacco and tobacco smoke (nicotine and reducing sugars, as well as the ratio between them, and the tar content in the smoke), the expert rating by leaf quality properties and the smoking tests [18]. The approach for the interpretation of data for the chemical composition of the tobaccos in the study (Table 2) was as follows: nicotine content was rated unidirectionally according to its nominal value, i.e., the highest concentration achieved the highest rank (rank 1). Reducing sugars contents were rated relative to the range accepted as optimal for Oriental tobaccos, 10-16%, in which all concentrations outside that range, either higher or lower, were rated negatively, i.e., the respective samples were assigned proportionally lower ranks. The same considerations were applied for the interpretation (rating) of the results for the ratio between nicotine and reducing sugars in the respective tobacco samples, referring to the optimal range of 6.00-10.00. The rating order with regard to the tar content in tobacco smoke was obtained unidirectionally starting from the minimal tar level (rank 1). The results from the rating of leaf quality elements and smoking properties (Table 3 and Table 4; Fig. 1 and Fig. 2) were applied directly. Thus, the resultant quality indices reflecting the relative importance of each quality element included in the matrix could be considered a complex expression of tobacco quality.

Table 4. Rating by smoking properties of tobaccos from Krumovgrad ecotype

Expert No	Sample [1)]											
	KR 01	**KR 02**	**KR 03**	**KR 04**	**KR 05**	**KR 06**	**KR 07**	**KR 08**	**KR 09**	**KR 10**	**KR 11**	**KR 12**
1	3	5	7.5	11	3	7.5	6	9	1	3	11	11
2	3	6.5	4.5	9	1.5	9	6.5	9	1.5	4.5	11.5	11.5
3	2	6	7.5	10	3	7.5	4.5	9	1	4.5	11.5	11.5
4	1	5	7.5	9.5	2	7.5	5	9.5	3	5	12	11
5	2	6	7.5	10	3	7.5	4.5	9	1	4.5	11.5	11.5
$\sum X_{ij}$	*11*	*28.5*	*34.5*	*49.5*	*12.5*	*39*	*26.5*	*45.5*	*7.5*	*21.5*	*57.5*	*56.5*
Rating	**2**	**6**	**7**	**10**	**3**	**8**	**5**	**9**	**1**	**4**	**11.5**	**11.5**

[1)] Sample coding is as given in Table 1.

The rating based on the complex quality valuation of the studied tobaccos from ecotypes Krumovgrad and Basma, respectively, is presented in Fig. 3 and Table 5.

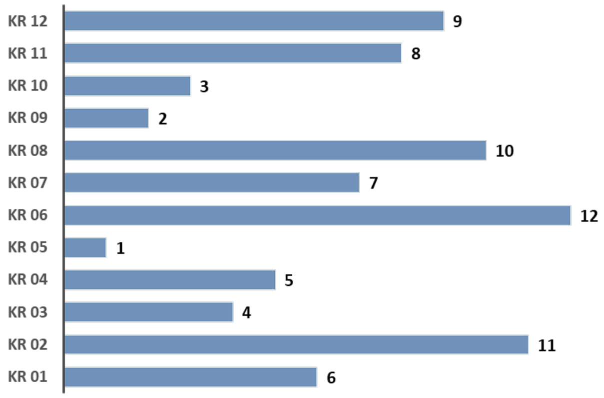

Fig. 3. Complex quality rating of tobaccos from Krumovgrad ecotype (Sample coding is as given in Table 1)

As described in the methodology section, the lower value of the respective quality index corresponded to higher quality, thus the complex quality rating of the tobaccos within Krumovgrad ecotype (Fig. 3) was as follows: the best rated tobaccos were those produced in regions Kardzhali (micro-region Patitsa), Haskovo-Harmanli (Stambolovo) and Ivaylovgrad (Belopoltsi), followed in descending order by the tobaccos from regions Krumovgrad (micro-regions Krumovgrad, Zvezdel and Baratsi), Svilengrad (Dimitrovche), Dzhebel (Fotinovo and Dzhebel), Svilengrad (Shishmanovo) and Krumovgrad (Strandzhevo), while the last place was occupied by the tobacco from region Momchilgrad (micro-region Chorbadzhiisko).

