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THE IMPACT OF INSERTION ON SOME TECHNOLOGICAL CHARACTERS OF BASMAK TOBACCO VARIETIES IN THE REPUBLIC OF MACEDONIA

Karolina Kocoska[1], Ilija Risteski[1], Romina Kabranova[2]

[1]"St. Kliment Ohridski" University- Bitola – Scientific Tobacco institute - Prilep, Kicevski pat bb, 7500 Prilep, Republic of Macedonia
[2]Faculty of Agricultural Sciences and Food, Ss.Cyril and Methodius University-Skopje, Republic of Macedonia

Corresponding author: karolina_kocoska@yahoo.com

Abstract
Technological characters determine the so-called technological - commercial quality of tobacco and tobacco products during fabrication. Three-year trials were performed with variety YK 7-4/2 (check) and three Basmak varieties - MK-1, MB-2 and MB-3. The trial was designed in randomized blocks with five replications. The aim of investigation was to determine water retention capacity, density, filling capacity and fractional composition of tobacco by insertions. WRC was determined by the method of (Boceski, 2003), filling capacity (cm^3/g) and density (g/cm^3) were determined using the Borgwaldt densimeter by the method of Shuto (1972) and fractional composition by the method of Dorahova and Dikker. During the three years of investigation, WRC ranged from 16.87% in the lower leaf of variety MB-2 to 23.70% in the middle leaf of MB-3, which proves that the investigated varieties of Basmak tobacco have higher WRC compared to the check. The lowest density by insertions and years and the highest filling capacity was recorded in the middle leaf of MB-2 in 2009 (0.195 g/cm^3). In the three years of investigation, the lowest average density was recorded in lower leaves of the variety MB-3 (0.213 g/cm^3) and the highest in top leaves of the check variety YK 7-4/2 (0.303 g/cm^3). The filling capacity was the highest (5.13 cm^3/g) in middle leaves of the variety MB-2 and the lowest (2.91 cm^3/g) in undertop leaves of the variety MB-3 in 2009. In average, the lowest positive fraction was measured in lower leaves of the variety MB-2 (78.99%) and the highest in middle leaves of the variety MB-3 (93.23%), while the negative fraction ranges from 10.16% in MB-3 to 21.11% in the check variety JK 7-4/2. The data obtained show that the characteristics of the investigated Basmak varieties are typical for the oriental tobacco.

Keywords: density, filling capacity, water retention capacity, faction.

Introduction

The structure of tobacco production in Macedonia consists of oriental tobacco types Prilep, Yaka and Djebel, presented with several varieties which account for about 95% of the total tobacco production. In recent years, new tobacco varieties of the type Basmak were included in the production. The yield and quality of tobacco raw material obtained from Basmak varieties meet the criteria and quality standards of both manufacturers and tobacco purchase companies.Tobacco is a very important industrial crop in our country, especially in areas where conditions for production of other crops are difficult. Of the total area planted with industrial crops, 82% belong to tobacco, most of it being grown in the southwestern and southeastern regions. Because of its good quality, Macedonian tobacco is highly appreciated in the international market and, along with other tobacco products, it is important export product. Republic of Macedonia accounts for 14% of the total oriental tobacco production in the Balkans in the period 2005-2011, with the types Yaka, Prilep, Djebel and Basmak. According to (Boceski, 2003), technological characters are divided into morphological, physical and organoleptic. Technological characters are determined in a laboratory, after curing of tobacco. This paper refers to some technological (physical) characters of tobacco raw, presented by insertions: water retention capacity, positive and negative fraction, density and filling capacity. Physical characters of tobacco are particularly important in manufacture of final products.

Material and methods

Three-year investigations were carried out with four tobacco varieties YK 7 - 4/2 (ø) and Basmak varieties MK-1, MB-2 and MB-3. Seedling was produced in the Scientific Tobacco Institute - Prilep in traditional way, in seedbeds covered with polyethylene. Investigations were made in randomized blocks with five replications, at 45 × 12 cm spacing, on previously treated soil. Tobacco leaves were harvested manually at 7 primings in the stage of technical maturity and then sun cured on horizontal frames. Technological characters of fermented tobacco (water retention capacity, density, filling capacity and fractional composition were investigated in Tobacco Company - Prilep, LTD Cigaretttes. Water retention capacity was tested on tobacco powder by the method of (Boceski, 1984). Filling capacity was expressed in cm^3/g and tobacco density (g/cm^3) was determined using Borgwaldt densimeter. Fractional composition was analysed by the method of Dorahova and Dikker, using vibrator with sieve apertures of 5.0 mm, 3.14 mm, 2.0 mm, 1.0 mm and 0.5 mm and horizontal vibration of 3 minutes. Fractions of the test material from each sieve were measured on analytical scale and the share of positive and negative fractions was expressed in percentage. The humidity of cut tobacco ranged from 13 to 15% and the cutting width was 0.7-0.8 mm.

