Agronomy Research **14**(S2), 1451–1459, 2016

Influence of the packaging material on the quality parameters of tobacco during ageing

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Abstract. Tobacco is one of the most extensively studied plant materials in the history. During its production tobacco leaf goes through many different operations from curing (drying) to ageing. Among all of them storage and ageing are very important operations. Properly stored tobacco develops its full flavour, becomes more aromatic and is ready to be sent to a customer for cigarette production. In this work changes in the quality of dried tobacco leafs during ageing (12 and 24 months) in different packaging materials are evaluated. Four samples of the FCV tobacco (Flue-Cured Virginia) grown in Northern Light Soils (NLS) region (India) were analysed. Two different liners inside of C-48 cartons – polyliner and kraft paper – were used for tobacco packaging. Quality evaluation of tobacco samples was done on the basis of analysis of chemical compo-nents (total alkaloids, reducing sugars, volatiles) and colour changing during the ageing process. Organoleptic analyses were performed as a final assessment of tobacco flavour and quality.

Key worlds: tobacco, total alkaloids, reducing sugars, volatiles, kraft paper, polyliner.

INTRODUCTION

Tobacco is one of the most economically significant agricultural crops in the world. The biggest producers and consumers are China, India, Brazil, USA and the European Union. The most widely used types of tobacco are Flue-Cured Virginia (FCV), Burley and Oriental tobacco (Davis, 1999). FCV tobacco is known for its sweet and aromatic taste and is mainly used for cigarette production. The main exporters of FCV tobacco are Brazil and India. After harvesting, tobacco leaf goes through many operations to become the final product. It must be cured (dried) and graded according a complex of physical characteristics. After packaging, tobacco products are stored and aged in warehouses for a period of 6 months to a couple of years. During each operation, quality control of the product is performed checking its physical or chemical characteristics. Tobacco storage and ageing are the last and very important operations before sending tobacco to a customer. Properly stored tobacco develops its full flavour, becomes more aromatic and usually darkens in colour. It is necessary to provide quality control of the packaging tobacco to avoid any mould or pest damage since it may lead to the loss of the product (Manickavasagan et al., 2007). Tobacco may be packaging with two different types of liners according to customer's request: polyliner or kraft paper. Tobacco stored either with polyliner or with kraft paper liner differs in colour, aroma and taste and physical characteristics (Ming, 2000; Senhofa, 2015). During storage of tobacco in the years 2010–2015 were observed harvest and post-harvest operations and internal and external factors that affect the quality of raw materials and final product.

MATERIALS AND METHODS

Four samples of the FCV tobacco, grown in Northern Light Soils (NLS) region, harvested and cured in 2011 and 2012, were provided by an unnamed company. The company does not wish to disclose its name. NLS region is located India. The altitude of NLS is in the range of 42 to 90 meters above sea level. The average day temperature during tobacco growing season was in the range of 20 to 34 °C with level of relative humidity of 60–90% and average annual rainfall of 1,231 mm. Soil types range from sandy to sandy loams (89% sand, 4% silt, 7% clay) with pH 5–6. The samples came from equivalent packages from two different customers using two different types of liners inside of C-48 cartons: kraft paper (Fig. 1) and polyliner (Fig. 2). Kraft paper is paper produced from pulp obtained by alkaline (sulphate) method. This paper is stronger than paper made from pulp obtained by acidic (sulphite) method. Polyliner is a packaging material from a vinyl polymer.

The mass of each sample was 500 grams.

Figure 1. C-48 cartons with kraft paper (author's archive).

Figure 2. C-48 cartons with polyliner (author's archive).

The samples of tobacco harvested in the year 2011have number 1, in the year 2012 number 2. The four samples are named in the following way (Table 1).

Table. 1 Sample identification

Sample	Year	Liner	Sample name
1	2011	Kraft paper	K1
2	2011	Polyliner	P1
3	2012	Kraft paper	K2
4	2012	Polyliner	P2

Samples were compared in the following way: K1 with P1 and K2 with P2. Comparison of K1 and K2 or P1 and P2 would not be correct since tobacco quality depends on weather, soil and similar conditions and varies from year to year. That is why only tobacco samples from the same year were compared.

