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Characterization of the General Quality of Kentucky Dark Fire-cured Tobacco Grown in Bulgaria

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Abstract

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Kentucky dark fire-cured tobacco finds its origin and has shaped as an individual tobacco type under the environmental conditions of North America. The type is not traditional for the agro-climatic conditions of Bulgaria. The aim of the current study was to evaluate by objective criteria the general quality of Kentucky dark fire-cured tobacco produced in Bulgaria. Tobacco was characterized with respect to the basic chemical and physical indexes of quality, expert and smoking assessment were also conducted. It was determined that with the applied technologies for production and curing tobacco developed quality profile corresponding to the basic requirements of the type.

Key words: dark fire-cured tobacco, Kentucky, quality indexes

Introduction

Kentucky dark fire-cured tobacco originated and shaped as distinct tobacco type (U.S. types 22 and 23) under the environmental conditions of North America, still being the major region of its production. The average dimensions of the last crop year in the USA were: crop area - 56600 da; average yield – 375 kg/da and total production of about 16.5 million kg/year (Capehart, 2006).

Miller and Fowlkes (1999), Maksymowicz (1997), Pearce et al. (2007) outline the basic characteristics of Kentucky dark fire-cured tobacco, as well as the technological requirements for its growing, curing, firing and market preparation. Tobacco plants are well-developed, high, and luxuriant, with a cylindrical or conical shape; leaves are dark green in color. Tobacco is grown on deep, well-drained soils, rich in organic matter, at relatively high rates of mineral fertilization; for the

enhancement of material quality topping of the plants is required. Traditionally, cut stalks are harvested and cured, but the practice of individual leaf picking and curing of tied leaves also exists. In the latter case, harvesting is typically conducted in 4 consecutive pickings, detaching 4-5 mature leaves from the stem at a time. Leaves normally are ready between 3 and 5 weeks after topping. With the leaf-by-leaf harvesting, the first picking usually takes place around the end of July or the beginning of August, and the rest follow in intervals of 15-20 days. From a technological and quality point of view the leaves from the second and third priming outdo those from the first and especially those from the fourth priming. Curing is done in barns, firing the tobacco over open fires from oak logs. Properly cured and finished tobacco should be medium to heavy bodied, with even dark brown to red-brown color, rich in nicotine and specified by distinctive strong flavor and aroma, due to the parallel running of drying and exposing to smoke. Cured leaves are large – 50-80 cm, lanceolated, thick, firm to close in structure, rich in nicotine (in some cases up to 5-8%) and with low sugar content – 1-2%. The smoke is alkaline; the smoking profile is characterized by intense flavor and aroma, pronounced physiological strength and "doping" satisfaction. Kentucky dark fire-cured tobacco is used for various products – dry and moist snuff, roll and plug chewing tobacco, strong black cigarettes, some specialty-type cigars, pipe and RYO/MYO tobacco blends (Leffingwell, 2001; Wahlberg and Ringberger, 1999).

Researchers (Maksymowicz, 1997; Miller and Fowlkes, 1999; Pearce et al., 2007) point out that the curing of dark tobacco is often more and art than science, the most crucial moment in the entire processing being its firing. The transformations in the chemical composition and the technological properties of the leaves during the process are so significant and complex that they are considered responsible for the formation of the overall quality of the final product. The firing process gives the name of the tobacco type - dark fire-cured (dark-fired) tobaccos, meaning that leaves are directly subjected to the smoke from open fires lit on the barn floor. Especially important is regarded the choice of firewood – fires require not very dry, strong-essence hard wood (e.g. oak), and in no way softwood or other resinous material, that will add undesirable odor to tobacco and will harshly and irreversibly impair its quality. For the optimal running of the process uniform distribution of temperature and humidity across the whole curing barn should be guaranteed.

Research on the chemical composition of dark fire-cured tobacco is rather sparse, devoted mainly to the disclosure of the contribution of firing (smoke) to the formation of the specific quality of the type, in terms of identifying smoke-derived and tobacco-inherent constituents as well as elucidating their relation to the consumer properties of the final products. Wahlberg and Ringberger (1999) report that the volatile fraction obtained from American dark fire-cured tobacco is an extremely complex mixture consisting of "genuine" tobacco constituents as well as of components derived from the hardwood smoke deposited onto the tobacco leaf during the fire-curing process. Thus, of the 300 neutral compounds identified by GC-MS, more than 150 are derived from tobacco itself and some 140 are derived from the hardwood smoke. Most of the

