Вестник ВГУИТ/ Proceedings of VSUET ISSN 2226-910X E-ISSN 2310-1202
DOI: http://doi.org/10.20914/2310-1202-2024-1-196-200 Research article
УДК 640 Open Access Available online at vestnik-vsuet.ru

Studying factors affecting yields of toxic compounds in smoke of products made of smoking fine cut tobacco

Ekaterina Yu. Smirnova [1] katrinka.smirnova@gmail.com 0000-0001-9213-9656
Evgeniya V. Gnuchikh [1] gnu20072007@yandex.ru 0000-0002-1565-3704
Evgeny A. Bubnov [1] hookj@mail.ru 0000-0003-4429-6440
Anatoly A. Slavyansky [2] mgutu-sahar@mail.ru 0000-0002-0262-8841

1 All Russian Research Institute of Tobacco, Makhorka and Tobacco Products, Moskovskaya street, 42, Krasnodar, Russia, 350042, Russia
2 Moscow State University of Technology and Management. K.G. Razumovsky, Zemlyanoy Val street, 73, Moscow, 109004, Russia

Abstract. Currently, the Russian market offers a wide range of smoking tobacco products. Cigarettes are in greatest demand. However, for many reasons, including high selling prices due to rising excise taxes, and dissatisfaction with taste characteristics, cigarette consumption is declining. There is a partial transition of consumers to other types of products, with fine-cut smoking tobacco being an alternative and obvious choice. From fine-cut smoking tobacco, consumers independently make products (roll-your-own cigarettes) of the Roll Your Own (RYO) type without a filter, wrapping a portion of tobacco with special paper manually, combining different types of tobacco, using different papers, changing the mass of tobacco and the diameter of the product, creating a product that meets taste preferences. Considering that nicotine and tar carry a toxic load for the body of consumers, it is relevant to study the content of smoke components of fine-cut smoking tobacco products (rolled tobacco), which may depend on many factors (weight of the product, diameter of the product, properties of tobacco, properties of paper). In present article technological properties of different tobacco sorts: Virginia Gold, Burley, Immuniy 580 and tobacco blend made of these sorts were examined. Composition of papers for hand made cigarettes and their air permeability were analyzed. Effect of products' constructive properties on contents of toxic compounds in the smoke (tar, nicotine) was studied. Correlation between cigarette paper air permeability and chemical composition of the smoke was experimentally found. Utilization paper with low air permeability increases nicotine and tar content in the smoke of final product. Increasing diameter and mass of the product also leads to increasing of tar and nicotine content.

Keywords: smoking tobacco, rolling paper, air permeability of paper, chemical composition, smoke, nicotine, resin, carbon monoxide.

Introduction

Researches on fine cut tobacco and products made of it are carried in FSBSI ARSRITTP at present moment. These researches are directed on studying technological properties of fine cut tobacco and chemical composition of smoke of final products. It is worth mentioning that at present time State regulation of toxic compounds contents in the smoke of products made of fine cut tobacco are absent. This is complicated factor for elaborating products with decreased toxicity, desired consumers' properties and technologies for their manufacturing. So further complex studies of this type of smoking product have significant scientific and practical interest and are prospective and actual.

Fine cut tobacco is utilized for making smoking product manually by inserting tobacco into ready cigarette plug or wrapping tobacco portion by special paper. Contents of toxic compounds in the smoke of products made of fine cut tobacco are affected by product construction (mass, diameter), composition of smoking tobacco and paper for its making [1].

Materials and Methods

Tobacco sorts with different taste and aroma properties and chemical composition were chosen for the research. They are: Virginia Gold, Burley, Immuniy 580 and tobacco blend made of these sorts in ratio 50:25:25.

