

Inhaled and ingested smoke: The health effects of tobacco and smoked foods

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OPINION PAPER

Abstract

In this paper we fulfil our precedent commitment on dangers associated with smoke, not discussed for its complexity in a previous paper published on food labels in IJFS n.1, 2025. We structured this final article in two sections: (i) the health effects of tobacco smoking and (ii) the health effects of smoked foods.

Keywords: Tobacco, cigarette, health, smoked food, cancer risk

Introduction

In a previous paper (Garattini and Fantozzi, 2025) on food labels, specifically analyzing some misleading uses of them, including those related to smoking, we highlighted the significant dangers associated with smoke and emphasized the need for a dedicated publication on this topic. This was due to the complexity of the issue, particularly concerning the presence of polycyclic aromatic hydrocarbons (PAHs) in food and their impact on human health. With this Opinion paper, we fulfil that commitment. We structured this article in two sections: (i) the health effects of tobacco smoking and (ii) the health effects of smoked foods.

in various forms, including smoking, chewing, or sniffing. Cigarettes are the most commonly smoked tobacco products (Anonymous, 2021; Mishra and Mishra, 2013). The tobacco plant is native to the Americas, where indigenous peoples used it in religious ceremonies and for its supposed medicinal properties. Following the arrival of Spanish conquistadors in the 15th century, tobacco was introduced in Europe as a trade commodity primarily for smoking. Its global popularity surged in the 19th century with the advent of mass-produced cigarettes (Mishra and Mishra, 2013). Today, the tobacco plant is grown worldwide. The top five producers of unmanufactured tobacco are China (around 40% of the global production), India (12%), Brazil (12%), Zimbabwe (4%), and the USA (3%).

Smoking Tobacco

What is tobacco?

Tobacco is a plant cultivated for its leaves rich in nicotine, a highly addictive stimulant alkaloid. It can be consumed

Health consequences of smoking

Cigarette smoking is known to cause 80% of all lung cancers and contributes to the development of at least 14 other types of cancer, mainly of the respiratory and digestive systems (IARC, 2012). Cigarette smoking is also

the leading risk factor for chronic obstructive pulmonary disease (COPD), a debilitating condition characterized by reduced respiratory function and a significant social and economic burden. Smokers also have a significantly higher risk of ischemic heart disease and stroke, two major contributors to cardiovascular disease, the leading cause of death in high-income countries (CDC, 2004).

The most serious consequence of smoking is premature death. The well-known British Doctors' Study, a 50-year prospective study in nearly 35,000 men, found that smokers live an average of 10 years less than nonsmokers. According to this study, out of 100 nonsmokers at the age of 35, 81 will reach 70, 59 will reach 80, and 24 will reach 90. In contrast, out of 100 lifelong smokers, only 58 reach 70, 26 reach 80, and only 4 will reach 90 (Doll *et al.*, 2004).

In 2008, the World Health Organization (WHO) declared tobacco to be the single largest preventable cause of death in the world. Smoking is responsible for an estimated 8 million deaths each year. More than 7 million of these deaths are the result of direct tobacco use, while about 1.3 million are the result of nonsmokers being exposed to secondhand smoke (SHS) (WHO, 2023). Environmental tobacco smoke (ETS) exposure has been linked to serious health effects in both adults and children, including cancer, heart disease, and respiratory disease (IARC, 2012; WHO, 2023). According to the Global Burden of Diseases (GBD) estimates for 2021, of all known behavioral, metabolic, and environmental risk factors, tobacco smoking remains the most harmful for mortality and disability in Western Europe (GBD, 2025).

The health benefits of quitting smoking are impressive. The British Doctors' Study showed that people who quit smoking by the age of 40 avoid almost all of the excess mortality risk associated with smoking. Quitting by age 50 significantly reduces the risk, while even those who quit by age 60 can still avoid almost half of their excess risk (Doll *et al.*, 2004). These findings emphasize that quitting smoking at any age has significant health benefits.

Epidemiology of smoking

The GBD study provides data on the prevalence of tobacco smoking in 204 countries and territories from 1990 to 2019. In 2019, an estimated 1.14 billion people were current smokers, consuming a total of 7.4 trillion cigarettes per year. The age-adjusted prevalence of smoking among people aged 15 years and older was 32.7% in men and 6.6% in women.

Although the global prevalence of smoking has declined significantly since 1990, by 27.5% among men and 37.7%

among women, population growth has led to an overall increase in the absolute number of smokers. In Western Europe, smoking prevalence was 28.8% for men and 22.7% for women (GBD Tobacco Collaborators, 2021).