Organoleptic analysis was done checking the aroma, colour and its intensity, elasticity and oiliness of the tobacco. Tobacco aroma may be juicy, sweetish, harsh, fruity, etc. Tobacco colour may vary from lemon to brown; it can be uniform or not. Regarding oiliness and elasticity, tobacco may be oily, dry, crispy, soft, gummy, etc. L*a*b colour space is known for its uniform and precise determination of the colour. 'L' shows the luminance (lightness) of the material on the scale from 0 (black) to 100 (white); 'a' scale ranges from negative (green colour) to positive (red colour) values, and 'b' scale ranges from negative (blue) to positive (yellow) values (Fig. 3) (Sachidananda, 2008).

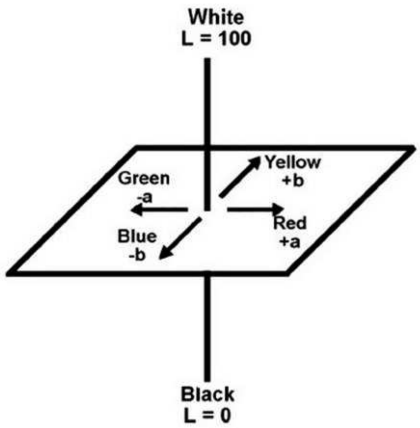

Figure 3. L*a*b colour space (Sachidananda, 2008).

For the analysis the following equipment and software were used: Standard fiber optic spectrometer Avantes AvaSpec-2048; AvaSoft, ver. 7.4; Microsoft Office Excel 2010; StatSoft STATISTICA, ver. 7.0. For spectrometric anlysis was used Avantes manual (Avantes, 2006).

L*a*b parameters were measured 10 times for each sample, since 'tobacco cake' has lighter and darker leaves. Prior every measuring session spectrometer was calibrated.

Gas Chromatography – Mass Spectrometry method (GC-MS) was used to identify the aromatic composition and volatile compounds of the tobacco samples. Analysis was performed with gas chromatograph GC-8000 from Fisons Instruments (Italy) with mass detector MD-800 and column Supercowax (fused silica capillary column 30 m length; 0.32 mm diameter; 65 µm film thickness; blue/plain hub). Helium was used as a carrier gas.

The beginning of the cycle started at 50 °C for 3 minutes and then the temperature would increase constantly by 3 °C per minute until reaching 250 °C. For identification of compounds, Library of chemical compounds and spectrums NIST (National Institute of Standards and Technology, USA) was used.

Determination of total alkaloids and reducing sugars in tobacco was done by colorimetric detection using the Skalar flow analyser. Moisture determination (oven volatiles) of tobacco products was done by oven drying. It was done according to Internal Standards of Philip Morris Q (KH) 0202 and Q (KH) 0210.

Alkaloids with a pyridine nucleus are determined by their reaction with cyanogen chloride in presence of sulfanilic acid. Formed imine derivative has a maximum absorption at 460 nm. Reducing sugars are determined by their reaction with p-hydroxybenzoic acid hydrazide in alkaline medium at 85 °C. Formed yellow osazone has a maximum absorption at 410 nm (DeBardeleben, 1987).

The analytical results (peak heights) are automatically processed by the system. The final results are expressed in % weight of dry tobacco.

RESULTS AND DISCUSIONS

Despite the fact that the tobacco samples are of the closest equivalent grades, tobacco is a biological material and may be harvested during slightly different level of ripeness, which means that there will be no completely equal ‘tobacco cakes’. Tobacco is very sensitive to internal and external conditions during its post-harvest operations.

In Tables 2 and 3 are listed aroma, colour, elasticity and oiliness of the samples.

Table 2. Organoleptic parameters of the samples from the year 2011

Parameters	Sample	
	K1	P1
Aroma	Typical, deep, strong, sweetish	Typical, mild, sweetish
Colour	From orange to dark brown	From orange to brown
Elasticity, Oiliness	Dry, crispy	Less dry, soft

Table 3. Organoleptic parameters of the samples from the year 2012

Parameters	Sample	
	K2	P2
Aroma	Typical, mild, sweetish	Typical, mild, from sweetish to fruity
Colour	From orange to deep orange	From yellowish to orange
Elasticity, Oiliness	From oily to crispy, soft	Oily, soft

Sample K1 has stronger aroma in comparison with sample P1. Also sample K1 is slightly darker. According to elasticity and oiliness characteristics, sample P1 is softer and less dry. Stronger aroma of the sample K1 is probably the result of more opened storage conditions inside of the C-48 carton with kraft paper liner. Air can go through the ‘tobacco cake’ accelerating the process of ageing. Also higher level of reducing sugars in the sample K1 can be the reason of such strong aroma. To ascertain this, the levels of total alkaloids and reducing sugar were measured. Colour is almost the same except for some areas of sample K1 where tobacco is dark brown. For more precise results of colour comparison, L*a*b analysis was performed. Sample P1 is less dry and softer in comparison with sample K1.