Standard methods adopted for tobacco industry were utilized for carried researches [2–10]:

– measuring cut width according to GOST 33789–2016 (ISO 20193:2012) "Tobacco and tobacco products. Determination of the width of the strands of cut tobacco" [2];

– sampling according to GOST R 53976–2010 (ISO 15592–1:2001) "Fine cut smoking tobacco and smoking articles made of it. Part 1: Sampling" [3];

– conditioning and testing under certain air conditions according to GOST 32795–2014 (ISO 15592–2:2001) "Fine cut smoking tobacco and smoking articles made of it. Methods for sampling, conditioning and analysis. Part 2: Atmosphere for conditioning and testing" [4];

Для цитирования
Смирнова Е.Ю, Гнучих Е.В., Бубнов Е.А., Славянский А.А. Исследование факторов, влияющих на содержание токсичных веществ в дыме изделий из табака курительного тонкорезаного // Вестник ВГУИТ. 2024. Т. 86. № 1. С. 196–200. doi:10.20914/2310-1202-2024-1-196-200

For citation
Smirnova E.Yu., Gnuchikh E.V., Bubnov E.A., Slavyansky A.A. Studying factors affecting yields of toxic compounds in smoke of products made of smoking fine cut tobacco. Vestnik VGUIT [Proceedings of VSUET]. 2024. vol. 86. no. 1. pp. 196–200. (in Russian). doi:10.20914/2310-1202-2024-1-196-200

© 2024, Смирнова Е.Ю. и др. / Smirnova E.Yu. et al.
This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License

– machine smoking of products according to international standard ISO 15592–3:2008 “Fine-cut tobacco and smoking articles made from it. Methods of sampling, conditioning and analysis. Part 3: Determination of total particulate matter of smoking articles using a routine analytical smoking machine, preparation for the determination of water and nicotine, and calculation of nicotine-free dry particulate matter” [5];

– measuring air permeability of cigarette paper according to GOST R 51295–2014 (ISO 2965:2009) “Cigarette paper, paper for filter wrapping and tipping paper including paper with separate or oriented perforated zone and paper with lines of different air permeability. Measuring air permeability” [6];

– tar defining according to GOST 30571–2003 (ISO 4387:2000) / GOST R 51976–2002 (ISO 4387:2000) “Cigarettes. Determination of total and nicotine-free dry particulate matter using a routine analytical smoking machine” [7];

– nicotine defining according to GOST 30570–2015 (ISO 10315:2013) “Cigarettes. Determination of nicotine in smoke condensates. Gas-chromatographic method” [8];

– water defining according to GOST 30622.1–2003 (ISO 10362–1:1999) “Cigarettes. Determination of water in total particulate matter from the mainstream smoke. Part 1: Gas-chromatographic method” [9].

Results

At first stage of the research technological properties, chemical composition and tasting of each sample were carried. Experimental results on technological properties of fine cut smoking tobacco are presented in table 1.

Table 1.

Technological properties of different samples of fine cut smoking tobacco

Tobacco (blend) name	Water content, %	Weight content, %		Width of the strands, mm	Tasting, points
		strand	dust		
Virginia Gold	17,67	78,42	0,36	0,8	72,4
Burley	19,78	77,90	0,24	0,8	63,1
Immuniy 580	19,67	76,26	0,38	0,8	62,7
Tobacco blend	18,49	76,80	0,40	0,8	70,5

As table 1 shows tobacco of Virginia Gold sort has maximum output of strand – 78.42% and high tasting score – 72.4 points.

The lowest strand output and tasting score has the tobacco of Immuniy 580 sort.

Table 2.

Chemical composition of cured tobacco

Tobacco (blend) name	Nicotine, %	Carbohydrates, %	Proteins, %	pH
Virginia Gold	0,6	18,6	5,7	5,5
Burley	1,3	1,4	9,1	6,3
Immuniy 580	1,2	3,4	9,2	5,5
Tobacco blend	0,9	11,5	7,8	5,6

During further studies for defining effect of product construction and paper air permeability samples of products were made of fine cut tobacco manually by special device consisting of plastic body two rollers and flexible belt. According to international standard ISO 15592–3 each type of smoking product was made with mass 400 mg (diameter 5.2 mm) and 750 mg (diameter 7.2 mm) utilizing paper of two types: A (OCB Premium on the base of rice with air permeability 10 CU) and B (OCB Organic Hemp on the base of cannabis with air permeability 3 CU) [10].