In turn, the results obtained for the tobaccos representing the ecotype Basma in the study revealed better indicators of the complex quality valuation in the tobaccos from Svilengrad region, followed by those from Momchilgrad, Krumovgrad (micro-region Krumovgrad), Haskovo, and at the end – from Krumovgrad (micro-region Pashintsi).

Table 5. Complex quality rating of tobaccos from Basma ecotype

Index	Sample rank by index [1]					Coefficient of importance	Quality index				
	BS 01	BS 02	BS 03	BS 04	BS 05		BS 01	BS 02	BS 03	BS 04	BS 05
Nicotine, %	3.5	5	1	3.5	2	0.20	0.70	1.00	0.20	0.70	0.40
RS [2], %	2.5	2.5	5	2.5	2.5	0.12	0.30	0.30	0.60	0.30	0.30
RS/Nicotine	2	5	4	2	2	0.18	0.36	0.90	0.72	0.36	0.36
Tar, mg/cig	1	4	2	3	5	0.10	0.10	0.40	0.20	0.30	0.50
Expert rating	3	1	4	2	5	0.15	0.45	0.15	0.60	0.30	0.75
Smoking rating	3	5	1	2	4	0.25	0.75	1.25	0.25	0.50	1.00
Total of quality indices							*2.66*	*4.00*	*2.57*	*2.46*	*3.31*
Rank							**3**	**5**	**2**	**1**	**4**

[1] Sample coding is as given in Table 1; [2] RS – reducing sugars, %.

4 Conclusions

The comparative multi-step analysis of the quality level in the monitoring of 2019 crop year Oriental tobaccos from the market sector of the "Basmi" variety group (ecotypes Krumovgrad and Basma) from different production areas in Bulgaria provided grounds for the following conclusions:

- In terms of the characteristic chemical indices of tobacco, a more balanced chemical composition within the tobaccos from Krumovgrad ecotype was revealed by "Krumovgrad 78" variety from region Kardzhali and "Krumovgrad 58" variety from regions Krumovgrad (micro-region Krumovgrad), Ivaylovgrad (micro-region Belopoltsi) and Dzhebel (micro-region Dzhebel). Accordingly, for the tobaccos in the Basma ecotype the balance in the chemical composition was better expressed in the samples from regions Haskovo, Svilengrad and Krumovgrad (micro-region Krumovgrad).
- In the assessment of the external leaf quality properties, statistically significant differences were established between the tobaccos compared within the respective ecotype. The best expert quality rating for ecotype Krumovgrad was that of "Krumovgrad 58" variety from region Svilengrad (sub-region Harmanli-Yaka), followed by the same variety from Dzhebel (sub-region Benkovski), "Krumovgrad 78" variety from Kardzhali and "Krumovgrad 58" variety from Krumovgrad (sub-region Krumovgrad), the latter sharing the same rank. In turn, for the tobaccos from ecotype Basma the best rated were the samples from Krumovgrad (micro-region Pashintsi) and Svilengrad (micro-region Raykova Mogila).
- The best smoking properties within the tobaccos from ecotype Krumovgrad were revealed by "Krumovgrad 58" variety from Haskovo-Harmanli region, followed by "Krumovgrad 90" variety from Krumovgrad (micro-region Baratsi) and "Krumovgrad 78" variety from Kardzhali (micro-region Patitsa); respectively, for ecotype Basma – by the tobaccos from regions Momchilgrad, Svilengrad and Krumovgrad (micro-region Krumovgrad).
- The rating of the investigated tobaccos by complex quality expression concluded that the best quality indicators for Krumovgrad ecotype were achieved by "Krumovgrad 78" variety in region Kardzhali (micro-region Patitsa), and "Krumovgrad 58" variety in regions Haskovo-Harmanli (Stambolovo) and Ivaylovgrad (Belopoltsi). The best complex quality among the studied tobaccos from Basma ecotype

characterized those produced in Svilengrad and Momchilgrad regions.