Regarding adolescent smoking, the 2019 European School Survey Project on Alcohol and Other Drugs (ESPAD), which surveyed representative samples of 15- to 16-year-old students in 35 European countries, found that the proportion of students smoking at least one cigarette in the previous 30 days was highest in Italy (32%), compared to the European average of 20%.

In addition, the proportion of students reporting daily smoking was also highest in Italy (19%), almost double the European average (10%) (Cerrai *et al.*, 2022).

Tobacco control: progress and challenges

Tobacco control is a public health area that aims to reduce tobacco-related morbidity and mortality by implementing strategies to reduce smoking prevalence. Unlike other harmful products that are quickly removed from the market, tobacco has remained available because of the industry's efforts to deny and conceal its dangers. For decades, tobacco companies influenced research and funded studies to cast doubt on the harmful health effects of smoking.

In response, the WHO launched the Framework Convention on Tobacco Control (FCTC) in 2003, which has now been adopted by 183 countries. The FCTC introduced the MPOWER strategy, which includes monitoring tobacco use, protecting people from smoke, providing cessation support, warning about risks, enforcing advertising bans, and raising taxes (WHO, 2021).

The WHO 2021 report highlights progress in tobacco control, with more than 5.3 billion people (69% of the global population) covered by at least one MPOWER measure at the highest level (WHO, 2021). Since the late 20th century, smoking prevalence has declined in most high-income countries, largely due to public awareness, strong tobacco control policies, and WHO leadership.

Europe enforces tobacco regulations through the Tobacco Taxation Directive (TTD) and the Tobacco Products Directive (TPD), ensuring high standards of health protection. However, disparities in policy implementation remain between EU countries. The Tobacco Control Scale (TCS), which quantifies policy implementation across Europe, shows scores ranging from 25/100 (Bosnia and Herzegovina) to 82/100 (Ireland and the United Kingdom) (Joossens *et al.*, 2022).

Spread of novel products

E-cigarettes are electronic devices that contain a liquid, a chemical mixture consisting of propylene glycol and flavorings, that is heated to produce an inhalable vapor, usually containing nicotine. Due to the shape, method of inhalation, taste, and possible nicotine content, e-cigarette users (known as “vapers”) experience a similar sensation to inhaling tobacco smoke from a conventional cigarette when using the product. E-cigarettes have been available in Europe since 2010. The latest Eurobarometer survey, conducted in 2023, shows that in the EU, more than 1 in 10 people have at least tried e-cigarettes, 8% have tried them once or twice, 3% have used them in the past, and 3% are current users (Eurobarometer, 2023). The prevalence of current e-cigarette users ranges from 0% in Portugal to 9% in Estonia.

Heated tobacco products (HTPs) are hybrids between e-cigarettes and combusted cigarettes: as e-cigarettes, they are equipped with an electronic device that heats a product to produce a nicotine-containing aerosol; as combusted cigarettes, the heated product is “real” tobacco. The first HTP was launched by Philip Morris International (PMI) and has been available in most high-income countries since 2016. In the EU in 2023, 4% had tried HTPs only once or twice, 1% had used them in the past, and 2% were current users (Eurobarometer, 2023). The vast majority of both e-cigarette and HTP users are dual users (i.e., they also smoke conventional cigarettes) (Scala *et al.*, 2025).

The most recent Cochrane review of e-cigarettes shows a higher success rate for quitting smoking compared to nicotine replacement therapy, but it is still extremely low (at least 90% of attempts fail) (Lindson *et al.*, 2020). There are no trials comparing e-cigarettes with the most effective smoking cessation medication. In addition, over 80% of people who quit using e-cigarettes continue to use nicotine-containing e-cigarettes after treatment. Outside the clinical setting, as a consumer product, e-cigarettes are not effective in increasing smoking cessation (Kalkhoran and Glantz, 2016). A recent prospective Italian study confirmed that e-cigarettes and HTPs do not help smokers quit; on the contrary, they promote smoking initiation among nonsmokers—especially among adolescents and young people—and relapse among former smokers (Gallus *et al.*, 2024).