compounds in the former group have been previously reported as constituents of other tobaccos. The latter group incorporates compounds associated with the aroma of tobacco and other smoked products, among which a whole series of Maillard products. Some 80 compounds were identified in the fraction containing weak acids, alkylphenols, quaiacols and syringols as major components, and cyclotenes and maltols as minor components. These compounds, which are largely derived from the hardwood smoke, give important contribution to the smoky, spicy, woody and sweet flavor of the fire-cured tobacco. Therefore, the selection of the most suitable hardwood for the process of firing is extremely important. Leffingwell and Alford (1998) investigated extracts from Kentucky tobacco to determine the main aroma precursors, inherent to tobacco or generated under the exposure to hardwood smoke. The authors specify that the lignin derived constituents of the phenolic complex during wood pyrolysis, such as syringol and related compounds, are the heart of tobacco aroma. These compounds are only generated during the curing and firing stages and practically are absent in extracts from other tobacco types. Other aroma-contributing compounds are also products of cellulose pyrolysis – maltol, furfural, and various cyclopentenolones, adding the "burnt sugar" note of the smoke.

Kentucky dark fire-cured tobacco is not typical for the agro-climatic conditions of Bulgaria, where it is not grown. Bulgaria is a traditional producer and exporter of high quality Oriental tobaccos; Virginia flue-cured and Burley are also produced in the country. No tobacco products containing Kentucky tobacco are manufactured in Bulgaria; the domestic consumption of such products is negligible and is secured by import.

The aim of our study was to follow the formation of the quality of Kentucky tobacco when grown under the conditions of Bulgaria with the application of adapted technologies for growing and curing, as well as to evaluate its general quality through objective characteristics.

Materials and Methods

A. Preparation of tobacco

Preliminary experiments were conducted, aimed at specifying the conditions of growing and curing that would most closely resemble the traditionally adopted technologies of the leading Kentucky dark fire-cured producing countries. The curing and firing stages were conducted in a reconstructed barn, originally used for flue-curing Virginia tobacco. The reconstruction included building of an outer burning chamber (fireplace) with attached exit tubes for smoke flue. The curing barn was equipped with bottom and top ventilation outlets. The process of curing included the following basic steps:

- *Housing the tobacco* – after elimination of defective, musty, crumpled, broken leaves, they were tied on laths at an average density of 45 leaves per linear meter. The approximate amount of tobacco in the barn was 800-850 kg.
- *Yellowing the leaves* – the process took 72 hours at constant temperature of 28-29°C and relative air humidity of 78-80%. Maintenance of the above parameters was completed by regulating the fire in the fireplace – more intensive during the night and weaker during the day. The higher air humidity was additionally

secured by periodic wetting of the floor with water.

• *Setting leaf color* – the duration of the phase was 144 hours. During the first 24 hours the temperature in the barn was gradually elevated to 38 °C and kept at that level for the rest of the period. Special attention was paid to the maintenance of good balance between temperature, air humidity and ventilation, in order to enable the development of the desired uniform brown color of leaf lamina.

• *Drying the leaf and browning the stem* – the phase lasted for 96 hours; air parameters in the barn kept at: temperature 40 °C and humidity 32-40% (by regulating ventilation outlets).

• *Drying the stem* – the duration of the phase was 144 hours. The process included a three time repetition of the following cycle: keeping the temperature at 40 °C for 24 hours and extinguishing the fire for another 24 hours, with vents tightly closed.

B. Analyses of tobacco samples

A representative sample was prepared from the cured tobacco material, according to the specifications of the Bulgarian State Standard 8027-75, which was assessed by the following characteristics:

1. Physical parameters of cured leaves – the basic elements of tobacco quality that could be directly measured were determined: leaves' geometric dimensions – by direct measuring (Peeva, 1988); stem percentage – by manual stemming and weighing (Peeva, 1988); density of cut tobacco – by the press method with a density meter (Bulgarian State Standard 16255-85); weight per area leaf lamina – by the disks' method (Peeva, 1988).

2. Outer attributes of tobacco quality – by an expert panel with regard to the quality elements specified in Official Standard Grades for Kentucky and Tennessee Fire-Cured and Foreign-Grown Fire-Cured Tobacco (1986).

3. Chemical indexes

• For the basic chemical indexes of tobacco continuous-flow methods were applied, carried out with a continuous-flow analyzer AA II C, "Technicon", USA:

- total alkaloids (as nicotine), % - ISO 15152;
- reducing sugars, % - ISO 15154;
- protein nitrogen, % - Bulgarian State Standard 15836-88.
- ammonia (ammonia nitrogen) – adapted method of the Institute of Tobacco and Tobacco Products for continuous-flow analysis;

• Total mineral matter (ash), % - ISO 2817;

• Potassium (as K_2O), % - Bulgarian State Standard 17365-94.

• pH of water extract from tobacco – Bulgarian State Standard 13306.

Each of the analyses (physical and chemical) adhered to the respective requirements in terms of minimal necessary number of repetitions and parallel runs.

4. Smoking characteristics – by a 7-member smoking panel, applying the analytical "profile description" method – Bulgarian State Standard 8389-86.

