Open Respir Arch. 2019;1(1-2):5–6

Sociedad Española de Neumología y Cirugía Torácica SEPAR

Open Respiratory Archives

www.elsevier.es/ora

Editorial

Cigarette: Perfect Engineering Product To Inhale But Not Safe

El cigarro: una obra de ingeniería para inhalar perfecta pero no segura

Introduction

An important component of the cigarette is the paper that wraps tobacco.[1] There are properties of the paper that have an important effect on the yield and composition of the smoke such as the type of paper, its weight, its density and its porosity.[1] It is known that adding certain substances to the paper of tobacco can affect its burning.[1] On the other hand, there are four physical parameters of great importance in the yield of the cigarette: the length, its circumference, the type of cut of the tobacco and the density of the packaging.[1]

Paper

Using a very porous paper increase the air that enters through the column of the cigarette which serves to dilute the smoke from the mainstream and increase the speed of burning. Therefore, the diffusion of certain gaseous components (*e.g.*, CO, CO_2, NO) is accelerated through the paper into the environment during inhalation and the diffusion of oxygen from the tobacco column, which causes faster combustion during inhalation intervals. It is also true that a high porosity cigarette contains fewer volatile carcinogens and nitrosamines than a low porosity cigarette.[1] It is known that adding certain salts and citrates to the cigarette paper reduces the rate of burning, as well as the toxic performance in smoke during inhalation.[1]

In 1993, cigarettes were manufactured with modified combustion properties (Fire Standard Compliant – FSC) which reduced the risk of fire.[2] Circumferential bands of different densities, compositions, width and separation along the cigarette are added to the cigarette and in this way FSC cigarettes were achieved. The cigarettes, thanks to these bands, turn off when they are not inhaled.[2] However, this approach means that the smoker could face a different exposure to smoke: changes in the combustion properties of cigarettes suggest a potential change in the characteristics of conventional cigarette smoke. Werley et al.[2] wanted to evaluate the toxicity in a cigarette by adding these cross bands, finding no toxicity differences between the cigarettes with and without bands, but there were differences in the amount of band material associated with an increase in some metals measured in tobacco smoke. Adding bands to the cigarette does not increase toxicity, genotoxicity or cytoxicity.[3–5]

Numerous adhesives are used in the manufacture of cigarettes, which could also affect toxicity and its chemistry. Coggins et al.[6] found differences in the constituents of the mainstream of the cigarette depending on the type of adhesive used, but these differences were not statistically significant either *in vitro* or *in vivo*.

Zumbado et al.[7] analysed the load of 33 elements in different types of cigarettes. They included not only elements considered classically toxic (arsenic, beryllium, cadmium, chromium, cobalt, lead, mercury, nickel, selenium and uranium) but also those considered as e-waste [REE: the rare earth elements. They are scandium and yttrium and 15 elements of the Lanthanide group (lanthanum, cerium, praseodymium, neodymium, pledge, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, tulio, ytterbium and lutetium)].[8] They analysed these elements separately on paper and in the filters and conclude that black tobacco contains the highest levels of known usual toxic elements and so-called REEs, and the paper used to wrap tobacco significantly modifies the concentration of these elements, and that flavoured paper that burns more fast contributes to higher levels of these elements.

Physical parameters of cigarettes

Cigarette length

As the length of the cigarette increases, there is a greater opportunity for air to enter through the paper and for certain gaseous components such as carbon monoxide and nitrous oxide to diffuse through the paper into the environment.[1] If everything remains stable except the length of the cigarette there will be a greater amount of tar and nicotine in the inhaled smoke since more tobacco is burned.[9]

Cigarette circumference diameter

If the density of tobacco in the cigarette is kept constant, a decrease in its circumference reduces the amount of tobacco that is burned. As a result of the above, the amount of tar, CO, volatile organic components and nicotine in the mainstream is reduced.[1] It has also been shown that reducing the diameter of cigarettes decreases their mutagenicity and cytotoxicity, but instead increases, in a non-dependent manner, cyanide hydrogen,[10] as well as the amount of formaldehyde.[11] McAdam et al.[11] have demonstrated that decreasing cigarette circumference

https://doi.org/10.1016/j.opresp.2019.08.004
2659-6636/© 2019 Sociedad Española de Neumología y Cirugía Torácica (SEPAR). Published by Elsevier España, S.L.U. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

influences the physical properties of the cigarette and secondary the nature of the smoke produced. Tobacco weight, mass burn rate, puff count and static burn time decrease with decreasing circumference, while draw resistance and the length of rod burned during puff and smoulder periods increase. The increases in formaldehyde relative to tar and the reduction in some of the specific bioactivities of the condensate with decreasing circumference appear to be related at least in part to a more oxidizing burning zone.

