Complex technological profiling of market dominating Oriental tobaccos from Krumovgrad region (Bulgaria)

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Abstract. The production of Oriental tobacco in Bulgaria in the last years has focused on varieties and ecotypes that are internationally marketable. The transformations in the tobacco sector and the established market trends substantiate the systematic, scientifically sound investigation of the technological quality of the Oriental tobacco leaf material, produced in Bulgaria. Therefore, the objective of this study was the comparative, chemical and technological, assessment of export-oriented Oriental tobaccos from Krumovgrad region. The objects of investigation were tobaccos from ecotype Krumovgrad (variety “Krumovgrad 90”), ecotype Katerini (variety “Katerini”) and ecotype Greek Basma (variety “Basma”); all from 2017 crop year, produced in four micro regions. The tobacco varieties were successively assessed in terms of leaf and smoke chemical composition, expert and smoking quality; the final complex rating was based on a formulated “quality index”. The comparative analysis, chemical and technological, of the market-dominating Oriental tobaccos from Krumovgrad region revealed that the Greek varieties “Basma” and “Katerini” were distinguished by a specific quality formation, compared with the traditional Bulgarian variety “Krumovgrad 90”. Differences were observed on a sub region and micro region basis. The complex evaluation of the tobaccos, based on chemical indices, expert and smoking assessment, spoke in favor of the Greek varieties.

1. Introduction
The important contribution of Bulgarian Oriental tobacco production to the gross national agricultural production can also be measured in terms of the employment of thousands of tobacco farmers, cultivating lands in specific disadvantaged areas; it has substantial impact on farmers’ social status and on the economic priorities of the respective administrative units [1]. The production of Oriental tobacco in Bulgaria in the last years has focused on varieties and ecotypes that are actually marketable on the international markets. This tendency resulted in the introduction of foreign varieties (mainly Greek), institutionally recognized, in some tobacco producing regions (those in South-West and South-East Bulgaria), thus enriching substantially the varietal structure of tobacco production. In many cases the newly introduced tobacco varieties fail to develop - sustainably over the years - their quality potential in the regions, due to the influence of various factors, e.g. limited adaptability, inadequate assessment of biological capacity towards the local ecological conditions, applied agricultural practices, and others; similar observations have been reported on a worldwide basis, as well [2-4]. Therefore, substantial interest has been focused on tendency establishment, allowing for the forecasting and targeting of
tobacco production (ecotypes) in the regions, by means of maintaining and development of consistent investigation (data collection and variety evaluation) on the status and the quality formation of tobacco production, as well as on the driving factors and mechanisms [5-11]. On the other hand, the varietal production re-structuring objectivizes certain consolidation of the Oriental tobacco ecotypes, thus increasing the opportunities to ensure constant amounts necessary for the manufacture of sufficiently large batches for export with defined quality characteristics by the leaf processing companies [12].

As it is known, the basic prerequisite for the production and marketing of high quality leaf tobacco is the technological comprehension of the capacity of the varieties, as well as the introduction of ones with valuable biological and economic indicators. Therefore the positive results will be strongly dependent on the successful choice of tobacco varieties, according to their designation, the existing ecological background and agricultural practices. Despite the availability of numerous varieties combining excellent biological, morphological, chemical, technological, and sensory traits worldwide, not all of them manage to adapt and manifest their nature in regions differing by soil and climatic conditions from the regions of their initial design; therefore, the choice of suitable varieties and production technologies is decisive in the manifestation of the inherent quality characteristics of the tobaccos from the respective ecotypes [13].

The current national production of Oriental tobacco in Bulgaria is determined predominantly by ecotype Krumovgrad (mainly “Krumovgrad 90” variety), together with a certain increase in the demand, respectively – in the production, of the Greek ecotypes Katerini and Greek Basma. The transformations in the Bulgarian tobacco sector and the established market trends substantiate the systematic, scientifically sound investigation of the technological quality of the Oriental tobacco leaf material produced in Bulgaria, which is an important segment of the national agricultural and economic reality. Based on these considerations, the objective of this study was the comparative, chemical and technological, assessment of export-oriented Oriental tobaccos from Krumovgrad region.