Table 3.

Chemical composition of products’ smoke with different constructions made of fine cut tobacco

Tobacco (blend) name	Width of the strands, mm	Sample №	Diameter, mm	Mass, mg	Paper type	Nicotine, mg/sample	Tar, mg/sample
Virginia Gold	0,8	1	5,2	400	A	0,70	31,24
		2	5,2	400	B	0,67	33,07
		3	7,2	750	A	0,95	42,93
		4	7,2	750	B	1,11	44,89
Burley	0,8	5	5,2	400	A	1,28	29,88
		6	5,2	400	B	1,37	29,49
		7	7,2	750	A	1,86	40,93
		8	7,2	750	B	1,92	42,38
Immuniy 580	0,8	9	5,2	400	A	1,01	20,85
		10	5,2	400	B	1,08	23,67
		11	7,2	750	A	1,60	33,69
		12	7,2	750	B	1,68	32,69
Tobacco blend	0,8	13	5,2	400	A	0,94	28,55
		14	5,2	400	B	1,08	29,51
		15	7,2	750	A	1,48	40,05
		16	7,2	750	B	1,42	41,27

As table 3 shows samples of same diameter but with different paper types and air permeability nicotine and tar content is different. Sample 1 with 5.2 mm diameter and A type paper compared to sample 2 with same diameter and B type paper has 4.5% higher nicotine content and 5.8% lower tar content. Sample 3 with 7.2 mm diameter and A type paper compared to sample 4 with same diameter and B type paper has 16% lower nicotine content and 4.5% lower tar content. Sample 5 with 5.2 mm diameter and A type paper compared to sample 6 with same diameter and B type paper has 7% lower nicotine content and 1.4% higher tar content. Sample 7 with 7.2 mm diameter and A type paper compared to sample 8 with same diameter and B type paper has 3.2% lower nicotine content and 3.5% lower tar content. Sample 9 with 5.2 mm diameter and A type paper compared to sample 10 with same diameter and B type paper has 6.9% higher nicotine content and 13.5% lower tar content. Sample 11 with 7.2 mm diameter and A type paper compared to sample 12 with same diameter and B type paper has 5% lower nicotine content and 3.1% higher tar content. Sample 13 with 5.2 mm diameter and A type paper compared to sample 14 with same diameter and B type paper has 15% lower nicotine content and 3.3% lower tar content. Sample 15 with 7.2 mm diameter and A type paper compared to sample 16 with same diameter and B type paper has 4.2% higher nicotine content and 3% lower tar content.

Results of cigarette formats (diameters) comparison utilizing same paper types are presented below. Sample 1 with 5.2 mm diameter compared to sample 3 with 7.2 mm diameter has 26.3% lower nicotine content and 27.2% lower tar content. Sample 2 with 5.2 mm diameter compared to sample 4 with 7.2 mm diameter has 39.6% lower nicotine content and 26.3% lower tar content. Sample 5 with 5.2 mm diameter compared to sample 7 with 7.2 mm diameter has 31.2% lower nicotine content and 26.9% lower tar content. Sample 6 with 5.2 mm diameter compared to sample 8 with 7.2 mm diameter has 28.6% lower nicotine content and 30.4% lower tar content. Sample 9 with 5.2 mm diameter compared to sample 11 with 7.2 mm diameter has 36.9% lower nicotine content and 38.1% lower tar content. Sample 10 with 5.2 mm diameter compared to sample 12 with 7.2 mm diameter has 35.7% lower nicotine content and 27.6% lower tar content. Sample 13 with 5.2 mm diameter compared to sample 15 with 7.2 mm diameter has 36.5% lower nicotine content and 28.7% lower tar content. Sample 14 with 5.2 mm diameter compared to sample 16 with 7.2 mm diameter has 23.9% lower nicotine content and 28.5% lower tar content.