Safety of novel products

Tobacco companies and affiliated researchers continue to claim that e-cigarettes reduce harm by 95% compared to traditional cigarettes. However, a recent review of the short-term effects of e-cigarettes

contradicts these claims. The current evidence shows no significant difference in cardiovascular risk, heart attacks, or metabolic dysfunction between e-cigarettes and conventional cigarettes. The relative risk reduction is minimal, that is, 16% for asthma, 47% for COPD, and 13% for oral diseases. Most importantly, dual use (both e-cigarettes and traditional cigarettes), the most common usage pattern in Italy and Europe, increases the risk of respiratory and cardiovascular diseases by 20–40% compared to exclusive cigarette use. This suggests that e-cigarettes, as currently used in Italy and Europe, may be more harmful than being beneficial to health (Glantz *et al.*, 2024).

Some recent studies have provided the first data on the potential role of e-cigarette use in cancer. One study found that exclusive e-cigarette users who had never smoked conventional cigarettes had the same epigenetic changes associated with cancer as conventional cigarette smokers. This suggests that e-cigarettes promote cancer development similar to conventional smoking (Herzog *et al.*, 2024). In addition, a case-control study conducted in the US involving nearly 5000 lung cancer cases and over 27,000 controls found that dual users had a fourfold higher risk of lung cancer compared to exclusive conventional cigarette smokers (Bittoni *et al.*, 2024).

Smoked Food

What are smoked foods?

Smoking is a technique that enriches food with particular aromas and flavors and, at the same time, in some cases, improves their shelf life.

Smoking has an antiseptic effect that depends on several factors such as the action of heat, lack of oxygen, dehydration, and the presence of antibacterial substances in smoke (e.g., formaldehyde, aldehydes, alcohols, and phenols).

The smoking of food has its roots in the history of mankind. The discovery of fire found that the cooking process would improve the digestibility of meat as well as that it could be preserved for a longer time.

The introduction of an interesting paper on smoked foods published by Cattaneo (AMALTEA) has provided below:

“.....Smoking is the oldest preservation technique implemented by man. Dating from discovery of fire, more than 90,000 years ago. It was probably accidentally discovered that the pieces of meat hung above

the fire in caves, in order to avoid the attack of the flies and insects, kept longer and tasted better.

Even in the peasant tradition it was customary to hang meat and sausages in the fireplace obtaining a mixture of smoked, dried and cooked product.

In 1800 smokehouses consisted of a single brick chamber where sawdust or wood and in which the products were hung. Currently, smoke generators are distinct from the smoking chamber. The original purpose of smoking was to increase the preservation for surface drying (with an increase in the concentration of the ingredients of the tanning) and by deposition of antimicrobial compounds. In many cases, the temperature during the smoking process was high enough to reduce the surface load of microorganisms significantly.

The situation today is different because the process has low effect on the microbiological stability of products and is mainly applied for the effect on sensory properties and smoking is combined with other techniques conservative. The temperature of the smoke itself may be sufficient to reduce significantly the number of microorganisms...”

The types of foods typically treated with this technique are meat, fish, vegetables, cured meats, and dairy products. The unit operations necessary for their preparation are (UNILEVER1) as follows:

- Food cleaning
- Marinating and cooking
- Salting
- Possible cooking
- Smoking

The process starts with food cleaning and toileting, followed by **marinating** by placing the food in a bath of water, vinegar, and wine to initiate tender cooking of the food. During this phase, spices, citrus juice or soy sauce, yogurt, beer, and cider are added to improve the taste.

The **salting** process involves either the immersion in brine or dry salting. Particularly in meat, dry salting involves pouring a mixture of salts, spices, and herbs (the so-called Rub) covering the entire surface; this mixture is “massaged” on the meat to allow the flavor to penetrate inside, and salt helps absorb moisture, thus preparing the food for smoking.

Cooking over direct heat automatically brings the food in contact with the smoke produced by the combustion of wood, and with it, the transfer of specific odors, flavors, and particulate compounds to the food.

Sources of wood

Different types of woods can be used for the smoking process, such as oak, beech, alder, cherry, and apple trees. Different woods provide different flavors to food when used for smoking. Untreated and resin-free wood must be used to avoid the formation of harmful substances during combustion. Traditionally, smoking is the slow combustion of wood chips or flours of different types of wood to which juniper berries, pine, or fir cones can be added for flavoring.

The smoke is produced by the slow and incomplete combustion of wood. In the absence of flame and an oxygen-poor atmosphere, it diffuses the flavor and impregnates the food, giving it an unmistakable taste and added value through cooking.

Composition of smoke

Smoke is composed of gaseous and solid phases. The gaseous phase, containing many **volatile substances**, is responsible for the preservation and aroma of the food. The solid phase contains unwanted substances such as PAHs and recognized carcinogens.

