

Tobacco in Australia

Facts & Issues

Relevant news and research

12.3 Chemicals and contaminants in tobacco products

Last updated September 2023

Research:.....	2
12.3 Chemicals and contaminants in tobacco products	2
12.3.1 Chemicals from the tobacco plant	3
12.3.2 Chemicals from fertilisers and pesticides	6
12.3.3 Chemicals and contaminants from the curing and aging of tobacco	6
12.3.4 Contamination of tobacco products with microorganisms.....	8
12.3.5 Additives and flavours.....	9
News:	10
12.3 Chemicals and contaminants in tobacco products	10
12.3.1 Chemicals from the tobacco plant	10
12.3.2 Chemicals from fertilisers and pesticides	10
12.3.3 Chemicals and contaminants from the curing and aging of tobacco	10
12.3.4 Contamination of tobacco products with microorganisms.....	10
12.3.5 Additives and flavours.....	10

Research:

12.3 Chemicals and contaminants in tobacco products

Abdel Rahman RT, Kamal N, Mediani A, and Farag MA. How Do Herbal Cigarettes Compare To Tobacco? A Comprehensive Review of Their Sensory Characters, Phytochemicals, and Functional Properties. *ACS Omega*, 2022; 7(50):45797-809. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/36570239>.

Pearson J, Ganz O, Ohman-Strickland P, and Wackowski OA. Shifts in preference for Natural American Spirit and associated belief that one's own cigarette brand might be less harmful than other brands: results from Waves 1-4 of the Population Assessment of Tobacco and Health (PATH) Study (2013-2018). *Tobacco Control*, 2021. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/34952863>.

E B, N E, S B, S S, D S, et al. An approach for the extract generation and toxicological assessment of tobacco-free 'modern' oral nicotine pouches. *Food and Chemical Toxicology*, 2020; 145:111713.

Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32998027>.

Kubica P. Ultrasound-Assisted Solvent Extraction of a Porous Membrane Packed Sample for the Determination of Tobacco-Specific Nitrosamines in the Replacement Liquids for E-Cigarettes.

Molecules, 2019; 24(24). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31861109>.

Kaiser S, Soares FLF, Ardila JA, Marcelo MCA, Dias JC, et al. Innovative Approaches for Estimating the Levels of Tobacco-Specific Nitrosamines in Cured Tobacco Samples. *Chemical Research in Toxicology*, 2018. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/30113823>.

U.S. National Cancer Institute and World Health Organization. Chapter 8: The Impact of Information on the Demand for Tobacco Products, in National Cancer Institute Tobacco Control Monograph 21.

The Economics of Tobacco and Tobacco Control. Section 4—Non-Price Determinants of Demand. NIH Publication, Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute; and Geneva, CH: World Health Organization: 2016. Available from: https://cancercontrol.cancer.gov/brp/tcrb/monographs/21/docs/m21_8.pdf.

Akhtar A, Kazi TG, Afridi HI, Musharraf SG, Talpur FN, et al. Vortex-assisted ionic liquid-based dispersive liquid-liquid microextraction for assessment of chromium species in artificial saliva extract of different chewing tobacco products. *Environmental Science and Pollution Research International*, 2016. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/27696158>.

Wackowski OA, Lewis MJ, Delnevo CD, and Ling PM. Smokeless Tobacco Risk Comparison and Other Debate Messages in the News. *Health Behav Policy Rev*, 2014; 1(3):183-90. Available from:

<http://www.ncbi.nlm.nih.gov/pubmed/25383357>.

Gottlieb JC, Cohen LM, and Haslam AK. Comparing college smokers' and dual users' expectancies towards cigarette smoking. *Addictive Behaviors*, 2014; 39(12):1784-8. Available from:

<http://www.ncbi.nlm.nih.gov/pubmed/25123347>.

Farhadmollashahi L. Sociocultural reasons for smokeless tobacco use behavior. *Int J High Risk Behav Addict*, 2014; 3(2):e20002. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/25032164>.

Burns D, Anderson C, and Gray N. Do changes in cigarette design influence the rise in adenocarcinoma of the lung? *Cancer Causes and Control*, 2011; 22(1):13-22. Available from: <http://www.springerlink.com/content/I5252n560213x511/>.