Discussion

Construction of smoking product (paper and filter) has the most significant effect on toxic compounds (tar and nicotine) content. Researches carried earlier [1] don't take into account strength (nicotine content) of tobacco blend and its further correspondence with nicotine content in the smoke of products.

Data obtained after carried research prove effect of product construction (diameter and air permeability of paper) on tar and nicotine content in the smoke of products made of fine cut smoking tobacco. Not only product construction but also composition of tobacco blend (nicotine content) affects on content of toxic compounds in the smoke.

Conclusion

Carried researches allow making the following conclusions:

1. Tobacco blend composition, product mass and diameter, paper characteristics affect toxic compounds content in the smoke of fine cut smoking tobacco.

2. Utilizing paper A (OCB premium on the base of rice with air permeability 10 CU) with higher air permeability for making product from smoking tobacco leads to 16% nicotine and 13.5% tar content decreasing in the smoke compared to products made of paper B (OCB Organic Hemp on the base of cannabis with air permeability 3 CU).

3. Decreasing product diameter from 7.2 to 5.2 mm and mass from 750 to 400 mg leads to 39.6% decreasing nicotine and 38.1% decreasing tar contents.

4. In order to decrease toxic impact on consumers we recommend manufacturing products made of fine cut tobacco with mass 400 mg, 5.2 mm diameter utilizing paper with air permeability not lower than 10 CU.

References

1 Kaiserman M.J., Rickert W.S. Handmade cigarettes: it's the tube that counts. American Journal of Public Health. 1992. vol. 82. no. 1. pp. 107-109. doi: 10.2105/ajph.82.1.107

2 GOST 33789–2016 (ISO 20193:2012). Tobacco and tobacco products. Determination of the width of the strands of cut tobacco. M., Standardinform, 2017. 11 p. (in Russian).

3 GOST R 53976–2010 (ISO 15592–1:2001). Fine-cut tobacco and smoking articles made from it. Methods of sampling, conditioning and analysis. Part 1: Sampling. M., Standardinform, 2010. 16 p. (in Russian).

4 GOST 32795–2014 (ISO 15592–2:2001). Fine-cut tobacco and smoking articles made from it. Methods of sampling, conditioning and analysis. Part 2: Atmosphere for conditioning and testing. M., Standardinform, 2014. 10 p. (in Russian).

5 ISO 15592–3:2008. Fine-cut tobacco and smoking articles made from it – Methods of sampling. Conditioning and analysis – Part 3: Determination of total particulate matter of smoking articles using a routine analytical smoking machine, preparation for the determination of water and nicotine. And calculation of nicotine – free dry particulate matter. (in Russian).

6 GOST R 51295–2014 (ISO 2965:2009). Materials used as cigarette papers, filter plug wrap and filter joining paper, including materials having a discrete or oriented permeable zone and materials with bands of differing permeability. Determination of air permeability. Introduced 2015–07–01. M., Standardinform, 2015. 20 p. (in Russian).

7 GOST 30571–2003 (ISO 4387:2000) / GOST R 51976–2002 (ISO 4387:2000). Cigarettes. Determination of total and nicotine-free dry particulate matter using a routine analytical smoking machine. M., Standardinform, 2005. 12 p. (in Russian).

8 GOST 30570–2015 (ISO 10315:2013). Cigarettes. Determination of nicotine in smoke condensates. Gas-chromatographic method. M., Standardinform, 2016. 8 p. (in Russian).

9 GOST 30622.1–2003 (ISO 10362–1:1999). Cigarettes. Determination of water in total particulate matter from the mainstream smoke. Part 1: Gas-chromatographic method. M., Standardinform, 2005. 8 p. (in Russian).

10 Campo San Segundo M.T. et al. Fine-cut tobacco: a priority for public health and consumer advocacy. Gaceta Sanitaria. 2011. .vol 26. no. 3. pp. 267-269. doi: 10.1016/j.gaceta.2011.09.010

11 Soleimani F., Dobaradaran S., De-la-Torre G.E., Schmidt T.C. et al. Content of toxic components of cigarette, cigarette smoke vs cigarette butts: A comprehensive systematic review. Science of the Total Environment. 2022. vol. 813. pp. 152667.

