PHENOL PENETRATION INTO MEAT PRODUCTS IN THE PROCESS OF SMOKING

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SUMMARY

The aim of the present elaboration has been the attempt to determine the influence of such factors as time of drying, dimensions of surface of the smoked products, concentration of the smoke components in the chamber and type of casings applied - on the quantity of phenols penetrating the meat product during the smoking process. Tests have been conducted on the microtechnological scale, using the sprayed liquid smoke of a trade name "Refined Smoke Flavour" (RSF).

It has been found that one of the most important factors is the dimensions of surface of the product but the quantities of the sprayed RSF in the smoking chamber are also important.

Extension of the drying time from 20 to 40 min. results in the lowered quantity of the penetrating RSF components - on an average by 42%. The type of the casing applied does not seem to have a substantial influence on the quantity of the penetrating RSF components.

Introduction

Preferences of the Polish consumer imply that most of the meat products are strongly smoked that is the external color is dark and the smoking aroma is clearly perceptible. Meat products constitute significant share of the total meat consumption in Poland. Therefore Polish consumers might be exposed to the negative influence of harmful or undesired compounds appearing in the smoke. As it was shown by Knowles et al. (1975), Jordan and Tooth (1985) and Hoffman (1990) phenols constituents of smoke might react with nitrite residuals creating nitroso- and nitrophenols.

Amount of phenol compounds penetrating into smoked product varies considerably from case to case. Strongly smoked products can contain even over 200 ppm of phenol, as it was found by Potthast (1977) in black smoked ham. Slightly smaller amount 122 ppm was determined by Bratzler et al. (1969) in Bologna sausage. Knowles et al. (1975) found 100 ppm in bacon.

Research on phenol presence in frankfurters, bacon and ham led by Borys (1993) indica-ted that phenols level ranged from 20 ppm to 76,2 ppm, in average 58,8 ppm in frankfurters, 36,4 ppm in bacon and 30,0 ppm in ham. He compared also the phenols contents in products smoked by traditional methods and with use of liquid smoke of trade name "Refined Smoke Flavour" (RSF), ascertaining that the phenols' content in RSF smoked products was lower by 30,6% in case of frankfurters, by 36,5% in case of bacon and higher by 34,7% in case of ham.

Chemical constitution of smoke depends on type of wood, decomposition conditions, applied smoke generators etc. In order to eliminate this group of factors, liquid smoke "Refined Smoke Flavour" (RSF, Polish patent no. 136687) has been used in research.

The study was aimed at evaluation of influence of the following factors:
- duration of drying of the meat products before smoking,
- development of product surface ratio,
- amount of liquid smoke atomized in the chamber,
- type of casings

on amount of phenols penetrating into the product.

Materials and method

Research was performed on the sausage manufactured according to used in Poland (industry standard) recipes and technology.

Experiments were performed on macro-technological scale using Seydelman smoking chamber of 2,7 m^3 capacity. Liquid smoke RSF was atomized using pneumatic atomizer for liquids TAM (Borys, Wierzbicki, 1987). Product's drying time, influence on phenol penetration into meat was evaluated for frankfurters. In all examined variants, stuffed frankfurters were left for one hour, then placed in the chamber pre-heated to 60°C. Product was dried in constant temperature 60°C with the full access of the fresh air during: 20 min. (variant I), 30 min. (variant II), 40 min. (variant III), 50 min. (variant IV).

After drying, influx of the fresh air was cut off and fan was switched off. Then RSF was atomized with rate 25 g/min, up to dose of 20 g per 1 m^3 of chamber capacity. Fan was put on again and temperature was raised to 70°C and kept on the constant level for next 15 minutes. Scalding was performed in 80°C until temperature of 72°C was reached in the product centre.

Influence of product surface area on the phenol penetration into product was tested on selected meat products in casings of different diameters, namely: frankfurters - casing \ 22 mm, hunter sausage - \ 40 mm, Cracow sausage - \ 60 mm, butt - \ 100 mm. In all cases duration of the drying process was 40 min. Remaining parameters of RSF application and scalding were exactly the same as in case of drying time influence tests.

Effect of RSF amount on phenol penetration was evaluated for two RSF levels: 20 and 50 g per 1 m^3 of the chamber capacity. Procedures and products tested were the same as in previously described experiments.

Influence of the type of casing was evaluated indirectly by means of assessment of the phenol penetration rate per surface area unit determined in above mentioned experiments.