World Health Organization. The scientific basis for product regulation. Technical Report Series, 945. Geneva: World Health Organisation, 2007. Available from: http://www.who.int/tobacco/global_interaction/tobreg/who_tsr.pdf.

12.3.1 Chemicals from the tobacco plant

Aggez, G, Ganioglu, E, Sahin, L, & Hafizoglu, N. (2022). Radiation doses due to smoking different types of tobacco leaves grown in Turkey. *Radiat Environ Biophys*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36153369>

Kozak, K, & Antosiewicz, DM. (2022). Tobacco as an efficient metal accumulator. *Biometals*. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36097238>

Zou X, Bk A, Rauf A, Saeed M, Al-Awthan YS, et al. Screening of polyphenols in Tobacco (*Nicotiana tabacum*) and determination of their antioxidant activity in different Tobacco varieties. *ACS Omega*, 2021; 6(39):25361-71. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34632194>

Yang Y, Li Y, Wang T, Chen W, Wang M, et al. Exposure to potentially toxic elements through the soil-tobacco-human pathway: Causative factors and probabilistic model. *Science of the Total Environment*, 2021:151379. Available from: <https://www.sciencedirect.com/science/article/pii/S0048969721064573>

Salahel Din K. (210)pb and (210)po concentration levels in tobacco products and resulting radiation dose for egyptian smokers. *Radiat Environ Biophys*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33730309>

Duan S, Yang J, Zhou Z, Xiao Y, Li S, et al. Quantitative relationship between paddy soil properties and cadmium content in tobacco leaves. *Bulletin of Environmental Contamination and Toxicology*, 2021; 106(5):878-83. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33811509>

Bontempo L, Bertoldi D, Franceschi P, Rossi F, and Larcher R. Elemental and isotopic characterization of Tobacco from umbria. *Metabolites*, 2021; 11(3). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33809890>

an Duong H, Thanh Nguyen D, Peka A, Toth-Bodrogi E, and Kovacs T. 210po in soil and tobacco leaves in quang xuong, vietnam and estimation of annual effective dose to smokers. *Radiation Protection Dosimetry*, 2020; 192(1):106-12. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33230527>

Lisboa TP, Mimura AMS, da Silva JCJ, and de Sousa RA. Chromium levels in Tobacco, filter and ash of illicit brands cigarettes marketed in Brazil. *Journal of analytical toxicology*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/31984423>

Ghanbar-Moghaddam B and Fathivand A. Study of polonium-210 in persian cigarette and Tobacco crops. *Radiat Prot Dosimetry*, 2020. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33119076>

Pappas RS, Watson CH, and Valentin-Blasini L. Aluminum in Tobacco products available in the United States. *Journal of analytical toxicology*, 2018; 42(9):637-41. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/29750257>

Hossain MT, Hassi U, and Imamul Huq SM. Assessment of concentration and toxicological (cancer) risk of lead, cadmium and chromium in tobacco products commonly available in bangladesh. *Toxicology Reports*, 2018; 5:897-902. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/30191134>

Ganguly K, Levanen B, Palmberg L, Akesson A, and Linden A. Cadmium in tobacco smokers: A neglected link to lung disease? *European Respiratory Review: An Official Journal of the European Respiratory Society*, 2018; 27(147). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/29592863>

Pinto E, Cruz M, Ramos P, Santos A, and Almeida A. Metals transfer from tobacco to cigarette smoke: Evidences in smokers' lung tissue. *J Hazard Mater*, 2017; 325:31-5. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/27914289>

Liu H, Zhang Y, Zhou X, You X, Shi Y, et al. Source identification and spatial distribution of heavy metals in tobacco-growing soils in shandong province of China with multivariate and geostatistical analysis. *Environmental Science and Pollution Research International*, 2017; 24(6):5964-75. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/28070814>

Lawler TS, Stanfill SB, deCastro BR, Lisko JG, Duncan BW, et al. Surveillance of nicotine and pH in cigarette and cigar filler. *Tob Regul Sci*, 2017; 3(Suppl 1):101-16. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/28989950>