12 Shihadeh A., Schubert J., Klaiany J., El Sabban M. et al. Toxicant content, physical properties and biological activity of waterpipe tobacco smoke and its tobacco-free alternatives. Tobacco control. 2015. vol. 24. no. 1. pp. i22-i30.

13 Farsalinos K.E., Gillman I.G., Melvin M.S., Paolantonio A.R. et al. Nicotine levels and presence of selected tobacco-derived toxins in tobacco flavoured electronic cigarette refill liquids. International journal of environmental research and public health. 2015. vol. 12. no. 4. pp. 3439-3452.

14 Farsalinos K.E., Gillman I.G., Melvin M.S., Paolantonio A.R. et al. Nicotine levels and presence of selected tobacco-derived toxins in tobacco flavoured electronic cigarette refill liquids. International journal of environmental research and public health. 2015. vol. 12. no. 4. pp. 3439-3452.

15 Auer R., Concha-Lozano N., Jacot-Sadowski I., Cornuz J. et al. Heat-not-burn tobacco cigarettes: smoke by any other name. JAMA internal medicine. 2017. vol. 177. no. 7. pp. 1050-1052. doi: 10.1001/jamainternmed.2017.1419

16 Ruprecht A.A., De Marco C., Saffari A., Pozzi P. et al. Environmental pollution and emission factors of electronic cigarettes, heat-not-burn tobacco products, and conventional cigarettes. Aerosol science and technology. 2017. vol. 51. no. 6. pp. 674-684. doi: 10.1080/02786826.2017.1300231

17 Goniewicz M.L., Knysak J., Gawron M., Kosmider L. et al. Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. Tobacco control. 2014. vol. 23. no. 2. pp. 133-139.

18 Mallock N., Pieper E., Hutzler C., Henkler-Stephani F. et al. Heated tobacco products: a review of current knowledge and initial assessments. Frontiers in Public Health. 2019. vol. 7. pp. 287. doi: 10.3389/fpubh.2019.00287

19 Novotny T.E., Slaughter E. Tobacco product waste: an environmental approach to reduce tobacco consumption. Current environmental health reports. 2014. vol. 1. pp. 208-216.

20 Stephens W.E. Comparing the cancer potencies of emissions from vapourised nicotine products including e-cigarettes with those of tobacco smoke. Tobacco control. 2018. vol. 27. no. 1. pp. 10-17.

Information about authors	**Contribution**
Ekaterina Yu. Smirnova graduate student, researcher, laboratory of standardization and quality, Federal State Budget Scientific Research Institute "All Russian Research Institute of Tobacco, Makhorka and Tobacco Products", Moskovskaya street, 42, Krasnodar, Russia, 350042, Russia, katrinka.smirnova@gmail.com https://orcid.org/0000-0001-9213-9656	review of the literature on an investigated problem, conducted an experiment, performed computations
Evgeniya V. Gnuchikh Dr. Sci. (Engin.), deputy director of research and innovation, Federal State Budget Scientific Research Institute "All Russian Research Institute of Tobacco, Makhorka and Tobacco Products", Moskovskaya street, 42, Krasnodar, Russia, 350042, Russia, gnu20072007@yandex.ru https://orcid.org/0000-0002-1565-3704	review of the literature on an investigated problem, conducted an experiment, performed computations, correct the article before submitting it to the editor
Evgeny A. Bubnov Cand. Sci. (Engin.), a leading researcher of the Laboratory of Machine Agro-Industrial Technologies , Federal State Budget Scientific Research Institute "All Russian Research Institute of Tobacco, Makhorka and Tobacco Products", Moskovskaya street, 42, Krasnodar, Russia, 350042, Russia, hookj@mail.ru https://orcid.org/0000-0003-4429-6440	consultation during results processing, correct the article before submitting it to the editor
Anatoly A. Slavyansky Dr. Sci. (Engin.), professor, head of the department of innovative technologies of products from plant raw materials, Moscow State University of Technology and Management. K.G. Razumovsky, Zemlyanoy Val street, 73, Moscow, 109004, Russia, mgutu-sahar@mail.ru https://orcid.org/0000-0002-0262-8841	wrote the manuscript, correct it before filing in editing and is responsible for plagiarism

Conflict of interest

The authors declare no conflict of interest.