Aroma of the sample K2 is slightly deeper; however both samples have mild and sweetish aroma (the sample P2 had even fruity aroma) – see volatile compounds in Table 5. As was mentioned before, more opened storage conditions inside of C-48 carton with kraft paper liner may result in deeper aroma. Also the smaller difference in aroma between the samples from the year 2 in comparison with the samples from the year 1 may be the result of small difference in levels of reducing sugars influenced by one-year ageing. In general, the colour of both samples is quite similar. However, the sample K2 has deep orange leaves and P2 has yellowish leaves. For more precise results of colour comparison L*a*b analysis was performed. The sample P2 is oily and soft. The sample K2 is slightly crispier, however soft as well.

Since the colour of the samples from the same year looks very similar, L*a*b analysis was performed. Each parameter was measured 10 times. Average values of L*a*b analysis results are shown in Table 4.

Table 4. Average value of L*a*b analysis results

Parameters	Sample			
	K1	P1	K2	P2
Average L	22.435	33.075	32.923	46.428
Average a	9.92	12.446	12.612	11.159
Average b	26.021	24.369	28.123	31.496

The following figures (Figs 4, 5) show comparisons of ‘L’ parameter values between samples K and P from different years.

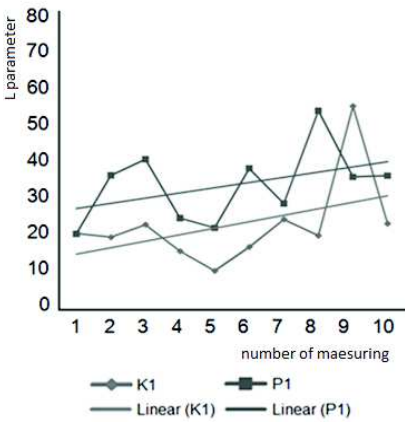

Figure 4. Luminance of the samples from the year 1.

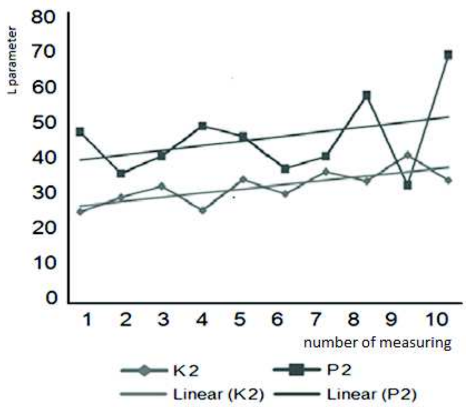

Figure 5. Luminance of the samples from the year 2.

The higher L values the lighter the material is. Both samples P1 and P2 have higher luminance comparing to the samples K1 and K2. Darker colour of the samples aged in C-48 cartons with kraft paper liner may be the result of faster ageing process.

L*a*b analysis results were processed in StatSoft STATISTICA software to compare the colour uniformity of the samples (Fig. 6).

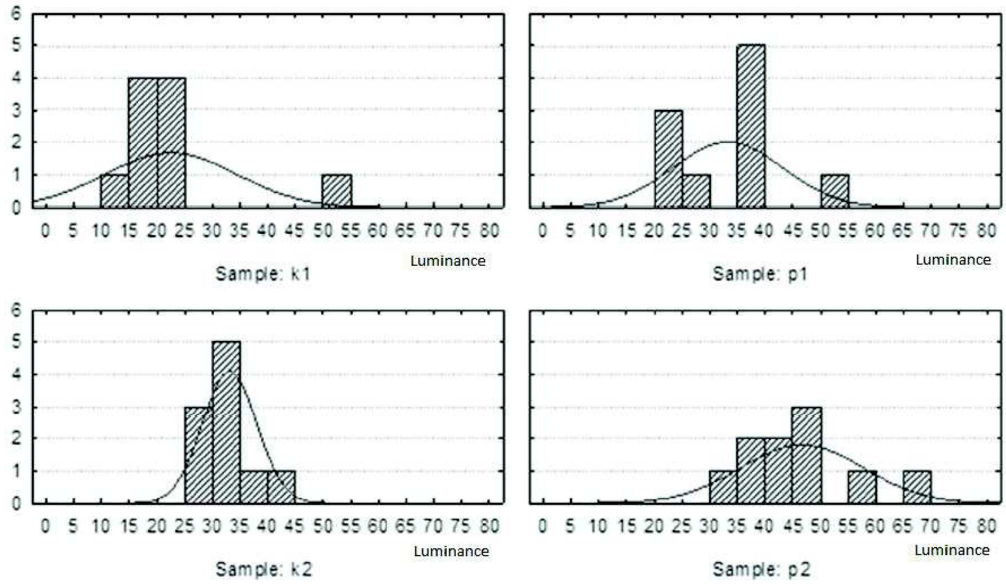

Figure 6. Colour uniformity of the samples.