2. Materials and methods

2.1. Plant material

The object of investigation were Oriental tobacco varieties (Nicotiana tabacum L.,) of ecotype Krumovgrad (variety “Krumovgrad 90”), ecotype Katerini (variety “Katerini”) and ecotype Greek Basma (variety “Basma”); all from 2017 crop year, produced in real production conditions in four micro regions of Krumovgrad region. The scheme of the sub- and micro regions that provided the tobacco ecotypes in the study is presented on Figure 1.

All tobacco materials were taken from different farmer lots in the respective producing micro region, in the form of stringed cured leaves. The bulk leaf samples were based exclusively on leaf material from upper stalk positions (upper middle leaves, kovalama and outh), representing the most characteristic and high quality leaf material in Oriental tobacco, corresponding to the standard first grade in commercial grading. The samples were further refined, by exclusion of damaged leaves, to uniform representative samples. The average analytical samples were obtained by mixing equal amounts of the selected stalk positions within the range of each micro region.
2.2. Tobacco material evaluation procedure

The tobacco varieties in the study were successively assessed by the following indices:

- **Tobacco chemical composition.** The basic chemical indices of tobacco leaf (%) were determined by a continuous-flow analysis, according to the standard methods, as follows: total alkaloids (as nicotine) [14], reducing sugars (RS) [15], total nitrogen [16], mineral matter (ash) [17], and potassium (as K$_2$O) [18]. Two derivative indices were calculated – reducing sugars/nicotine and reducing sugars/ash, informative of tobacco content balance.

- **Smoke composition.** Smoke tar and nicotine contents (mg/cig) were calculated according to the model described in [19]. The results refer to a standard filter-tipped cigarette, with 21 mm filter rod length, 3/35000Y acetate filament, 84 mm total cigarette length, and 7.9 mm cigarette diameter.

- **Expert assessment.** The analysis was performed by a five-member expert panel, by the direct comparison method. The experts ranked the coded samples according to the integrated perception of leaf quality elements. Expert rankings were processed for statistical significance and unanimity by calculating the relative ranking coefficient (RRC), the ranking coefficient (RC) and the coefficient of concordance ($W$), applying the $F$-test (at a hypothesis probability level of 95%). The threshold $W$ value for statistical agreement of individual results was 0.50; the $W$ values proven as reliable by the $F$-test indicated that the experts ranked the samples unanimously and the differences were really existing [20].

- **Smoking assessment.** Smoking tests (with cigarettes made from the respective cut rag tobacco) were performed by a five-member smoking panel, by the direct comparison method. The statistical processing of the individual results was the same as in the expert assessment [20].

- **Complex evaluation.** The complex evaluation included the indices determining tobacco quality; in particular, chemical composition (characteristic indices of Oriental tobacco, nicotine, RS, RS/nicotine), smoke composition (tar), expert and smoking assessment. The ranking of the varieties in the procedure was a function of the results from the analysis of the respective index, according to its correlation, positive or negative, with leaf quality. In brief, for positively-related indices, the sample with the highest index value was awarded rank one, the rest of the samples were ranked in descending order, and vice versa for negatively-related indices. A coefficient of importance was proposed in advance by the expert panel for each of the indices. The final rating of the tobaccos was achieved by formulating a “quality index” as a complex characteristic of tobacco quality; the lower value of the index indicated better quality [21].
3. Results and discussion

3.1. Chemical composition of tobacco and tobacco smoke.

Data about the analyzed indices of the chemical composition of the studied tobaccos are presented on Figure 2, and those about smoke composition indices – on Figure 3.

