

## Sugar as Tobacco Additive Tastes ‘Bitter’

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### Introduction

Tobacco additives might have an effect on toxicity, addictiveness and attractiveness of the tobacco product. Therefore, from 20th May 2016 the new Tobacco Product Directive 2014/40/EC (TPD) enables strengthened reporting obligations on all ingredients and emissions from tobacco products [1]. These reporting obligations could be of special importance for the additive sugar, as this carbohydrate is the main tobacco additive and contributes to all effects as described above.

Sugar makes up to 2 weight percent of the tobacco in a cigarette, leaving natural present sugar and other sweetening additives aside [2]. Tobacco manufacturers add sugars to tobacco to improve the flavour of tobacco, and to help the tobacco bind together and stay moist. The presence of natural sugar and the addition of other sugars to tobacco are widely discussed as there are some main concerns regarding their:

**Toxic effects-** Most of the sugars are completely burnt (pyrolysed) during smoking and several aldehydes are formed like acetaldehyde and formaldehyde [3]. The addition of sugars to tobacco increases the levels of aldehydes present in mainstream tobacco smoke [3]. These aldehydes are identified as (possibly) carcinogenic in humans [4] and generally more toxic via inhalation compared to ingestion as the respiratory system largely lacks the detoxifying metabolic pathways of the digestive system [3,5].

**Addictive potential-** Tobacco smoke contains high levels of acetaldehyde upon pyrolysis of sugar, which contributes among others, to the addictive potential of cigarettes [6]. Acetaldehydes react with amino acids resulting in the compound harman. Harman is an inhibitor of the enzyme monoamine oxidase (MAO) which degrades neurotransmitters involved in drug addiction, like dopamine and noradrenaline [5,7,8]. Also, harman can bind to several neurotransmitter receptors [9,10] or can act synergistically with nicotine [11]. Accordingly, acetaldehyde may exert additive effects on nicotine bioavailability, duration, and concentration in the blood or nicotine dependent activation of mesolimbic pathways in the brain [8].

**Attractiveness-** Consumer acceptance of tobacco smoke is, amongst others, proportional to the sugar level in tobacco [5]. Selecting tobaccos that are naturally high in sugar or adding sugars to cigarettes, masks the bitter taste of the tobacco smoke and makes the smoke tolerable to the smoker. In addition, the burnt sugars give a sweet caramel flavour to the product, which produces a more palatable and attractive product that encourages greater use. With regard to the increase of sugar concentrations in tobacco and the flavouring potency, sugar can be considered as hidden flavouring.

Besides the strong indication that sugar contributes to the above described effects, there is still a large knowledge-gap on the health effects of sugar in tobacco, which was also stressed by the editor of *Nicotine and Tobacco Research* recently [12]. The outcomes of dose-

response studies on sugars, irrespective of whether they are already present or being added, can support regulation of the maximum sugar content levels of the final tobacco products. Natural sugars are largely metabolized during the curing of the tobacco leaves. This loss of sugars may be compensated during the manufacturing process, according to the TPD. This results in sugar levels up to 12% of the total weight of the tobacco product [2]. However, as the initial content, and loss of sugar in the tobacco leaf is not defined this results in undefined amounts of sugar that can be added and remains a point of discussion. The problem is complicated by the many sweet additives (or sugar isoforms), that contribute to the over-all sugar concentrations in tobacco products. Defining and regulating maximum sugar levels in tobacco better fit the need to protect the consumer, as the actual source, already present in tobacco or added to it during manufacturing, in any form, is not crucial for its health effects. Since 2009 the use of sugar and sweeteners as additive is prohibited in Canada, which demonstrates that it is also possible to manufacture cigarettes without sugars [13].

As added sugars are one of the main ingredients in cigarettes and contribute to smoking pleasure and the formation of toxic, carcinogenic and addictive compounds upon combustion, it is clear that more research is needed. Regulators can support research and reporting on toxicity, CMR properties (carcinogenic, mutagenic or reprotoxic), addictiveness, flavour and dosimetry of sugar. To this end, guidelines and recommendations were developed for assessing the impact of tobacco additives on these three aspects of toxicity [14], addictiveness [8] and attractiveness [15]. Another important instrument to meet this need is to include sugar on the priority list in the next intended revision round. The priority list [16] has been established in line with the TPD Article 13, which includes additives for which enhanced reporting is required in cigarettes and roll-your-own tobacco on their toxicity, addictiveness and CMR properties in unburned and burned form. The priority list contains 15 additives which were selected based on the following criteria; (1) significantly contributing or increasing the toxicity or addictiveness of the products concerned (2) resulting in a characterising flavour; (3) facilitating inhalation or nicotine uptake; or (4) leading to the formation of substances that have CMR properties; or (4) which are amongst the most commonly used additives by weight or number according to the reporting of ingredients (Article 6.1 and 6.2 of the TPD [1]). Sugar adheres to all of these criteria, as also pointed out in the opinion of the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) [17]. Extensive research can help regulators to set maximum sugar content levels of the final tobacco products, supported by data on sugar levels in tobacco, and aldehyde levels in smoke retrieved by measurements of commercially available brands.

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