Kubalek D, Sersa G, Strok M, Benedik L, and Jeran Z. Radioactivity of cigarettes and the importance of (210)po and thorium isotopes for radiation dose assessment due to smoking. *J Environ Radioact*, 2016; 155-156:97-104. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/26942842>

Groth AC, Barnes JH, Lewis C, Murray CK, Albahadily F, et al. Forensic analysis of cigarette ash-brand determination through trace-metal analysis. *Journal of Forensic Sciences*, 2016; 61(4):913-21. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/27364270>

O'Connor RJ, Schneller LM, Caruso RV, Stephens WE, Li Q, et al. Toxic metal and nicotine content of cigarettes sold in China, 2009 and 2012. *Tobacco Control*, 2015; 24 Suppl 4:iv55-9. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/25335903>

Fresquez MR, Gonzalez-Jimenez N, Gray N, Watson CH, and Pappas RS. High-throughput determination of mercury in Tobacco and mainstream smoke from little cigars. *Journal of analytical toxicology*, 2015; 39(7):545-50. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/26051388>

ia B, Feng M, Xu G, Xu J, Li S, et al. Investigation of the chemical compositions in tobacco of different origins and maturities at harvest by gc-ms and hplc-pda-qtof-ms. *Journal of Agricultural and Food Chemistry*, 2014; 62(22):4979-87. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/24833170>

Arain SS, Gul Kazi T, Afridi HI, Brahman KD, NaEmuliah, et al. Arsenic content in smokeless tobacco products consumed by the population of pakistan: Related health risk. *Journal of AOAC International*, 2014; 97(6):1662-9. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/25632442>

Zhang L, Wang X, Guo J, Xia Q, Zhao G, et al. Metabolic profiling of chinese tobacco leaf of different geographical origins by gc-ms. *Journal of Agricultural and Food Chemistry*, 2013; 61(11):2597-605. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/23441877>

Fresquez MR, Pappas RS, and Watson CH. Establishment of toxic metal reference range in tobacco from US cigarettes. *Journal of analytical toxicology*, 2013; 37(5):298-304. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/23548667>

US Department of Health and Human Services. A report of the Surgeon General: How tobacco smoke causes disease. US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2010. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK53017/>.

Centers for Disease Control and Prevention (US); National Center for Chronic Disease Prevention and Health Promotion (US); Office on Smoking and Health (US). How Tobacco smoke causes disease: The biology and behavioral basis for smoking-attributable disease: A report of the Surgeon General. Atlanta, Georgia Centers for Disease Control and Prevention (US), 2010. Available from: https://www.cdc.gov/tobacco/data_statistics/sgr/2010/index.htm.

Papastefanou C. Radioactivity of tobacco leaves and radiation dose induced from smoking. *Int J Environ Res Public Health*, 2009; 6(2):558–67. Available from: <http://www.mdpi.com/1660-4601/6/2/558>

Djordjevic MV and Doran KA. Nicotine content and delivery across tobacco products. *Handbook of Experimental Pharmacology*, 2009; (192):61-82. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/19184646>

Muggli ME, Ebbert JO, Robertson C, and Hurt RD. Waking a sleeping giant: The tobacco industry's response to the polonium-210 issue. *American Journal of Public Health*, 2008; 98(9):1643-50. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/18633078>

McNeill A, Bedi R, Islam S, Alkhatib MN, and West R. Levels of toxins in oral tobacco products in the UK. *Tobacco Control*, 2006; 15(1):64-7. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/16436408>

Stephens WE, Calder A, and Newton J. Source and health implications of high toxic metal concentrations in illicit tobacco products. *Environmental Science & Technology*, 2005; 39(2):479-88. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/15707047>

Li Z, Wang L, Yang G, Shi H, Jiang C, et al. Study on the determination of polyphenols in tobacco by hplc coupled with esi-ms after solid-phase extraction. *Journal of Chromatographic Science*, 2003; 41(1):36-40. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/12597595>

Mage DT. Are all cigarettes equal? *Environmental Health Perspectives*, 2001; 109(12):A570–1. Available from: <http://www.pubmedcentral.nih.gov/picrender.fcgi?artid=1240525&blobtype=pdf>

Laugesen M. The regulation of nicotine and harmful cigarette constituents. Discussion paper for the victorian smoking and health program. 1997.