Received 29/01/2024 **Accepted in revised** 12/02/2024 **Accepted** 01/03/2024

Исследование факторов, влияющих на содержание токсичных веществ в дыме изделий из табака курительного тонкорезаного

Аннотация. В настоящее время на российском рынке представлен широкий ассортимент курительной табачной продукции. Наибольшим спросом пользуются сигареты. Однако, по многим причинам, в том числе из-за высокой отпускной цены вследствие роста акцизов, и из-за неудовлетворенности вкусовыми характеристиками потребление сигарет снижается. Происходит частичный переход потребителей на другие виды изделий, при этом табак курительный является альтернативным и очевидным выбором. Из табака курительного тонкорезаного потребители самостоятельно изготавливают изделия (самокрутки) типов Roll Your Own (RYO) без фильтра, оборачивая порцию табака специальной бумагой вручную, комбинируя различные сорта табака, используя различную бумагу, меняя массу табака и диаметр изделия, создавая продукт, отвечающий вкусовым предпочтениям. Учитывая, что никотин и смола несут токсическую нагрузку для организма потребителей актуальным является изучение содержания компонентов дыма изделий из табака курительного тонкорезаного (самокруток), которое может зависеть от множества факторов (масса изделия, диаметр изделия, свойства табака, свойства бумаги). В настоящей статье исследованы технологические свойства различных сортов табака: Вирджиния Голд, Берлей, Иммунный 580 и табачной смеси, изготовленной из этих сортов. Проанализирован состав бумаги для самокруток и ее воздухопроницаемость. Изучено влияние конструктивных свойств изделий на содержание в дыме токсичных соединений (смол, никотина). Экспериментально установлена корреляция между воздухопроницаемостью бумаги для самокруток и химическим составом дыма. Использование бумаги с низкой воздухопроницаемостью увеличивает содержание никотина и смол в дыме конечного продукта. Увеличение диаметра и массы изделия также приводит к увеличению содержания смол и никотина.

Ключевые слова: табак курительный, бумага для самокруток, воздухопроницаемость бумаги, химический состав, дым, никотин, смола, монооксид углерода.

Екатерина Ю. Смирнова аспирант, научный сотрудник, лаборатория стандартизации и качества, Федеральное Государственное Бюджетное Научное Учреждение «Всероссийский научно-исследовательский институт табака, махорки и табачных изделий», ул. Московская, 42, г. Краснодар, 350042, Россия, katrinka.smirnova@gmail.com

https://orcid.org/0000-0001-9213-9656

Евгений А. Бубнов к.т.н., ведущий научный сотрудник, лаборатория машинных агропромышленных технологий, Федеральное Государственное Бюджетное Научное Учреждение «Всероссийский научно-исследовательский институт табака, махорки и табачных изделий», ул. Московская, 42, г. Краснодар, 350042, Россия, hookj@mail.ru

https://orcid.org/0000-0003-4429-6440

Евгения В. Гнучих д.т.н., зам. директора по научной работе и инновациям, Федеральное Государственное Бюджетное Научное Учреждение «Всероссийский научно-исследовательский институт табака, махорки и табачных изделий», ул. Московская, 42, г. Краснодар, 350042, Россия,, gnu20072007@yandex.ru

https://orcid.org/0000-0002-1565-3704

Анатолий А. Славянский д.т.н, профессор, заведующий кафедрой, кафедра инновационных технологий продуктов из растительного сырья, Московский государственный университет технологий и управления имени К.Г. Разумовского, ул. Земляной вал, 73, г. Москва, 109004, Россия, mgutu-sahar@mail.ru

https://orcid.org/0000-0002-0262-8841