The preservative action of smoking is, as already stated, a result of the temperature, dehydration, an oxygen-deficient environment, and the specific antibacterial action of some of the substances present, particularly formic aldehyde.

Many factors influence the speed at which smoke penetrates food. However, the slower and lower the treatment, the better the final smoking result. A good smoking process, therefore, can last up to a few days.

European and Italian laws allow the use of smoke flavorings that “simulate” the smoking process. Smoke flavoring minimizes the amount of carcinogenic aromatic hydrocarbons in food but is not as qualitative as compared to the natural smoking process (CIBO360).

Smoke production

There are three ways to (See Table 1) produce smoke for food (SCUBLA)(UNILEVER2):

1. **The Hot smoking** procedure takes place at temperatures between 50 and 90°C in tunnel machinery. To obtain real cooking of the food, the temperature inside the food is monitored. Hot smoking time is generally shorter and is dependent on the size of the food. With this method, a 5–30% weight loss is

expected. The foods to which hot smoking is usually applied are frankfurters, Prague ham, herring, and stewed bacon.

2. **Medium smoking takes place at temperatures between about 40 and 70°C.** For smoking at medium temperatures, it is recommended to preheat the oven to about 60°C, while for hot smoking, the oven is preheated to about 95°C. The embers are covered with sawdust or chips to obtain heat and smoke. If the temperature rises too high, the exhaust fume control is kept almost completely closed, and water is sprayed over the burning sawdust to lower the temperature.
3. **Cold smoking:** It involves temperatures between 20 and 25°C and a humidity of 70%. This technique is carried out in installations known as sterners (ALTON), usually for semi-fatty foods such as salmon.

Cold smoking is used to perfume meat: in this case, raw or cooked food that has undergone prior cooking is used. The temperature for cold smoking must be between 16 and 40°C, depending on the size of the food and the required results. If the temperature rises too high, the oven door is opened, and the smoke discharge is reduced. It is the presence of smoke that characterizes the smoky scent of cold-smoked food, which is what gives these foods their smoky aroma. The duration of this process is much longer than the medium or hot smoking process, from a few days to several weeks.

This process lengthens the shelf life of food by preventing mold formation and results in a weight loss of 25% (15% due to salting and 10% due to smoking). The cold smoking technique is usually applied to foods such as speck, bacon, salmon, salami, raw bacon, and smoked scamorza.

Smoke industrial technologies

As already mentioned, the smoking process is preceded by a salting phase, the aim of which is to dehydrate the food, inactivate its internal microorganisms, and make it tastier.

The actual smoking process takes place in installations known as **smokehouses** (see Figure 1), where wood is slowly combusted in the absence of flames and in an oxygen-poor atmosphere previously purified by filters of different diameters that help retain larger particles (soot) (ALTON). Generally, systems with an external smoke generator are preferable as they guarantee greater hygiene and healthiness of the final product.

As far as meat and fish are concerned, generally, salting is carried out before smoking, followed by smoking and seasoning of the product. Cheeses (pecorino, caciotta, scamorza, etc.), on the other hand, are usually subjected to superficial smoking to give them a particular taste; in this case, the purpose of the process is flavoring and not preservation. Smoked foods have high nutrient content because, as they are drier, they are more concentrated than fresh foods.

Smoke Flavorings

In recent years, the addition of smoke flavoring has taken over at the industrial level by the addition of liquids containing aromas and particulate substances, collected by various methods from burning wood, to the products to be smoked. These are classified as “liquid smoke.”

Liquid smoke or smoke extract is a smoke concentrate used to impart the smoke aroma to food products without really smoking.

Table 1. Summary of the main operating parameters for the three cited types of smoking (SCUBLA)..

	Hot	Average	Cold	Time	Temperature [°C]
Fish	*			45–60 minutes	90–100
Salmon			*	About 8–10 hours	22–25
Stuffed hams		*		90–120 minutes	5 – 60
Sausage		*		90–120 minutes	50–60
Frankfurters		*		90–120 minutes	50–60
Pork		*		90–120 minutes	50–60
Poultry	*			3–6 hours	100
Hams, Speck			*	4–6 days	20–30
Hungarian salami			*	1–2 days	20–30
Liver			*	1–2 days	20–30
Cheese			*	Variable	20–25