Kessler D. The control and manipulation of nicotine in cigarettes. *Tobacco Control*, 1994; 3(4):362–9. Available from: <http://tobaccocontrol.bmj.com/cgi/reprint/3/4/362>

Tso TC, Harley N, and Alexander LT. Source of lead-210 and polonium-210 in tobacco. *Science*, 1966; 153(3738):880-2. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/5914751>

12.3.2 Chemicals from fertilisers and pesticides

Domingues CE, Kordiak J, Pedroso CR, de Oliveira Stremel TR, Beber de Souza J, et al. Optimization and validation of ultrasound application with a low-temperature method to analyze organochlorine pesticides in smuggled cigarette tobacco. *Anal Methods*, 2022; 14(29):2857-65. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35833565>

Xiong W, Tao X, Zhang H, Huang M, and Shao J. Determination of commonly used multiclass pesticide residues in Tobacco and cigarette smoke by ultra-performance liquid chromatography-tandem mass spectrometry. *Journal of Chromatographic Science*, 2021. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/34599330>

Lopez Davila E, Houbraken M, De Rop J, Wumbei A, Du Laing G, et al. Pesticides residues in tobacco smoke: Risk assessment study. *Environmental Monitoring and Assessment* 2020; 192(9):615. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/32876774>

Quadroni S and Bettinetti R. An unnoticed issue: Organochlorine pesticides in tobacco products around the world. *Chemosphere*, 2019; 219:54-7. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/30529853>

World Health Organization. Tobacco and its environmental impact: An overview., Geneva: WHO, 2017. Available from: <https://apps.who.int/iris/bitstream/handle/10665/255574/9789241512497-eng.pdf>.

Armentrout J. The effects of fertilizer on burley tobacco, *Nicotiana tabacum*. , 2014, The University of Tennessee. Available from: https://www.utm.edu/departments/msanr/_pdfs/Armentrout_research_project_final.pdf.

Mayer-Helm B. Method development for the determination of 52 pesticides in tobacco by liquid chromatography-tandem mass spectrometry. *Journal of Chromatography A*, 2009; 1216(51):8953-9. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/19926093>

McDaniel PA, Solomon G, and Malone RE. The tobacco industry and pesticide regulations: Case studies from tobacco industry archives. *Environmental Health Perspectives*, 2005; 113(12):1659-65. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/16330343>

Kutywayo V. Chemical alternatives for soil fumigation with methyl bromide on tobacco seedbeds in nematode and weed control. *Communications in agricultural and applied biological sciences*, 2003; 68(4 Pt A):115-22. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/15149099>

Chapman S. "Keep a low profile": Pesticide residue, additives, and freon use in Australian tobacco manufacturing. *Tobacco Control*, 2003; 12 Suppl 3(Suppl 3):iii45-53. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/14645948>

Turusov V, Rakitsky, V., Tomatis, L. Dichlorodiphenyltrichloroethane (ddt): Ubiquity, persistence, and risks. *Environmental Health Perspectives*, 2002; 110(2):125-8.

12.3.3 Chemicals and contaminants from the curing and aging of tobacco

Fan, J, Kong, G, Yao, H, Wu, Y, Zhao, G, Li, F, & Zhang, G. (2023). Widely targeted metabolomic analysis reveals that volatile metabolites in cigar tobacco leaves dynamically change during

fermentation. *Biochem Biophys Res Commun*, **35**, 101532. Retrieved from

<https://www.ncbi.nlm.nih.gov/pubmed/37637940>

Zhang, Q, Kong, G, Zhao, G, Liu, J, Jin, H, Li, Z et al. (2023). Microbial and enzymatic changes in cigar tobacco leaves during air-curing and fermentation. *Appl Microbiol Biotechnol*. Retrieved from

<https://www.ncbi.nlm.nih.gov/pubmed/37458766>

Wen, C, Wanrong, H, Pinhe, L, Jie, L, Qianying, Z, Quanwei, Z et al. (2022). Effects of fermentation medium on cigar filler. *Front Bioeng Biotechnol*, **10**, 1069796. Retrieved from