Results and discussion

Water retention capacity

Water retention capacity (WRC) is one of the most important technological properties which affect the condition of tobacco during its treatment and processing. The ability of tobacco to receive and retain the moisture at certain temperature and relative humidity has an influence on many technological properties of tobacco, such as fractional composition, filling capacity and the ability of tobacco to withstand a pneumatic transport.

Table 1. Water retention capacity by leaf position, in%

Variety	Year	Insertions							Average
		Lower primings	Upper primings	Lower middle leaf	True middle leaf	Upper middle leaf	Under top leaf	Top leaf	
JK 7-4/2 Ø	2009	15.81	17.62	18.79	18.99	19.32	21.57	19.72	18.48
	2010	17.63	19.47	20.24	21.47	18.73	21.36	20.59	17.24
	2011	21.60	22.59	20.48	20.68	20.64	20.38	22.31	21.24
	Average	18.35	19.89	19.84	20.38	19.56	21.10	20.87	18.99
	Index	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
MK-1	2009	14.28	17.45	17.76	19.02	18.61	20.32	20.07	14.81
	2010	17.04	18.62	19.00	20.37	20.83	21.56	21.77	18.30
	2011	19.96	20.87	20.07	26.51	24.37	24.20	21.64	22.52
	Average	17.09	18.98	18.94	21.97	21.27	22.03	21.16	18.54
	Index	93.13	95.42	95.46	107.80	108.74	104.41	101.39	97.63
MB-2	2009	13.65	18.69	18.27	18.85	18.75	19.53	21.21	18.39
	2010	17.22	19.15	18.54	19.79	21.10	22.09	20.66	18.80
	2011	19.73	22.69	21.56	22.63	20.61	20.45	23.39	21.58
	Average	16.87	20.18	19.46	20.42	20.15	20.69	21.75	19.59
	Index	91.93	101.46	98.08	100.20	103.02	98.06	104.20	103.16
MB-3	2009	16.56	20.80	20.44	19.76	22.32	22.33	21.00	17.50
	2010	16.44	17.78	17.80	20.17	22.57	22.60	23.44	16.67
	2011	19.73	23.02	23.42	23.65	26.20	22.66	21.78	22.92
	Average	17.58	20.53	20.55	21.19	23.70	22.53	22.07	19.03
	Index	95.80	103.22	103.58	103.97	121.17	106.78	105.73	100.21

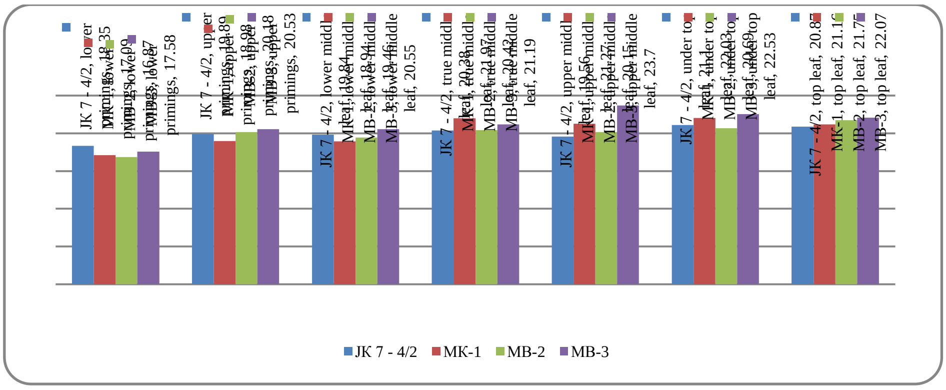

Figure 1. Water retention capacity of tobacco leaves by leaf position (in %)