As seen from the data in Figure 2, significantly higher nicotine contents were found in the tobaccos of the Basma ecotype, 3.30% and 2.89%; respectively, the lowest levels, with no statistical difference between them, were in the local “Krumovgrad 90” variety (micro region Krumovgrad, 1.27%) and the Greek “Katerini” variety (1.37%). The local variety from the other two micro regions, Baratzi and Strandzhevo, showed considerably high nicotine content, with no significant variation, 2.00% and 2.23%. The RS content varied in a very wide range, from 4.66% to 15.50%; non-distinctive differences were found between “Krumovgrad” 90 (Baratzi) and “Basma” (Buk), and between “Katerini” and “Basma” (Baratzi). Total nitrogen contents were relatively high, ranging from 2.36% in “Basma”, Baratzi (also: 2.37% in “Krumovgrad 90”, Strandzhevo) to 3.46% in “Krumovgrad” 90 (Krumovgrad). The Greek varieties, “Basma” and “Katerini”, had significantly higher levels of ash and potassium, compared with the local “Krumovgrad 90” variety. The ratio RS/nicotine, important for smoke taste perception, was most balanced in “Krumovgrad 90” (Strandzhevo) and in the Greek “Katerini” varieties, falling within the desired range of 6-10; the rest of the tobaccos were with substantially lower index values, 2.86-4.17, suggestive of existing misbalance in leaf composition. The Greek varieties were distinguished by lower values (0.71-0.83) of the second calculated index, RS/ash, compared with the local variety (0.95-1.81), with the single exception of “Krumovgrad” 90 (Krumovgrad, 0.43); the lower index value suggested worsened general quality.
Figure 3. Smoke composition indices for the studied Oriental tobaccos from Krumovgrad region. 

Kr90 – “Krumovgrad 90” variety (three micro regions); Kat – “Katerini” variety (one micro region); Bas – “Basma” variety (two micro regions).

Smoke nicotine variation (Figure 3) followed the pattern observed for the leaf nicotine content in the studied tobaccos. The tobaccos formed three couples according to the content of smoke nicotine, with no significant differences within the groups; the lowest levels were in “Krumovgrad 90” and “Katerini” from micro region Krumovgrad (1.09 and 1.18 mg/cig), and the highest – in “Basma” from micro regions Buk and Baratzi (3.12 and 2.65 mg/cig). The Greek varieties “Basma” and “Katerini” produced definitely lower tar levels in the smoke (16.59-18.22 mg/cig) than the traditionally produced in the region local “Krumovgrad 90” variety (20.23-31.13 mg/cig).

The results from the analyses of leaf and smoke chemical composition revealed that the Greek Basma ecotype tobaccos were with higher nicotine, ash and potassium content, lower nitrogen and tar content, and similar RS content, compared with the traditionally produced “Krumovgrad 90” variety (ecotype Krumovgrad). “Katerini” variety, compared to “Krumovgrad 90”, in turn, was characterized by higher ash and potassium content and lower tar content, while the rest of the chemical indices were within the characteristic range for Oriental tobacco. The comparison of the tobaccos produced in Krumovgrad region suggested a more balanced chemical composition of the local “Krumovgrad 90” variety from micro region Strandzhevo.

3.2. Expert assessment

As already described, the expert assessment of the Oriental tobacco varieties produced in four micro regions of Krumovgrad region took in consideration the integrated manifestation of all external leaf quality elements. The results from the assessment by the expert panel are presented in Table 1.

As seen from the data in Table 1, the expert assessment of tobacco leaf quality revealed definitively better quality levels in the “Basma” variety from micro region Baratzi, followed by “Basma” (micro region Buk), “Katerini (Krumovgrad) and the “Krumovgrad 90” variety tobaccos (Strandzhevo, Baratzi and Krumovgrad). The rating was proven statistically significant at 95% probability (W=0.88).
Table 1. Expert assessment of the studied Oriental tobaccos from Krumovgrad region.