The colour of the sample K2 is more uniform in comparison with the sample P2. Both samples K1 and P1 have low uniformity of colour. However, if we compare the changes between samples from different years aged in the same conditions, we can see that colour uniformity of tobacco aged in C-48 carton with kraft paper liner may change during the ageing process. But this information may vary since the sample size was 500 grams out of 200 kg 'tobacco cake'.

GC-MS analysis results are shown in the Fig. 7 and Fig. 8. Many volatile compounds were detected during this experiment. The list of compounds with highest peaks is shown in Table 5.

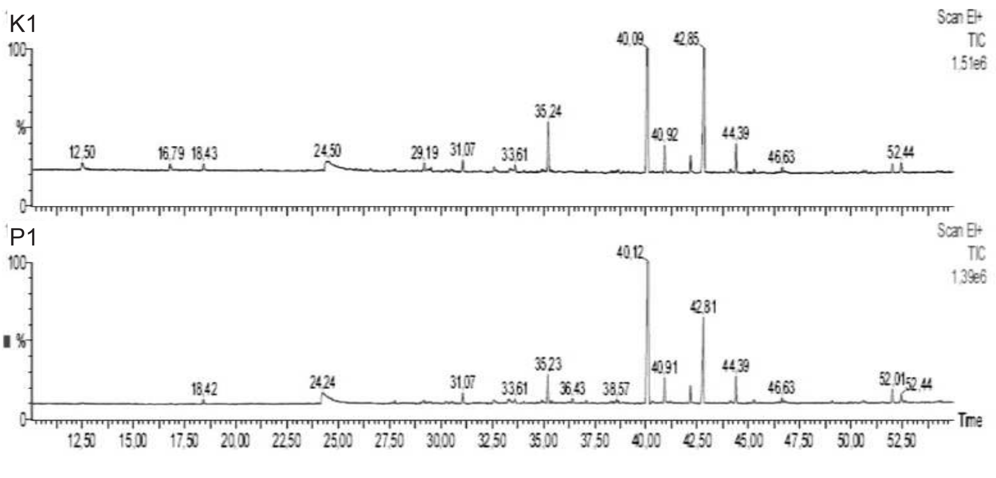

Figure 7. GC-MS analysis of volatile compounds of the samples from the year 2011 (K1, P1).

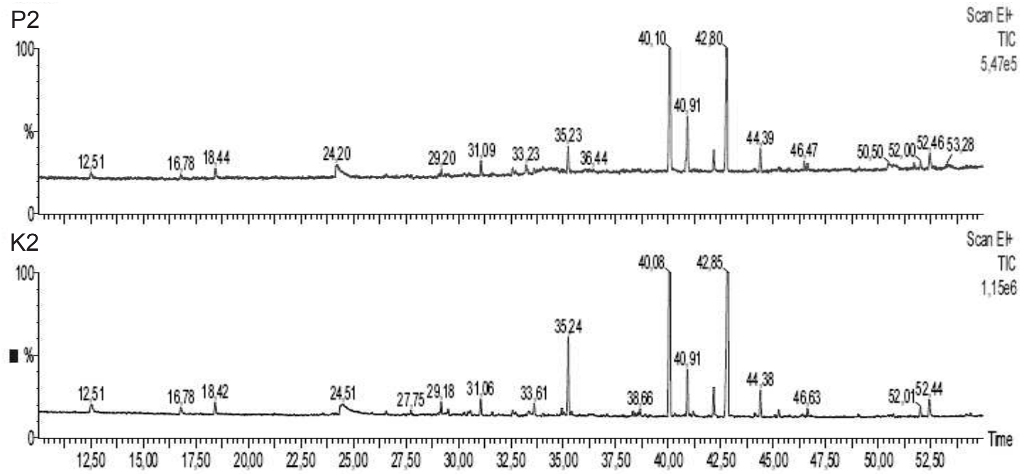

Figure 8. GC-MS analysis of volatile compounds of the samples from the year 2012 (P2, K2).