The ability of tobacco to receive and retain moisture differs from variety to variety. Due to this property, different tobaccos have different percentage of humidity. Water retention capacity depends on chemical composition (pectic substances) and leaf structure. The results on water retention capacity of the varieties tested (Table 1 and Figure 1) range from 13.65% in lower primings of the the variety MB-2 in 2009 to 26.20% in the upper middle leaf of the MB-3 variety in 2011.
(Patche and Gjorgjioski.1967) reported that carbohydrates, organic acids and their salts, amino acids etc. have a positive impact on water retention capacity of tobacco. (Nuneski, 1975) points out that water retention capacity of Prilep tobacco from the region of Krusevo amounts to 19.78% in lower middle leaf, 21.3% in true middle leaf and 20.14% in upper middle leaf. According to (Nuneski, 2008) and his studies on Izmir Basma tobacco from Turkey, the highest WRC was recorded in the under top leaves (29.51%) and top leaves (29.95%). The average water retention capacity in our investigations, however, ranged from 16.87% in MB-2 variety to 23.70% in the upper middle leaf of MB-3 variety, which is 6.78% higher than the check. Varieties MK-1, MB-2 and MB-3 showed higher WRC compared to the check. Higher water retention capacity compared to the other varieties was recorded in variety MB-3, ranging from 17.58% in the lower primings, 20.53% in the upper primings, 20.55% in lower middle leaf, 21.19% in true middle leaf, 23.70% in the upper middle leaf, 22.53% in under top leaf and 7.22% in 22:53 the top leaf.

Density

In manufacture of tobacco, the weight and volume of cut tobacco are very important. They largely determine the use value and the commercial value of the raw material. Tobacco density was measured by leaf positions and years at 13% absolute humidity Table 2. The lowest density (0.195 g/cm^3) and the highest water retention capacity was recorded in the true middle leaf of the variety MB-2 in 2009. The highest density (0.344 g/cm3) and the lowest water retention capacity was recorded in the under top leaves of the variety MB-3 in 2009. During the three years of investigation, the lowest density was observed in the lower primings of MB-3 (0.213 g/cm^3) and the top leaves of the check variety YK 7-4/2 had the highest density (0.303 g/cm^3). With regard to leaf position, there are no significant differences in density and water retention capacity among the varieties tested. According to (Boceski, 2003), density is a bulk weight of cut tobacco, expressed in g/l or g/cm^3. The reciprocal value of density is filling capacity, expressed in cm^3/g. Tobacco with lower density has higher water retention capacity and in fabrication it gives higher number of cigarettes from 1 kg of tobacco, i.e. it has higher economic value compared to tobacco with higher density.

Table 2. Tobacco density by leaf position, in g/cm^3

Variety	Year	Insertions							Average
		Lower primings	Upper primings	Lower middle leaf	True middle leaf	Upper middle leaf	Under top leaf	Top leaf	
JK 7-4/2 Ø	2009	0.211	0.231	0.207	0.213	0.239	0.307	0.318	0.247
	2010	0.227	0.249	0.246	0.308	0.299	0.300	0.284	0.273
	2011	0.259	0.235	0.255	0.274	0.296	0.258	0.308	0.269
	Average	0.232	0.238	0.236	0.265	0.278	0.288	0.303	0.263
	Index	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
MK-1	2009	0.212	0.225	0.213	0.202	0.252	0.292	0.308	0.243
	2010	0.247	0.261	0.274	0.270	0.327	0.308	0.296	0.283
	2011	0.197	0.228	0.240	0.272	0.291	0.299	0.311	0.262
	Average	0.219	0.238	0.242	0.248	0.290	0.300	0.305	0.263
	Index	94.12	100.00	102.54	93.58	104.32	104.17	100.66	100.01
MB-2	2009	0.205	0.231	0.214	0.195	0.250	0.308	0.287	0.241
	2010	0.241	0.279	0.310	0.300	0.335	0.312	0.299	0.297
	2011	0.231	0.283	0.282	0.282	0.312	0.297	0.266	0.279
	Average	0.226	0.264	0.269	0.259	0.299	0.306	0.284	0.272
	Index	97.41	110.92	113.98	97.74	107.55	106.25	93.73	103.42
MB-3	2009	0.201	0.250	0.261	0.258	0.283	0.344	0.329	0.275
	2010	0.232	0.236	0.281	0.267	0.251	0.277	0.252	0.257
	2011	0.206	0.247	0.255	0.269	0.301	0.298	0.287	0.266
	Average	0.213	0.244	0.266	0.265	0.278	0.306	0.289	0.266
	Index	91.81	102.52	112.71	100.00	100.00	105.21	95.38	101.14

The values for density by belts and years are presented in Table 2. The lowest density was recorded in the lower belt of MB-2 in 2009 (0.218 g/cm^3) and the highest density in the upper belt of MB-3 2009 (0.337 g/cm^3). According to the average values, the lowest density was recorded in the lower belt of MK-1 (0.228 g/cm^3) and the highest in the upper belt of the same variety (0.302 g/cm^3), which is 2.03% more than the check variety. It can be stated that the tested varieties are characterized by density increase from the lower to the upper belt.