| Expert No | Variety (micro region) | Bas (Baratzi) | Bas (Buk) | Kat (Krumovgrad) | Kr 90 (Baratzi) | Kr 90 (Strandzhevo) | Kr 90 (Krumovgrad) |
|-----------|------------------------|---------------|-----------|------------------|----------------|---------------------|--------------------|
| 1         |                        | 1             | 2         | 3                | 5              | 4                   | 6                  |
| 2         |                        | 1             | 2         | 3                | 3.5            | 3.5                 | 5                  |
| 3         |                        | 1             | 2         | 3                | 5              | 4                   | 6                  |
| 4         |                        | 1             | 2         | 3                | 5              | 4                   | 6                  |
| 5         |                        | 1             | 2         | 3                | 4              | 5                   | 6                  |
| ∑x_{ij}   |                        | 5             | 10        | 15               | 22.5           | 20.5                | 29                 |
| RRC^{d}   |                        | 0.05          | 0.10      | 0.15             | 0.22           | 0.20                | 0.28               |
| RC^{e}    |                        | 1.00          | 0.50      | 0.33             | 0.22           | 0.24                | 0.17               |

Rating: 1 2 3 5 4 6

a Variety “Basma” (two micro regions).
b Variety “Katerini” (one micro region).
c Variety “Krumovgrad 90” (three micro regions).
d Relative ranking coefficient.
e Ranking coefficient.

3.3. Smoking assessment.

The smoking assessment procedure, according to the above-described scheme, resulted in the rating of the studied tobacco varieties according to the integrated perception and evaluation of all sensory characteristics of tobacco smoke, i.e. aroma, taste, strength, and their individual features (Table 2).

Table 2. Smoking assessment of the studied Oriental tobaccos from Krumovgrad region.

| Expert No | Variety (micro region) | Bas (Baratzi) | Bas (Buk) | Kat (Krumovgrad) | Kr 90 (Baratzi) | Kr 90 (Strandzhevo) | Kr 90 (Krumovgrad) |
|-----------|------------------------|---------------|-----------|------------------|----------------|---------------------|--------------------|
| 1         |                        | 1             | 3.5       | 2                | 3.5            | 5.5                 | 5.5                |
| 2         |                        | 1             | 3.5       | 2                | 3.5            | 5.5                 | 5.5                |
| 3         |                        | 1             | 4         | 2                | 4              | 4                   | 6                  |
| 4         |                        | 1             | 4.5       | 2.5              | 4.5            | 2.5                 | 6                  |
| 5         |                        | 1             | 3.5       | 2                | 3.5            | 5.5                 | 5.5                |
| ∑x_{ij}   |                        | 5             | 19        | 10.5             | 19             | 23                  | 28.5               |
| RRC^{d}   |                        | 0.05          | 0.18      | 0.10             | 0.18           | 0.22                | 0.27               |
| RC^{e}    |                        | 1             | 0.26      | 0.48             | 0.26           | 0.22                | 0.18               |

Rating: 1 3.5 2 3.5 5 6

a Variety “Basma” (two micro regions).
b Variety “Katerini” (one micro region).
c Variety “Krumovgrad 90” (three micro regions).
d Relative ranking coefficient.
e Ranking coefficient.

The rating of the tobaccos from the smoking tests, providing the most direct assessment of tobacco quality (Table 2), were in favor of the “Basma” variety from micro region Baratzi, followed by “Katerini” variety (Krumovgrad micro region); the rest of the tobaccos were rated in descending order, “Basma” (Buk) and the local “Krumovgrad 90” variety from the three micro regions (Baratzi, Strandzhevo and Krumovgrad). The rating was unanimous and statistically significant (W=0.83).
The parallel between the results from the two subjective sensory test procedures, the expert and the smoking assessment, revealed that there was not a complete concurrence, due to the absence of unanimous correlation between external leaf quality elements and smoking profile in tobacco. From the perspective of tobacco farmers the expert assessment has a relatively greater significance, while the smoking assessment prevails in importance from the point of view of tobacco product manufacturers.

3.4. Complex evaluation.
According to the established analytical approach, the final evaluation of tobacco quality levels in the study was completed on the basis of sample rating at different coefficients of importance (relative weight) for the basic quality indices, as shown in Table 3.