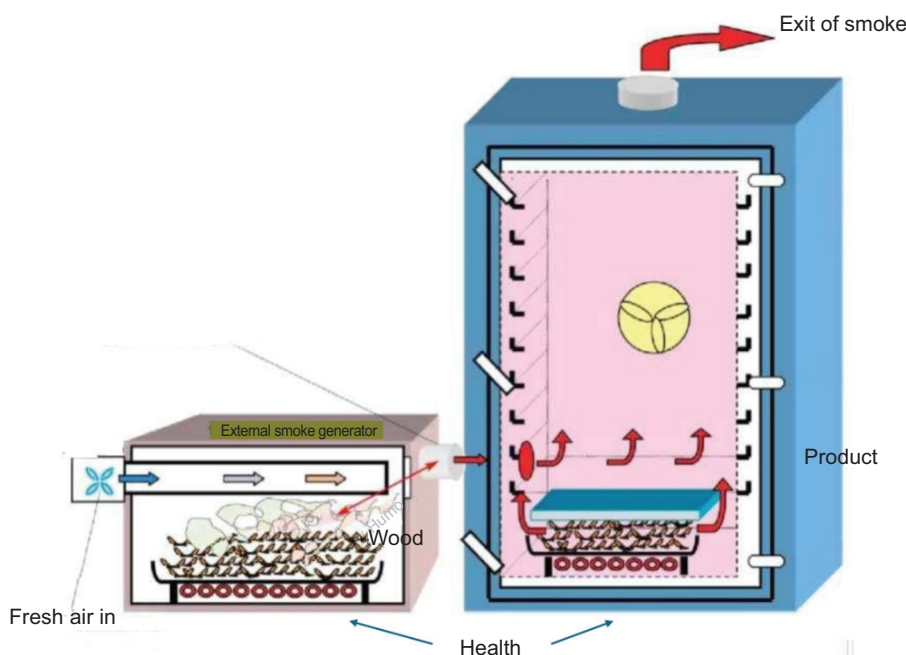


Figure 1. An example of a smokehouse.

Liquid smoke (ref. LIQUID) was marketed for the first time by the American Ernest H. Wright in 1895 in bottles under the name “condensed smoke.” In this process, as the wood burns, the smoke enters the pipes of a stove, and cold air is introduced, which condenses the smoke.

The discovery of liquid smoke occurred during a “competition” with his friends; after smoking ham, the experiment aimed to create the taste of ham without smoking it, and if successful, the product would be sold. This product is popular in the United States and Canada. In Europe, the process emerged in the 1980s and is mainly used in the northern European countries.

In Europe, liquid smoke is obtained by burning beech wood, while in America (Canada and the United States), hickory wood, a North American walnut variety, is used. The wood is cleaned and dried to a moisture content of 1% and placed in a combustion chamber at a temperature between 300 and 400°C, where the wood pyrolysis process takes place. The smoke produced is conveyed to a condensation tower where it meets a flow of cold water and condenses in a settling chamber. The resulting mixture is sometimes filtered with charcoal. Another production method is to bubble the smoke produced in cold water and concentrate the aromas in the mixture, and then extract the liquid smoke and filter. The smoke is condensed and purified to reduce the levels of potentially toxic substances such as PAHs (e.g., benzopyrenes), which are carcinogenic. Pure liquid smoke is a corrosive

substance, but is used in such small quantities that it does not pose health risks, as it is vaporized or dissolved by special machines during production, and benzopyrenes remain in a dose much lower than their lethal levels (CEIRSA).

Liquid smoke can be applied in four ways, as follows:

1. Immersion
2. Showering
3. Nebulization (used for small cured meats such as sausages and small cheeses)
4. Incorporation or injection into the dough

In the United States, liquid smoke is used in 76% of the smoked foods, while in Europe, it is used in 20–30% of smoked foods.

EU Regulatory Laws

EFSA assesses the safety of smoke flavorings (liquid smoke) in the EU.

Curiously but sadly, the EFSA experts carry out this work solely based on the information given by applications for authorization submitted by commercial operators.

Their risk assessments help decision-makers to decide whether or not (i) to include a new smoke flavoring in the

EU list, (ii) to renew currently authorized ones, or (iii) to update the way they are used in different types of food.

EFSA experts provide guidance to applicants solely on the information required by them to carry out safety assessments, including administrative, technical data, and toxicological tests.

In particular, liquid smoke flavorings are regulated separately from other flavorings as they consist of complex mixtures that give rise to different safety concerns (see Table 2).