Results and Discussion

The growing and curing of tobacco was carried out by applying an adapted technology, following as closely as possible the classic approaches. The formation of tobacco quality was followed at each stage of the curing process, as expressed by the respective changes in the outer quality

Table 1

Physical parameters of tobacco leaves

Parameter	Dimension	Value
Average leaf length	cm	70
Average leaf width	cm	23
Leaf length/width ratio (leaf shape)	-	3.04
Stem	%	30.43
Average lamina thickness	mm	0.21
Density	g/cm^3	0.366
Weight per area leaf lamina	$g/100\ cm^2$	0.460

Table 2

Parameters of tobacco chemical composition

Characteristics	Value
Nicotine, %	3.59
Reducing sugars, %	2.26
Protein nitrogen, %	1.05
Potassium, %	1.90
Ammonia, %	0.19
Ash, %	14.21
pH	5.32

characteristics of tobacco. In the end of the yellowing phase a uniform deep yellow coloration of the leaves was observed, accompanied by a partial browning of the tips. Leaves were soft and smooth to the touch. In the next phase a uniform browning of leaf lamina was recognized. Upon conclusion of the curing process tobacco formed a uniform deep red to brown color. Leaves were elastic, strong, comparatively smooth and soft to the touch, with a specific, intensive and rich odor.

The physical parameters of the leaves directly measured are presented in Table 1.

Data about leaf geometry led to the conclusion that Kentucky tobacco grown in compliance with the requirements of the traditional technology succeeded to develop broad enough leaves under the soil and climatic conditions of Bulgaria. Leaves were with narrow-elongated (lanceolated) shape and high percentage of midrib (stem). Cured tobacco was of high density both in the cut rag form (bulk density) and the whole leaf form (respective values of 0. 366 g/cm^3 and 0.460 $g/100\ cm^2$). The filling power of cut tobacco, therefore, is expected to be low (2.732 cm^3/g), which should be considered in the design of tobacco products.

The expertise of the cured tobacco material was based on the sensory assessment of the basic elements of quality specified in the official standard grades for

dark fire-cured tobacco (Official Standard Grades for Kentucky and Tennessee Fire-Cured and Foreign-Grown Fire-Cured Tobacco, 1986) - body (density and thickness), maturity, structure, oiliness, elasticity, strength, finish, color, and injury tolerance of cured leaves. The expert panel detected: presence of mature, immature and ripe material in the sample, presence of leaves with more close and open structure, thinner and heavier leaves. The body of the leaves was assessed as medium; leaf surface was oily to rich; the elasticity was medium to good. The strength was within the normal limits of the type. Color intensity was moderate, with clear finish; color was uniform and clean in nature. Injuries were mainly due to mechanical damage.

Among the characteristics of tobacco chemical composition were selected those that basically determine the manifestation of quality and smoking properties of the type. The results are presented in Table 2.

Under the growing conditions of Bulgaria and the applied agricultural and curing practices, tobacco demonstrated nicotine and reducing sugars content within the range, characteristic of the type (http://www.ikisan.com, 2006; Leffingwell, 2001). At that, the proportions influentially determining the character and balance of taste were as follows: Nicotine / Sugars = 0.59 and Nicotine / Proteins = 3.42. Ash content was relatively low which corresponded to the slower burning rate observed during smoking. The level of ammonia (ammonia salts) is an index that is specific and controlled for all dark tobaccos, while it is not determined in bright tobaccos (flue-cured Virginia, Oriental, etc.) (Leffingwell, 2001). Ammonia and ammonia compounds increase smoke alkalinity, in such way substantially influencing the smoking and physiological properties of tobacco smoke. The established ammonia values were low enough as not to expect a prevalent "ammonia touch" during smoking.

Smoking assessment was considered decisive in terms of final evaluation of the quality of Kentucky tobacco grown and cured in Bulgaria. By the descriptive method the elements of tobacco smoking profile were listed. Each feature of tobacco smoking characteristics was assessed in 5 degrees of expression – from weak to strong. The taste was characterized by under-medium to medium bitterness, medium to above-medium harshness, under-medium to medium (but still clean) mouth coating and medium to above-medium fullness, with no clearly detected defects. Aroma was specific and pleasant, described as medium intensive, expressive (typical), pure, dense and complex. Physiological impact was assessed as medium to above-medium, with moderate sharpness. The overall impression was of well-expressed specificity and typicalness of the smoking profile.

Conclusions

The study of the basic quality features of Kentucky dark fire-cured tobacco allows for making conclusions about the formation of tobacco general quality under the growing conditions of Bulgaria. Observing the requirements of the traditional technology of production, and under the adapted scheme of leaf curing and firing, tobacco material was shaped, which did not deviate from the common characteristics of the type in terms of the regarded quality items. On the grounds of

the achieved results certain recommendations about further improvement of some of the curing or processing activities can be formulated, with respect to tobacco leaf usability.

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