Tobacco cut

Years ago, Hoffmann and Hoffmann[1] already summarized this aspect: *When the width of shredded tobacco is modified from a fine to a coarse cut, the number of puffs per cigarette increases. In general, cigarettes that are filled with a more coarsely cut tobacco burn less efficiently than those made with finely cut shreds. When comparing the smoke of cigarettes filled with coarse-cut tobacco (1.27 mm) and smoke of cigarettes made with a fine-cut tobacco (0.42 mm), showed only slight differences in smoke yields. However, a comparison of mouse skin bioassays of "tars" from cigarettes made with a given tobacco that was cut at a rate of 20, 30, or 50 cuts per inch (1.27, 0.85, and 0.51 mm) showed that the finer the cut of the tobacco, the lower was the tumorigenicity of the resulting "tar".*

Packing density

Increasing the mass of the tobacco in a cigarette means increasing the packing density, and it is expected that yields of "tar" and nicotine in the smoke will rise accordingly. However, packing more than 1.0 g tobacco into an 85-mm cigarette causes the yields of "tar" and nicotine in the smoke to decrease, most likely because the tobacco acts as a filter for the smoke and retains more of it.[1]

In conclusion, cigarettes have clearly changed in the last 70 years, they are the perfect engineering product to inhale, but the risk of getting sick, as a result of their consumption, has not changed.

Conflicts of interest

JIG-O has received honoraria for lecturing, scientific advice, participation in clinical studies or writing for publications for (alphabetical order): AstraZeneca, Chiesi, Esteve, Faes, Gebro, Menarini, and Pfizer. CAJ-R: has received honoraria for advisory and talks for pharma companies trading smoking cessation medications. SS-R has received honoraria for lecturing, participation in clinical studies and writing for publications for (alphabetical order): Boehringer, Esteve, Pfizer y Sandoz. CG-B have no conflicts of interest.

References

1. Hoffmann D, Hoffmann I. The changing cigarette, 1950–1995. J Toxicol Environ Health. 1997;50:307–64, http://dx.doi.org/10.1080/009841097160393.
2. Werley MS, Jerome AM, DeSoi DJ, Coggins CRE, Oldham MJ, McKinney WJ. A comprehensive evaluation of the toxicology of experimental cigarettes manufactured with banded papers. Inhal Toxicol. 2013;25:19–33.
3. Theophilus EH, Shreve WK, Ayres PH, Garner CD, Pence DH, Swauger JE. Comparative 13-week cigarette smoke inhalation study in Sprague–Dawley rats: evaluation of cigarettes with two banded cigarette paper technologies. Food Chem Toxicol. 2007;45:1076–90.
4. Theophilus EH, Pence DH, Meckley DR, Keith Shreve W, Ayres PH, Bombick BR, et al. Toxicological evaluation of cigarettes with two banded cigarette paper technologies. Exp Toxicol Pathol. 2007;59:17–27.
5. Alpert HR, O'Connor RJ, Spalletta R, Connolly GN. Recent advances in cigarette ignition propensity research and development. Fire Technol. 2010;46:275–89.
6. Coggins CRE, Jerome AM, Lilly PD, McKinney WJ, Oldham MJ. A comprehensive toxicological evaluation of three adhesives using experimental cigarettes. Inhal Toxicol. 2013;25(S2):6–18.
7. Zumbado M, Luzardo OP, Rodríguez-Hernández A, Boada LD, Henríquez-Hernández LA. Differential exposure to 33 toxic elements through cigarette smoking, based on the type of tobacco and rolling paper used. Environ Res. 2019;169:368–76.
8. Tansel B. From electronic consumer products to e-wastes: global outlook, waste quantities, recycling challenges. Environ Int. 2017;98:35–45.
9. Moore GE, Bock FG. Tar" and nicotine levels of American cigarettes. Natl Cancer Inst Monogr. 1968;28:89–94.
10. Coggins CRE, McKinney WJ, Oldham MJ. A comprehensive evaluation of the toxicology of experimental, non-filtered cigarettes manufactured with different circumferences. Inhal Toxicol. 2013;25(S2):69–72.
11. McAdam K, Eldridge A, Fearon IM, Liu CH, Manson A, Murphy J, et al. Influence of cigarette circumference on smoke chemistry, biological activity, and smoking behaviour. Regul Toxicol Pharmacol. 2016;82:111e126.

José Ignacio de Granda Orive[a,*], Segismundo Solano-Reina[b], Carlos de Granda-Beltrán[c], Carlos Andrés Jiménez-Ruiz[d]
[a] *Servicio de Neumología, Hospital Universitario 12 de Octubre, Universidad Complutense, Madrid, Spain*
[b] *Servicio de Neumología, Hospital General Universitario Gregorio Marañón, Madrid, Spain*
[c] *Facultad de Medicina, Universidad de Valladolid, Valladolid, Spain*
[d] *Unidad Especializada en Tabaquismo de la Comunidad de Madrid, Madrid, Spain*

[*] Corresponding author.
E-mail address: igo01m@gmail.com (J.I. de Granda Orive).