All products were tested on phenols' content. Samples were collected from chilled products, 24 hours after completion of smoking process. From each variant two samples 1 kg each were collected, minced 3 times, then phenols were isolated by means of steam distillation under analytical procedure given by Borys (1992). Phenols content was calculated on the basis of determined amounts of following compounds: guaiacol (GU), phenol (PH), 4-methyl guaiacol (4-MG), m- and p- cresol (CR), 4- ethyloguaiacol (4-EG), syringol (SY), eugenol (EU), 4-methyl-syringol (4-MS), 4-ethyl-syringol (4-ES) and cyclotene (CY). As it was shown by Borys (1992) yield ratio for this method is in average about 63,3%. Actual value of recovery depending on particular compounds as follow: for phenol - 93,4%, 4-methyl guaiacol - 72,0%, m- and p- cresol - 79,6%, 4-ethyloguaiacol - 61,2%, syringol - 58,6%, 4-methyl-syringol - 28,4%, 4-ethyl-syringol - 18,8% and for cyclotene - 73,2%.

Results and discussion

Determined phenols content in frankfurters dried during 20, 30, 40 or 50 minutes is presented in fig. 1. Experiments show that phenols penetration ratio decreased with the extension of the drying period, the most significant reduction was observed with drying period extension from 20 to 40 minutes. Further extension of the drying time caused only small decrease of phenol, cresols and guaiacol content whereas the content of cyclotene and syringol and its derivatives slightly increased. Total content of phenols dropped from 85,8 mg/kg for 20 min. drying time to 49,5 (40 min. drying time) and 51,5 mg/kg (50 min. of drying).

Determined phenols contents in the meat products with a different casings diameter and consequently different surface area per unit of weight, for two levels of RSF and traditional smoking method are presented in table 1.

Analysis of results shows clear tendency of phenol content decline with the increase of the casing diameter, in other words with decreasing surface area per unit of weight. For RSF dose of 20 g per 1m^3 of chamber capacity phenols amounted to: 49,5 mg/kg for frankfurters (0,21 m^2/kg) and 13,9 mg/kg for butt (0,05 m^2/kg). Similarly for RSF dose of 50 g per 1 m^3 of chamber capacity, phenols content dropped from 80,1 mg/kg in case of frankfurters to 16,8 mg/kg for butt. Results are presented in table 2.

Since only few experiments were performed it is only possible to point out certain trends rather than formulate precise conclusions. It seems that the range of amount of phenols penetrating into product is relatively narrow. For RSF maximal and minimal values differ from the average by 41 and 42% respectively. This confirms previously formulated observation that penetration rate depends of development of the product surface.

Analysing the penetration rate versus RSF dose, it was ascertained, that increase of RSF dose from 20 to 50 g per 1 m3 of chamber capacity (250% growth) results in relatively smaller increase of phenols contents in the product, namely:

- for frankfurters from 49,5 to 80,1 mg/kg, increase rate - 61%,
- for hunter sausage from 32,6 to 43,0 mg/kg, increase rate - 32%,
- for Cracow sausage from 14,4 to 19,4 mg/kg, increase rate - 35%,
- for butt from 13,9 to 16,8 mg/kg, increase rate - 21%.

Also in this case, trend indicating that penetration rate depends of development of the product surface was observed.
For none of the permeable type of casings tested in the experiments (cellulose - for frankfurters, natural - for hunter sausage, collagen - for - Cracow sausage and butt, any significant effect on phenols penetration rate attributed to type of casing was found. Cracow sausage was the only excption with the phenols content lower than expected in all smoking variants. This can be probably attributed to the raw materials composition and effects of drying process, which contributed to creation of the protective layer on the surface of the product which lowered the rate of phenol diffusion into the product.

Conclusion

The studied factors affecting the rate of phenols penetration into the products can be ranked as follows according to the significance of impact:

- development of the products surface ratio: 4-fold reduction of the development of surface area per weight unit (Frankfurters - 0,21 m^2/kg , butt - 0,05m^2/kg) resulted for RSF level of 50 g per 1m^3 of chamber capacity in 5-fold decrease of phenol content in the product,- drying time: in case of large surface area per unit of weight the extension of drying time from 20 to 40 minute reduced the level of phenols by 40%,- amount of RSF atomized in chamber: increased concentration of RSF (from 20 to 50 g per 1m^3 of chamber capacity) resulted in phenols content increase by 61% for frankfurters and only 21% in case of butt, which was undoubtly strongly connected with the development of surface ratio,
- type of casing: experiments performed do not allow clear conclusion about the influence of the type of casing on the phenols penetration rate; however, it seems that different types of permeable casing represent similar permeability for phenol constituents of the smoke.

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Table 1 Comparison of the amount of phenols penetrating into meat product in dependance on surface area and RSF dose
Table 2 Phenols contents in tested sausages in relation to RSF dose
Fig. 1 The infuence of drying time on amount of phenols penetrating into the frankfurters