Table 5. Volatile compounds of the samples

Peak, time (min)	Compound	Peak, time (min)	Compound
12.5	aliphatic	40.92	benzyl alcohol
16.79	aliphatic	42.17	2-phenylethanol
18.43	aliphatic carbonyl	42.85	aliphatic alcohol
24.50	acetic acid	44.39	acetyl pyrrole
29.19	aliphatic carbonyl	46.63	aliphatic
33.61	2H-pyran-2-on	52.01	aromatic aldehyde
35.24	*unidentified*	52.44	heterocyclic
36.24	sesquiterpenic carbonyl	55.20	aliphatic
40.09	nicotine	56.54	aliphatic alcohol

The results of GC-MC analyses show quantitative and qualitative biochemical composition of the samples. The highest peaks on all chromatograms are the peaks of nicotine, the main alkaloid in the tobacco leaf. Second highest peaks are the peaks of aliphatic alcohol with retention time of 42.85 minutes. Also following peaks look sizeable: the peak of unidentified compound with retention time of 35.24 minutes and the peak of benzyl alcohol with retention time of 40.92 minutes. Comparing quality and quantity of the peaks, we can say that the type of liner does not affect biochemical composition of the tobacco leaf, which means that both types of packaging can be used without unwanted changes in the product.

Results of total alkaloids and reducing sugars levels were corrected according to percentage of oven volatiles. The amount of total alkaloids and reducing sugar on dry weight basis was determined after correction. Values for total alkaloids can be identified with the value for alkaloid nicotine content because other alkaloids are present in negligible amounts. Results of total alkaloids, reducing sugars and oven volatiles can be found in Table 6.

Table 6. Total alkaloids, reducing sugars and oven volatiles determination

Parameters	Sample			
	K1	P1	K2	P2
TA (%)	2.81	3.17	2.82	3.00
RS (%)	10.58	7.95	9.90	9.05
OV (%)	8.80	9.30	9.20	8.50

All of the samples have normal levels of total alkaloids and reducing sugars, according to standards for NLS FCV tobacco (1.5–3.5% of nicotine, 7–18% of reducing sugars).

Both samples aged with kraft paper liner have lower level of nicotine comparing to the samples aged with polyliner; however, the level of reducing sugars is higher. The amount of nicotine and that of sugars usually have an inverse relationship. As it was assumed during organoleptic analysis, the difference in reducing sugars levels between samples K2 and P2 is not that big whereas the level of reducing sugars in the sample K1 is much higher than in the sample P1 (it may be the reason of such difference in aroma between these two samples).

CONCLUSION

The following conclusions based on the results can be done: tobacco aged with kraft paper liner has a stronger and deeper aroma in comparison with tobacco stored with polyliner. Tobacco aged for two years has a stronger aroma than tobacco aged for one year. Comparing the changes between samples from different years, aged in the same conditions, we can see that colour uniformity of tobacco aged in C-48 carton with kraft paper liner may change during the ageing process. But this parameter may vary.

Comparing the quality and quantity of the peaks on the chromatograms, we can say that the type of liner does not affect biochemical composition of the tobacco leaf. The highest peaks on all chromatograms are the peaks of nicotine, second highest peaks are the peaks of aliphatic alcohol, next peaks are unidentified compound and the benzyl alcohol. It means that both types of packing can be used without unwanted changes in the product. Ageing in a C-48 carton with kraft paper liner can proceed faster because there are more open storage conditions (air goes through 'tobacco cake' easier), whereas in a carton with polyliner, conditions are more stable and not affected by weather or season of the year.

In both types of storage levels of total alkaloids and reducing sugars stay in ranges of standards for NLS FCV tobacco For sample K1 is the measured value of total alkaloids 2.81%, for sample P1 3.17%, for sample K2 2.82% and for sample P2 3.00%. However, tobacco aged in C-48 cartons with kraft paper liner has a higher level of reducing sugar. For sample K1 is the value 10.58, for sample P1 7.95%, for sample K2 9.90% and for sample P2 9.05%. These values correspond to the values indicated by Manickavasagan, at al., 2007.

According to conclusions, the following can be recommended: for faster ageing in stable weather conditions kraft paper liner can be used. This type of storage can be recommended for domestic use of tobacco. Polyliner is better for maintaining stable conditions of the product during ageing as well as during the transportation.

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