The following regulations apply to liquid smoke flavoring:

1. Regulation (EC) No 1321/2013: Establishes the list of smoke flavoring primary products authorized in the EU as such in or on foods and/or for the production of smoke flavoring derivatives.
2. Regulation (EC) No 2065/2003: Establishes a procedure for the evaluation and authorization of smoke flavorings for use in the EU.
3. Regulation (EC) No 627/2006: This regulation on quality criteria for validated analytical methods for sampling, identification, and characterization of primary smoking products provides the necessary technical information on analytical methods for the collection of data on smoke flavorings.

Health Risks

Among the various substances present in smoke, there are harmful ones, such as polycyclic aromatics (oncogenic substances), including benzo(a)pyrene and benzo(a)anthracene. Through particular production techniques (type of wood used, physical filters, distillation, temperature, and humidity), an attempt is made to limit the quantity of these compounds, as much as possible, which are strictly regulated by the legislator.

As the temperature drops, the humidity of the environment must be reduced and the exposure time must be increased (cold smoke is used, for example, and a longer smoking time (e.g., for salmon and other raw foods).

The alternative technique or the so-called liquid smoke, obtained by condensation and purification of the smoke derived from the combustion of wood, reduces the content of potentially toxic substances such as PAHs (e.g., benzopyrene), which are carcinogenic.

The purified mixture is then applied to the product through nebulization, showering, immersion, or injection into the mixture.

In any case, the liquid smoking technique has a very less preservative effect, and this characteristic is therefore obtained through the use of specific additives (such as nitrites, nitrates, ascorbic acid, and ascorbates) or other preservation techniques.

The information provided above indicates that artisanal products are not always preferable to industrial ones because a food product smoked at home is much more likely to be seriously contaminated by PAHs than one that has undergone industrial smoking processes.

Conclusions

Smoking tobacco

Despite the reduction in smoking prevalence from the implementation of effective tobacco control policies following growing awareness of the harmful effects of smoking, tobacco smoking remains a leading risk factor for mortality and disability in Western Europe. The last decade has seen the proliferation of novel products, including e-cigarettes and HTPs, which are promoted by the tobacco industry as much safer alternatives to tobacco. However, the safety of these products, if any, appears to be limited. Moreover, in real life, e-cigarettes and HTPs are not effective in helping smokers quit and act as a strong gateway to smoking conventional cigarettes, especially for young people. Based on the current evidence, tobacco harm reduction (i.e., the promotion of novel products as alternatives to conventional cigarettes) is not a viable public health strategy and is primarily a marketing tactic of the tobacco industry. Public health should instead focus on the cessation of smoking and nicotine use.

Smoked foods

We underline our concerns on the real safety of the utilization of smoked foods because the time of direct exposure of food to smoke and high heat allow the formation of PAHs. Similarly, the utilization of the so-called “liquid smoke” on foods, and concerns on the adopted procedure of control by EFSA, cannot equally cancel any toxicity risks due to the presence of PAHs.

In conclusion, we emphasize that smoke is harmful, not only when inhaled but also at the table. Moderating the intake of smoked foods and adopting safer food preparation methods are conscious choices to protect our health.

Table 2. The possible risks of flavorings on human health identified by EFSA.

