Influence of the shower treatment on the PAH levels in Frankfurters after smoking

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I. INTRODUCTION

Smoking is a traditional method of food preservation that also enhances the sensory properties of smoked meat products (*e.g.* Frankfurters) [1]. In order to produce the expected smoldering smoke, the pyrolysis temperature of woodchips is usually set in the range of 300 to 900 °C. However, it is well known that the polycyclic aromatic hydrocarbons (PAHs) are formed during the incomplete combustion of wood above 500 °C and then accumulate on the surface of smoked meat products. Considering that modern smoking systems involve not only smoking but also many other processes such as drying, cooking, and showering. To extend the shelf life, cooked sausages are cooled down immediately in the smoking chamber by showering them with cold water. The aim of this study was to verify the hypothesis that showering significantly affects the levels of PAHs in sausage casings.

II. MATERIALS AND METHODS

Production of Frankfurters: The beef, pork, pork back fat, sheep casings and additives were purchased from MEGA eG (Stuttgart, BW, Germany), spices from Frutarom Production GmbH (Freilassing, BY, Germany), and beech woodchips "Räuchergold KL 2-16" from J. Rettenmaier & Söhne GmbH+Co KG (Rosenberg, BW, Germany). The Frankfurters were produced as described [1]. The smoke was produced by a temperature-controlled smoldering smoke generator (REICH Thermoprozesstechnik GmbH, Schechingen, BW, Germany). The woodchips were ignited in the first 132 s, and then kept smoldering at two set temperatures (750 °C and 900 °C) by adjusting the volume flow. The specific parameters of the whole processing are shown in Table 1. The casings were removed form sausages for the determination of PAHs. A three-way-ANOVA was used as a statistical test.

Table 1 – The specific parameters of Frankfurters production.

Parameter	Production process				
	Reddening	Drying	Smoking	Cooking	Showering
Temperature/ time	55 °C/30 min	50 °C/12 min	750 °C/3,11,15 min 900 °C/3,11,15 min	75 °C / 20 min	Ca. 12°C 10 min
Humidity	80%	/	/	97%	/
Fresh air	/	100%	/	/	/
Exhaust	/	100%	75%	/	50%
Circulating air in smoke chamber	12.2 m^3/h	12.2 m^3/h	17.4 m^3/h, 900 °C 16.0 m^3/h, 750 °C	14.0 m^3/h	5.2 m^3/h
Transportation air and smoldering air	/	100%	100%	/	/

Determination of PAHs: PAHs calibration mix standard was purchased from Sigma-Aldrich Co. Ltd (Laramie, WY, USA). The Sep-Pak silica cartridges of Waters (Milford, MA, USA) were used. The extraction, clean-up and determination of PAHs in casings was carried out according to our established method [1].

III. RESULTS AND DISCUSSION

Although, the cold-water showering rapidly cools down the core temperature of cooked Frankfurters for a longer shelf life, the impact of this treatment on the contents of PAHs is still unclear so far. As illustrated in Figure 1, the residual levels of PAHs were significantly influenced by the smoke generation temperature and the smoking time ($p<0.001$). In contrast, the levels of both benzo[α]pyrene (B*α*P) and PAH4, as well as the content of each PAH, showed only slight differences ($p>0.05$) between the casing samples of before and after showering under the same smoking conditions. It should be noted that the weight ratio of the casing to the whole sausage was only approximately 5.78 wt%, and the levels of PAHs in the meat were much lower. Therefore, the levels of BαP and PAH4 in Frankfurters did not exceed the maximum levels specified in the EU Regulation (Commission Regulation (EU) 2023/915) for smoked meat products, which are 2.0 µg/kg for BαP and 12.0 µg/kg for PAH4.

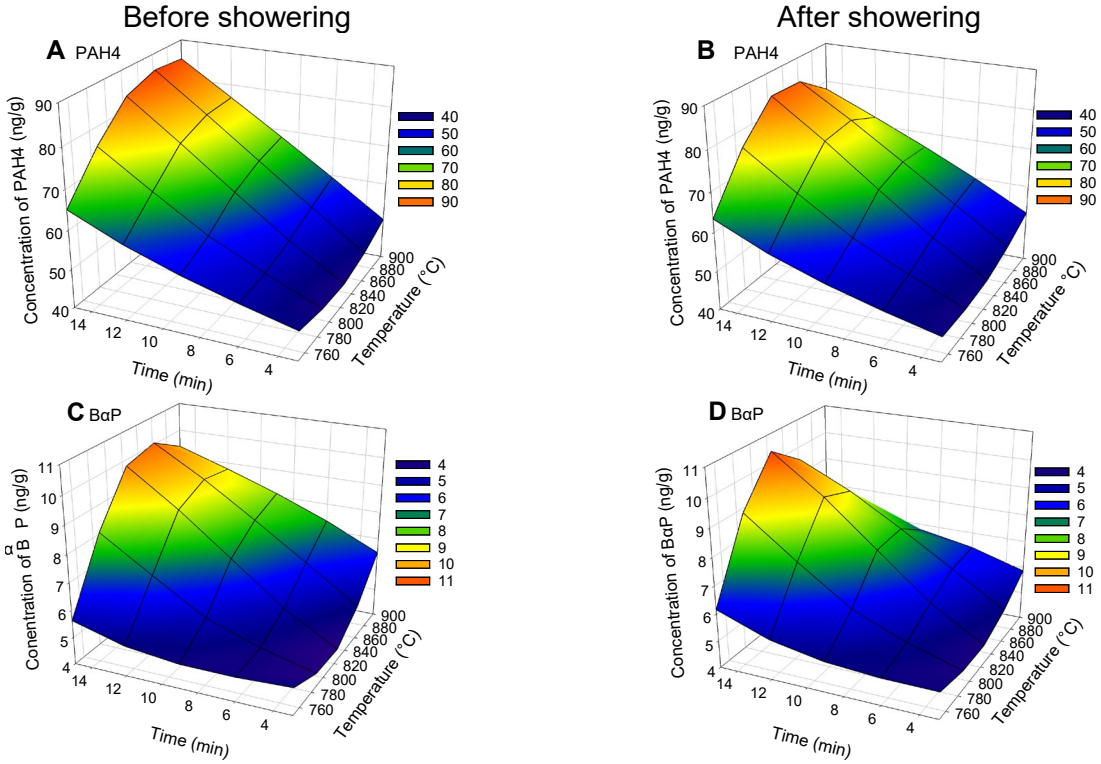

Fig 1. PAH4 and B*α*P levels before and after showering as a function of smoke time and generation temperature

IV. CONCLUSION

The results of this study showed that PAH levels were significantly affected by smoke generation temperature and smoking time. However, showering had only a slight effect on the accumulation of BαP and PAH4 in sausage casings. These findings suggest that PAHs may be incorporated or bound into the matrix of natural casings, which cannot be mitigated by cold-water showering.

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