Water retention capacity

Water retention capacity is reciprocal value of density and is expressed in cm^3/g tobacco. Actually, it is the volume in cm^3 which is occupied by 1 g of tobacco under certain test conditions. The data on water retention capacity of tobacco (in cm^3/g) by leaf position are presented in Table 3 and Figure 3. The lowest water retention capacity was measured in the under top leaves of MB-3 in 2009 (2.91 cm^3/g) and the highest water retention capacity was found in MB-2 in 2009 (5.13 cm^3/g). The average filling capacity during the three-year investigations ranged from 3.30 cm^3/g in top leaves of the check variety to 4.71 cm^3/g in variety MB-3, which is 8.78% higher compared to the check. The obtained data show that filling capacity in the four varieties tested, with some variations, gradually decreases from the lower to the upper primings.

Fractional composition

After cutting, tobacco material consists of fractions with different dimensions. Fractional composition of cut tobacco has a major impact on the filling capacity of tobacco blends in cigarette production and efficiency. The fraction coefficient is the ratio between positive and negative fraction. Positive faction consists of tobacco particles that remain on a screen mesh of over 2 mm and negative faction consists of tobacco particles below 2 mm. The lowest percentage of positive fraction in the varieties tested (Table 4, Figure 4) was recorded in the lower primings of MK-1 in 2010 (72.58%) and the highest in the true middle leaf of MB-3 in 2009 (96.20%). During the three-year investigations, climate conditions had a big impact on the share of positive fraction of cut tobacco. In dry conditions of 2011, the share of positive fraction was smaller. On average, the lowest positive fraction was recorded in lower primings of the variety MB-2 (78.99%) and the highest in the upper middle leaf of MB-3 (93.23%), which is 1.44% higher compared to the check variety. The results show that raw material of the varieties MK-1 and MB-3 has a good fractional composition, which exceeds 85%.

Table 3. Filling capacity of the cut tobacco by leaf position, in cm^3/g

Variety	Year	Insertions							Average
		Lower primings	Upper primings	Lower middle leaf	True middle leaf	Upper middle leaf	Under top leaf	Top leaf	
JK 7-4/2 Ø	2009	4.74	4.33	4.83	4.69	4.18	3.26	3.14	4.17
	2010	4.39	4.02	4.06	3.25	3.34	3.33	3.52	3.70
	2011	3.86	4.25	3.92	3.65	3.38	3.87	3.25	3.74
	Average	4.33	4.20	4.27	3.86	3.63	3.49	3.30	3.87
	Index	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
MK-1	2009	4.71	4.48	4.69	4.95	3.97	3.42	3.24	4.21
	2010	4.05	3.83	3.65	3.70	3.06	3.25	3.38	3.56
	2011	5.12	4.38	4.17	3.68	3.44	3.34	3.21	3.91
	Average	4.63	4.23	4.17	4.11	3.49	3.34	3.28	3.89
	Index	106.93	100.71	97.66	106.48	96.14	95.70	99.39	100.43
MB-2	2009	4.88	4.33	4.67	5.13	4.00	3.25	3.48	4.25
	2010	4.15	3.58	3.23	3.33	2.98	3.20	3.34	3.40
	2011	4.13	3.54	3.55	3.55	3.21	3.37	3.76	3.62
	Average	4.45	3.82	3.82	4.00	3.40	3.27	3.53	3.76
	Index	102.77	90.95	89.46	103.63	93.66	93.70	106.97	97.16
MB-3	2009	4.97	4.00	3.83	3.88	3.53	2.91	3.04	3.74
	2010	4.31	4.24	3.56	3.75	3.98	3.61	3.97	3.92
	2011	4.85	4.05	3.92	3.72	3.32	3.35	3.48	3.81
	Average	4.71	4.10	3.77	3.78	3.61	3.29	3.50	3.82
	Index	108.78	97.62	88.29	97.93	99.45	94.27	103.03	98.71