References	proFagus Smoke R714 (SF-001)	Smoke Concentrate 809045 (SF-003)	Scansmoke SEF7525 (SF-004)	SmokeZ C-10 (SF-005)	SmokeZ Enviro-23 (SF-006)	proFagus Smoke R709 (SF-008)	Fumokomp (SF-009)
	https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2023.8363	https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2023.8365	https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2023.8363	https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2023.8367	https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2023.8368	https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2023.8369	https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2023.8370
Source Material	The source materials used for manufacturing the Primary Product proFagus Smoke R714 (SF-001) are beech (<i>Fagus sylvatica</i> > 90%) and oak (<i>Quercus robur</i> < 10%); other wood species might be present at levels < 1%. The wood used is obtained in equal parts from industrial dried cuts (approximately 33.3%), industrial fresh cuts (approximately 33.3%), and untreated remaining material (slabs) from the wood industry (approximately 33.3%). Upon its arrival at the manufacturing site, the wood is inspected for the absence of impurities.	The source material of Smoke Concentrate 809045 (SF-003) is only beech wood (<i>Fagus sylvatica</i> L.). According to the applicant, the wood is obtained from untreated natural hardwood and is free from pesticides (Documentation provided to EFSA No. 1).	The source material of Scansmoke SEF7525 (SF-004) is a tar obtained by the applicant from an external supplier as by-product from the production of liquid smoke. According to a statement of the supplier, the tar is produced from a mixture of 30–40% red oak (<i>Quercus rubra</i>), 30–40% white oak (<i>Quercus alba</i>), 5–15% maple (<i>Acer saccharum</i>), 5–15% beech (<i>Fagus grandifolia</i>), and 5–15% hickory (<i>Carya ovata</i>) (Documentation provided to EFSA No. 1 and 2). The hardwoods are blended as sawdust, which is then dried and heated to generate smoke.	The source material of SmokeZ C-10 is hardwood sawdust from hard maple (<i>Acer saccharum</i>) (25–60%), white oak (<i>Quercus alba</i>) (10–40%), hickory (<i>Carya ovata</i>) (10–25%), and low quantities of other wood species: white/black ash (<i>Fraxinus americana</i>) (0–15%), birch (<i>Betula papyrifera</i> and <i>Betula alleghaniensis</i>) (0–15%), beech (<i>Fagus grandifolia</i>) (0–15%), and cherry (<i>Prunus serotina</i>) (0–15%) (Documentation provided to EFSA No. 1). According to the applicant, the wood is not subjected to any chemical treatment, including treatment with pesticides.	The source material of SmokeZ Enviro-23 is hardwood sawdust from white oak (<i>Quercus alba</i>) (20–75%), hard maple (<i>Acer saccharum</i>) (25–65%), and low quantities of other wood species including hickory (<i>Carya ovata</i>) (0–15%), white/black ash (<i>Fraxinus americana</i>) (0–15%), birch (<i>Betula papyrifera</i> and <i>Betula alleghaniensis</i>) (0–15%), beech (<i>Fagus grandifolia</i>) (0–15%), and cherry (<i>Prunus serotina</i>) (0–15%). According to the applicant, the wood is not subjected to any chemical treatment, including treatment with pesticides.	The source materials of proFagus Smoke R709 (SF-008) are beech (<i>Fagus sylvatica</i> > 90%) and oak (<i>Quercus robur</i> < 10%); other wood species might be present at levels < 1%. The wood used for manufacturing the primary product is obtained in equal parts from industrial dried cuts (approximately 33.3%), industrial fresh cuts (approximately 33.3%), and untreated remaining material (slabs) from the wood industry (approximately 33.3%).	The source material of Fumokomp Conc 8SF-009 is hardwood from beech (<i>Fagus sylvatica</i> L.) (85–100%) and hornbeam (<i>Carpinus betulus</i> L.) (0–15%). According to the applicant, the trees from which the wood is used for manufacturing the Primary Product "do not receive any chemical treatment in the period of 1 year before felling, or after"

(continues)

Table 2. Continued

	proFagus Smoke R714 (SF-001)	Smoke Concentrate 809045 (SF-003)	Scansmoke SEF7525 (SF-004)	SmokeZ C-10 (SF-005)	SmokeZ Enviro-23 (SF-006)	proFagus Smoke R709 (SF-008)	Fumokomp (SF-009)
Method of manufacture of the Primary Product	In the manufacturing process, the wood pieces are dried and then subjected to pyrolysis resulting in a water insoluble tar-phase and a smoke condensate. The smoke condensate is subjected to distillation and extraction, resulting in an aqueous smoke fraction. In a second phase, these intermediates are further processed to obtain the two building blocks of the Primary Product.	The production of the Primary Product comprises the following steps: 1) Smoke generation: The dried wood chips are smouldered in a smoke generator under defined conditions. 2) Condensation and absorption of smoke: The smoke is passed through a condenser and subsequently absorbed in a water/ethanol mixture, and the formed wood tar is then discarded. 3) Further processing: The liquid smoke is treated with activated charcoal to reduce the level of polycyclic aromatic hydrocarbons (PAHs). The charcoal is then removed by filtration, and the Primary Product is obtained after removing the residual solvents by distillation. The applicant submitted a description of the manufacturing process, with information on the drying step and the pyrolysis conditions.	The Primary Product is obtained by (i) extracting the tar raw material with diethyl ether, (ii) subjecting the extracts to purification steps and (iii) combining the obtained fractions (SEF1 and SEF2) at a defined ratio. In the first step, the extraction of an aqueous suspension of the tar is performed under alkaline conditions (pH-adjustment by addition of sodium hydroxide). The organic phase is subjected to evaporation to remove solvent and water and subsequently to vacuum distillation. After re-dilution with diethyl ether, the obtained distillate is treated with activated carbon to remove polycyclic aromatic hydrocarbons (PAHs), and SEF1 is obtained after evaporation of the solvent and a final filtration (1 mm).	The Primary Product is obtained after separation from the sedimented tar and subjecting the aqueous phase to a filtration step (1 µm). The applicant submitted a description of the manufacturing process, including information on the drying step of the sawdust and the pyrolysis conditions.	Dried wood sawdust is pyrolysed in a reactor; the formed smoke vapour is condensed, and the condensate is transferred into a storage tank. Then, water is added, resulting in an aqueous mixture with less than 40% of organics, and the formation of three distinct phases. The lower, tarry phase and the upper oily phase are discarded, and the remaining aqueous phase is filtered (1 µm). At another production site, this aqueous phase is further processed by another addition of water until the content of organics is less than 25%. The resulting water-insoluble tarry phase is discarded.	As described by the applicant (Documentation provided to EFSA No. 1), the manufacturing process comprises pyrolysis of the dried wood pieces and condensation of the generated wood gas. The obtained smoke condensate is further concentrated by evaporation; after adjustment of the total acid content, the remaining "pyroligneous acid" forms the smoke flavoring.	The dried wood is pyrolysed in a continuously operated Lambotte retort with automated gas-purging. The wood tar obtained by sedimentation is subsequently subjected to a series of fractional vacuum distillations. The Primary Product is obtained by combining appropriate distillates on the basis of the intended sensory properties of the final product.