In order to derive the respective variety ranks, it was necessary to specify, in advance and in a more precise way, the interpretation of data about the chemical composition of tobacco leaves and smoke. Thus, nicotine was ranged according to its absolute content value, i.e. the highest content in the respective tobacco was awarded rank one, and so forth. The RS contents were ranked in relation to the accepted optimal range, 10÷16%; higher and lower RS values, respectively, delivered lower tobacco ranks. The same approach was applied for the interpretation of RS/nicotine ratio, with an optimal range of 6÷10. The ranking of tobaccos according to the tar content (mg/cig) was from the minimal (rank one) to the maximal (rank six) value. The final ranks obtained from the expert and smoking assessment were applied directly. The calculated quality indices in the evaluation matrix were considered as a complex expression of tobacco variety quality.

Table 3. Complex evaluation matrix of the investigated tobaccos from Krumovgrad region.

| Index                | Variety rank | CI g | Quality index |
|----------------------|--------------|------|---------------|
|                      | Bas (A) b | Bas (B) b | Kat c | Kr90 (A) d | Kr90 (B) c | Kr90 (C) f | Bas (A) | Bas (B) | Kat | Kr90 (A) | Kr90 (B) | Kr90 (C) |
| Nicotine (%)         | 2         | 1     | 5     | 3     | 4     | 6     | 0.20 | 0.40 | 0.20 | 1.00 | 0.60 | 0.80 | 1.20 |
| RS (%)               | 2         | 4     | 2     | 5     | 2     | 6     | 0.12 | 0.24 | 0.48 | 0.24 | 0.60 | 0.24 | 0.72 |
| RS/Nicotine          | 4         | 6     | 1.5   | 3     | 1.5   | 5     | 0.18 | 0.72 | 1.08 | 0.27 | 0.54 | 0.27 | 0.90 |
| Tar (mg/cig)         | 2         | 1     | 3     | 5     | 4     | 6     | 0.10 | 0.20 | 0.10 | 0.30 | 0.50 | 0.40 | 0.60 |
| Expert               | 1         | 2     | 3     | 5     | 4     | 6     | 0.15 | 0.15 | 0.30 | 0.45 | 0.75 | 0.60 | 0.90 |
| Smoking              | 1         | 3.5   | 2     | 3.5   | 5     | 6     | 0.25 | 0.25 | 0.88 | 0.50 | 0.88 | 1.25 | 1.50 |
|                      | Sum of quality indices | 1.96 | 3.04 | 2.76 | 3.87 | 3.56 | 5.82 |
| Rating               | 1         | 3     | 2     | 5     | 4     | 6     |

a Variety “Basma” (micro region Baratzi).
b Variety “Basma” (micro region Buk).
c Variety “Katerini” (micro region Krumovgrad).
d Variety “Krumovgrad 90” (micro region Baratzi).
e Variety “Krumovgrad 90” (micro region Strandzhevo).
f Variety “Krumovgrad 90” (micro region Krumovgrad).
g Coefficient of importance.
h Reducing sugars.

As seen from Table 3, the final rating of the tobaccos in the study by the complex evaluation of tobacco quality indices was as follows: the best rated was the “Basma” variety from micro region Baratzi, followed by “Katerini (Krumovgrad) and “Basma” (Buk), and finally the tobaccos of the local “Krumovgrad 90” variety from the three micro regions (Strandzhevo, Baratzi and Krumovgrad).
4. Conclusions
The comparative analysis, chemical and technological, of the market-dominating Oriental tobaccos from Krumovgrad region in Bulgaria revealed that the Greek selection - “Basma” and “Katerini”, was distinguished by a specific quality formation, compared with the Bulgarian selection - “Krumovgrad 90”. Moreover, differences were observed on a sub region and micro region basis. The local “Krumovgrad 90” variety from micro region Strandzhevo was with the most favourable chemical composition, while the expert and smoking assessment tests prove some superiority of the Greek varieties composition. The final, complex evaluation of the tobaccos, based on chemical indices, expert and smoking assessment, spoke in favour of the quality indices of the studied Greek selection of varieties.

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