<https://www.ncbi.nlm.nih.gov/pubmed/36588960>

Feng Y, Zhao Y, Li Y, Zhou J, Li Y, et al. Physiological and transcriptome analysis reveals the differences in nitrate content between lamina and midrib of flue-cured tobacco. *Sci Rep*, 2022;

12(1):2932. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35190651>

Konstantinou E, Fotopoulou F, Drosos A, Dimakopoulou N, Zagoriti Z, et al. Tobacco-specific nitrosamines: A literature review. *Food and Chemical Toxicology*, 2018; **118**:198-203. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/29751076>

Czoli CD and Hammond D. Carcinogen exposure among canadian tobacco users: Changes in NNK exposure from 2007-09 through 2012-13. *Cancer Epidemiology, Biomarkers & Prevention*, 2018.

Available from: <https://www.ncbi.nlm.nih.gov/pubmed/29358222>

Collishaw N. Blowing smoke: The history of tobacco-specific nitrosamines in canadian tobacco.

Tobacco Control, 2017; **26**(4):365-70. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/27272915>

Law AD, Fisher C, Jack A, and Moe LA. Tobacco, microbes, and carcinogens: Correlation between Tobacco cure conditions, Tobacco-specific nitrosamine content, and cured leaf microbial community.

Microb Ecol, 2016; **72**(1):120-9. Available from: <https://pubmed.ncbi.nlm.nih.gov/27023797/>

Fresquez MR, Pappas RS, and Watson CH. Establishment of toxic metal reference range in tobacco from US cigarettes. *Journal of analytical toxicology*, 2013; **37**(5):298-304. Available from:

<https://www.ncbi.nlm.nih.gov/pubmed/23548667>

US Department of Health and Human Services. A report of the Surgeon General: How tobacco smoke causes disease. US Department of Health and Human Services, Centers for Disease Control and

Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on

Smoking and Health, 2010. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK53017/>.

Centers for Disease Control and Prevention (US); National Center for Chronic Disease Prevention and Health Promotion (US); Office on Smoking and Health (US). How Tobacco smoke causes disease: The

biology and behavioral basis for smoking-attributable disease: A report of the Surgeon General.

Atlanta, Georgia Centers for Disease Control and Prevention (US), 2010. Available from:

https://www.cdc.gov/tobacco/data_statistics/sgr/2010/index.htm.

Rickert W, Joza P, Sharifi M, Wu J, and Lauterbach J. Reductions in the tobacco specific nitrosamine (tsna) content of tobaccos taken from commercial canadian cigarettes and corresponding reductions

in tsna deliveries in mainstream smoke from such cigarettes. *Regulatory Toxicology And*

Pharmacology, 2008; **51**(3):306–10. Available from:

<http://www.ncbi.nlm.nih.gov/pubmed/18508168>

Gray N and Boyle P. The case of the disappearing nitrosamines: A potentially global phenomenon. *Tobacco Control*, 2004; 13(1):13-6. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/14985588>

Ashley D, Johnson DR, McCraw JM, Richter P, Pirkle JL, et al. Tobacco-specific nitrosamines in U.S. Brand and non-U.S. Brand cigarettes. *Nicotine and Tobacco Research*, 2003; 5(3):323-32. Available from: <https://pubmed.ncbi.nlm.nih.gov/12791527/>

Townsend D. Potential method to reduce controversial compounds in flue-cured tobacco. in Joint Meeting of the Smoke and Technology Groups of CORETSA, CORETSA Congress. Innsbruck, Austria. 1999.

Fisher S, Speigelhalter B, and Eisenbarth J. Investigations on the origins of tobacco-specific nitrosamines in mainstream smoke of cigarettes. *Carcinogenesis*, 1990; 11(5):723–30. Available from: <http://carcin.oxfordjournals.org/cgi/reprint/11/5/723>

Hecht SS and Hoffmann D. Tobacco-specific nitrosamines, an important group of carcinogens in tobacco and tobacco smoke. *Carcinogenesis*, 1988; 9(6):875-84. Available from: <https://pubmed.ncbi.nlm.nih.gov/3286030/>