Description of the physical state and sensory characteristics	The applicant described the smoke flavoring Primary Product as a "viscous liquid of brown color with a characteristic odor of freshly generated smoke." The Primary Product has a staining index (at 440 nm) ranging from 105 to 125. The applicant indicated that the Primary Product has a refraction index (at 20°C) ranging from 1.388 to 1.396, a viscosity (at 25°C) ranging from 9 to 10 cP, a pH ranging from 2.2 to 2.4, and an average density of approximately 1.110 g/L. The applicant described the Primary Product as "Immiscible with water. Fully miscible with polar solvents such as ethanol, acetone, or isopropanol. Immiscible with nonpolar solvents such as toluene or benzene."	The Primary Product is a brown viscous liquid with a characteristic odour of freshly generated smoke and has an average density (at 4°C) of 1.275 g/L (n = 12). The pH ranges from 2.8 to 3.0, the refraction index ranges from 1.51 to 1.52, the coefficient of extinction (at 400 nm) ranges from 1.9 to 2.4, and the flash point is > 100°C.	The applicant described the smoke flavoring Primary Product as "an aqueous amber brown liquid with characteristics of smoke aroma and flavor" (Documentation provided to EFSA No. 1). The Primary Product has a pH ranging from 2.15 to 2.6, a viscosity (at 25°C) ranging from 2 to 3 cP, a refraction index ranging from 23 to 27 °BRIX, and a density (at 20°C) of approximately 1050 g/L. The applicant described the Primary Product as "soluble in alcohol-based solvents and immiscible in oil-based solvents."	The applicant described the Primary Product as "Miscible in alcohol-based solvents and immiscible in oil-based solvents."	The applicant described the smoke flavoring Primary Product as a "viscous liquid of brown color with a characteristic odor of smoke." The Primary Product has an average density of approximately 1020 g/L, a refraction index (at 20°C) ranging from 1.340 to 1.355, a pH ranging from 2.0 to 2.5, a staining index (at 440 nm) ranging from 11 to 17, and a viscosity (at 20°C) of 6 cP (n = 5).	The Primary Product is a viscous, oily, pale/yellowish-brownish liquid, not miscible in water, and is described to have an odor of leafy woods. The Primary Product has an average density of 1.100 g/L, a pH value ranging from 2 to 6, a refraction index (at 20°C) ranging from 1.485 to 1.550, and a viscosity (at 40°C) ranging from 7.06 to 12.6 centistokes (cSt).
Principal volatile constituents of the Primary Product	see composition in the referred document	see composition in the referred document	see composition in the referred document	see composition in the referred document	see composition in the referred document	see composition in the referred document
References	https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efs.2023.8363	https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efs.2023.8365	https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efs.2023.8366	https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efs.2023.8367	https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efs.2023.8369	https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efs.2023.8370

Note: For specific and complete information, the readers are invited to use the references listed in this table.

Conflicts of Interest

None.

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