As final remarks, it could be pointed out that the findings by this study once again supported the importance of annual monitoring of the quality level of Bulgarian Oriental tobacco, as there is an undisputed need of adequate and carefully interpreted data in the national tobacco sector.

References

1. G. Gay, Tob. Rep. **1**, 30 (2020)
2. A. Kinay, Ind. J. Agric. Sci. **90**, 874 (2020)
3. D. Kurt, S. Afr. J. Bot. **154**, 190 (2023)
4. A. Kinay, Commun. Soil Sci. Plant Anal. **54**, 62 (2023)
5. M. Odabas, N. Şenyer, D. Kurt, Concurr. Comput. Pract. Exper. **35**, e7506 (2023)
6. A. Kinay, M. Comert, D. Kurt, Commun. Soil Sci. Plant Anal. **53**, 2105 (2022)
7. A. Kinay, H. Erdem, Turkish J. Agric. Food Sci. Technol. **9**, 601 (2021)
8. I. Tabaxi, C. Zisi, S. Karydogianni, A. Folina, I. Kakabouki, A. Kalivas, D. Bilalis, Asian J. Agric. Biol. **1**, 1 (2021)
9. M. Tepecik, A. Ongun, Turkish J. Agric. Res. **7**, 156 (2020)
10. D. Kurt, A. Kinay, Ind. Crops Prod. **162**, 113276 (2021)
11. M. Senbayram, S. Ekren, S Sekin, Proceed. "Workshop on Tobacco Agriculture and Its Problems in the Aegean Region", December 21, Bornova/İzmir, 75-89 (2005)
12. D. Kurt, Contrib. Tob. Nic. Res. **30**, 50 (2021)
13. D. Kurt, G. Yılmaz, Anadolu Tarim Bilim. Derg. **35**, 59 (2020)
14. S. Ekren, Fresenius Environ. Bull. **27**, 313 (2018)
15. Y. Karabulut, S. Ekren, J. Agric. Sci. **6**, 282 (2022)
16. J. Trajkoski, M. Mitreski, V. Pelivanoska, N. Zdraveska, R. Mavroski, Tobacco. **65**, 80 (2015)
17. H. Karim, M. Mohammad, J. Zankoy Sulaimani – Part A. **22**, 89 (2020)
18. V. Nikolova, N. Nikolov, V. Popova, S. Peeva, D. Drachev, IOP Conf. Ser.: Mater. Sci. Eng. **1031**, 012095 (2021)
19. ISO 15152:2003. *Tobacco. Determination of the content of total alkaloids as nicotine – continuous-flow analysis method* (International Organization for Standardization (ISO), Geneva, Switzerland, 2003)
20. ISO 15154:2003. *Tobacco. Determination of the content of reducing carbohydrates – continuous-flow analysis method* (International Organization for Standardization (ISO), Geneva, Switzerland, 2003)
21. BDS 15836:1988. *Tobacco and tobacco products. Methods of total nitrogen determination* (Bulgarian Institute for Standardization, Sofia, 1988) [in Bulgarian]
22. ISO 2817:1999. *Tobacco and tobacco products. Determination of silicated residues insoluble in hydrochloric acid* (International Organization for Standardization (ISO), Geneva, Switzerland, 1999)
23. S. Gueorgiev, V. Popova, Biotechnol. Biotechnol. Equip. **1**, 61 (1999).
24. BDS 9271:1985. *Tobacco and tobacco products. Bulgarian Oriental tobacco, fermented and manipulated* (Bulgarian Institute for Standardization, Sofia, 1985) [in Bulgarian]
25. V.P. Borovikov, I.P. Borovikov, *STATISTICA. Statistical analysis and data processing in the Windows environment* (Filin, Moscow, 1998) [in Russian]