12.3.4 Contamination of tobacco products with microorganisms

Wen, C, Wanrong, H, Pinhe, L, Jie, L, Qianying, Z, Quanwei, Z et al. (2022). Effects of fermentation medium on cigar filler. *Front Bioeng Biotechnol*, 10, 1069796. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36588960>

Chattopadhyay, S, Ramachandran, P, Malayil, L, Mongodin, EF, & Sapkota, AR. (2022). Conventional tobacco products harbor unique and heterogenous microbiomes. *Environ Res*, 220, 115205. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/36592812>

Zheng T, Zhang Q, Li P, Wu X, Liu Y, et al. Analysis of microbial community, volatile flavor compounds, and flavor of cigar Tobacco leaves from different regions. *Frontiers in Microbiology*, 2022; 13:907270. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35756070>

Srivastava S, Sajid M, Singh H, and Bharadwaj M. Delineating the bacteriome of packaged and loose smokeless Tobacco products available in north India. *Appl Microbiol Biotechnol*, 2022. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35604437>

Malayil L, Chattopadhyay S, Bui A, Panse M, Cagle R, et al. Viable bacteria abundant in cigarettes are aerosolized in mainstream smoke. *Environmental research*, 2022; 212(Pt D):113462. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/35580667>

Chattopadhyay S, Malayil L, Mongodin EF, and Sapkota AR. A roadmap from unknowns to knowns: Advancing our understanding of the microbiomes of commercially available tobacco products. *Applied Microbiology and Biotechnology*, 2021; 105(7):2633-45. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/33704513>

Marchese S, Polo A, Ariano A, Velotto S, Costantini S, et al. Aflatoxin b1 and m1: Biological properties and their involvement in cancer development. *Toxins (Basel)*, 2018; 10(6). Available from: <https://www.ncbi.nlm.nih.gov/pubmed/29794965>

Law AD, Fisher C, Jack A, and Moe LA. Tobacco, microbes, and carcinogens: Correlation between Tobacco cure conditions, Tobacco-specific nitrosamine content, and cured leaf microbial community. *Microb Ecol*, 2016; 72(1):120-9. Available from: <https://pubmed.ncbi.nlm.nih.gov/27023797/>

Norberg M, Malmberg G, Ng N, and Brostrom G. Use of moist smokeless tobacco (snus) and the risk of development of alcohol dependence: A cohort study in a middle-aged population in sweden. *Drug Alcohol Depend*, 2015. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/25707707>

Eaton T, Falkinham JO, 3rd, and von Reyn CF. Recovery of mycobacterium avium from cigarettes. *Journal of Clinical Microbiology*, 1995; 33(10):2757-8. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/8567919>

12.3.5 Additives and flavours

News:

12.3 Chemicals and contaminants in tobacco products

Australian Government. Australian cigarette ingredient information. Canberra, Australia 2020. Last update: Viewed Available from: <https://www.health.gov.au/resources/collections/australian-cigarette-ingredient-information>.

Schmid T. Pest control in tobacco warehousing., in Tobacco Asia2017. Available from: www.tobaccoasia.com/features/pest-control-in-tobacco-warehousing/.

Food and Drug Administration (FDA). Chemicals in cigarettes: From plant to product to puff. US 2017. Available from: <https://www.fda.gov/TobaccoProducts/Labeling/ProductsIngredientsComponents/ucm535235.htm>.

12.3.1 Chemicals from the tobacco plant

Fusetto R and O'Hair RAJ. Nicotine as an insecticide in Australia: A short history. Chemistry in Australia: Royal Australian Chemical Institute, 2015. Last update: Viewed Available from: <http://chemaust.raci.org.au/article/october-2015/nicotine-insecticide-australia-short-history.html>.

Rogers K. Alkaloid. Britannica, 2002. Last update: Viewed Available from: <https://www.britannica.com/science/alkaloid>.

12.3.2 Chemicals from fertilisers and pesticides

12.3.3 Chemicals and contaminants from the curing and aging of tobacco

12.3.4 Contamination of tobacco products with microorganisms

Pratt K. Study links tobacco microbials, carcinogens. Phys.org, 2016. Available from: <http://phys.org/news/2016-06-links-tobacco-microbials-carcinogens.html>

12.3.5 Additives and flavours