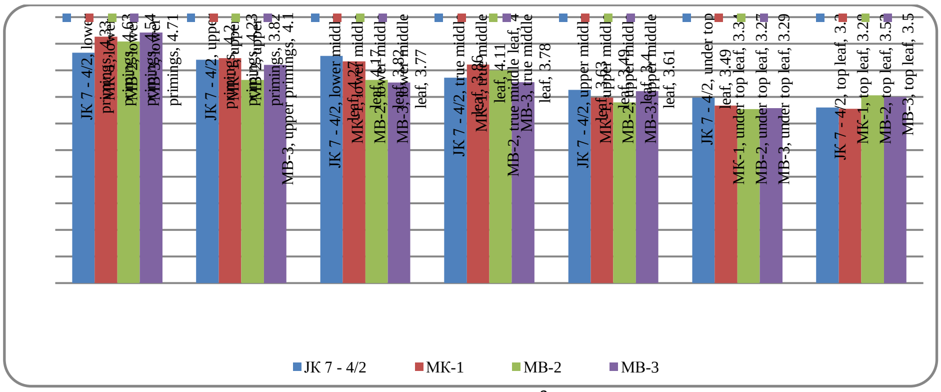

Figure 3. Filling capacity of cut tobacco by leaf position, in cm^3/g (average)

(Najdoski, 1980) in his four-year investigations of Prilep tobacco reported that cut tobacco from the middle belt has the highest percentage of positive faction, with 85.80 % in 1976 and 78.80% in 1973. In other harvests this percentage varies depending on the climate conditions.

Negative faction by varieties and leaf position, presented in Table 5, showed that the lowest percentage (3.80%) was recorded in the true middle leaf of MB-3 in 2009 and the highest (27.42%) in MK-1 in 2010. On average, the negative fraction has the lowest percentage in the upper middle leaf of MB-3 (6.77%) and the highest percentage in the lower primings of MB-2 (21.01%), which is

24.39% higher than the check variety. The average negative fraction for the seven leaf positions in the four varieties ranges from 16.10% in MB-3 to 11.21% in the check variety YK 7-4/2.

Table 4. Positive fraction in the cut tobacco by leaf position, in %

Variety	Year	Insertions							Average
		Lower primings	Upper primings	Lower middle leaf	True middle leaf	Upper middle leaf	Under top leaf	Top leaf	
JK 7-4/2 Ø	2009	86.76	89.94	92.18	93.12	94.44	90.44	91.98	91.27
	2010	83.50	90.62	91.92	93.44	92.28	90.66	89.54	90.28
	2011	79.06	79.58	86.00	88.00	89.00	88.32	84.00	84.85
	Average	83.11	86.71	90.03	91.52	91.91	89.81	88.51	88.80
	Index	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
MK-1	2009	88.12	91.12	90.70	91.54	91.36	91.78	89.78	90.63
	2010	72.58	87.18	88.34	89.86	94.63	93.02	90.52	88.02
	2011	77.60	78.34	88.00	86.40	87.20	84.10	81.42	83.29
	Average	79.43	85.55	89.01	89.27	91.06	89.63	87.24	87.31
	Index	95.58	98.66	98.87	97.54	99.08	99.80	98.57	98.32
MB-2	2009	78.76	85.76	88.22	89.42	92.50	90.44	89.16	87.75
	2010	77.74	86.38	88.32	91.72	93.02	92.16	90.58	88.56
	2011	80.46	80.86	85.90	89.00	87.70	83.34	86.54	84.83
	Average	78.99	84.33	87.48	90.05	91.07	88.65	88.76	87.05
	Index	95.04	97.26	97.17	98.39	99.09	98.71	100.28	98.03
MB-3	2009	80.80	88.96	92.80	96.20	94.78	93.30	90.70	91.08
	2010	83.50	90.62	91.92	93.44	92.28	90.66	89.54	90.28
	2011	80.04	84.06	87.68	89.66	92.62	92.54	90.54	88.16
	Average	81.45	87.88	90.80	93.10	93.23	92.17	90.26	89.84
	Index	98.00	101.35	100.85	101.73	101.44	102.63	101.98	101.17

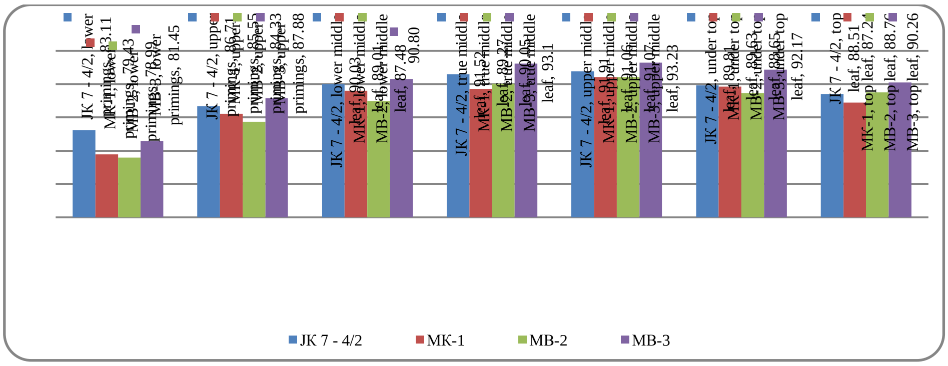

Figure 4. Positive fraction in the cut tobacco by leaf position, in % (average)

Table 5. Negative fraction in the cut tobacco by leaf position, in %

Variety	Year	Insertions							Average
		Lower primings	Upper primings	Lower middle leaf	True middle leaf	Upper middle leaf	Under top leaf	Top leaf	
JK 7-4/2 Ø	2009	13.24	10.06	7.82	6.88	5.56	9.56	8.02	8.73
	2010	16.50	9.38	8.08	6.56	7.72	9.34	10.46	9.72
	2011	20.94	20.42	14.00	12.00	11.00	11.68	16.00	15.15
	Average	16.89	13.29	9.97	8.48	8.09	10.19	11.49	11.21
	Index	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
MK-1	2009	11.88	8.88	9.30	8.46	8.64	8.22	10.22	9.37
	2010	27.42	12.82	11.66	10.14	5.37	6.98	9.48	11.98
	2011	22.40	21.66	12.00	13.60	12.80	15.90	18.58	17.68
	Average	20.57	14.45	10.99	10.73	8.94	10.37	12.76	13.01
	Index	121.79	108.73	110.23	126.53	110.51	101.77	111.05	116.06
MB-2	2009	21.24	14.24	11.78	10.58	7.50	9.56	10.84	12.25
	2010	22.26	13.62	11.68	8.28	6.98	7.84	9.42	11.44
	2011	19.54	19.14	14.10	11.00	12.30	16.66	13.46	15.17
	Average	21.01	15.67	12.52	9.95	8.93	11.35	11.24	12.95
	Index	124.39	117.91	125.58	117.33	110.38	111.38	97.82	115.52
MB-3	2009	19.20	11.04	7.20	3.80	5.22	6.70	9.30	8.92
	2010	16.50	9.38	8.08	6.56	7.72	9.34	10.46	9.72
	2011	20.94	15.94	12.32	10.34	7.38	7.46	9.46	11.74
	Average	18.55	12.12	9.20	6.90	6.77	7.83	9.74	10.16
	Index	109.83	91.20	92.28	81.37	83.68	76.84	84.77	90.63

Conclusions

Water retention capacity ranged from 16.87% in the middle primings of the variety MB-2 to 23.70% in the upper-middle leaf in MB-3, which is 6.78% higher than the check. -The lowest density was recorded in lower primings of MB-3 (0.213 g/cm^3) and the highest in the top leaf of the check variety YK 7-4/2 (0.303 g/cm^3). The average filling capacity ranged from 3.30 cm^3/g in the top leaf of the check variety to 4.71 cm^3/g in the lower primings of MB-3, which is 8.78% higher compared to the check. From the data obtained it can be concluded that the filling capacity of the varieties tested, with few exceptions, gradually decreases from lower primings to the top. Positive faction was the highest in the upper middle leaf of MB-3 (93.23%), which is 1.44% higher than the check, and the lowest in lower primings of MB-2 (78.99%). The results show that raw material of the varieties MK-1 and MB-3 has a good fractional composition, which exceeds 85%. The lowest share of negative fraction was recorded in the upper middle leaf of the variety MB-3 (6.77%) and the highest in lower primings of MB-2 (21.01%), which is 24.39% higher than the check variety.

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