ELEVENTH MEETING OF EUROPEAN MEAT RESEARCH WORKERS

BEOGRAD, AUGUST 16th to 22th, 1965.

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EFFECT OF FRICTION SMOKE DENSITY ON ORGANOLEPTIC PROPERTIES OF ELECTROSTATICALLY SMOKED PRODUCTS

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Chemical composition of smoke is largely dependent on the method of smoke generation. The composition of smoke generated in open hearth and the composition of friction smoke show considerable differences (6,12). The amount of air present in the process of generating smoke undoubtedly affects the quality of smoke. Since the quality of smoked products depends on the smoke components, it is the factors affecting the quality of smoke that influence the quality of smoked products.

EXPERIMENTAL METHODS

1. Choice of Wood for Generation of Smoke.- For the generation of smoke we used beech logs cut in the shape of parallelepipeds with the sides 1o x 18 x 11o cm., with moisture contents 21%.

2. Generation of Friction Smoke.- For the generation of smoke we employed a friction type generator, a construction of our own for this purpose. The friction surface between the beech log and the friction disc was 2o x 36 cm., and pressure o,3o kg/sq.cm. The rate of rotation of friction

disc was 12oo r/min. The smoke generated by friction was introduced by means of fan (with the capacity of 13oo cu.m/hr) into the chamber for electrostatic smoking. The diluted friction smoke was obtained by sucking the air through an opening (1o x 1o cm) situated in front of the fan parallel with its horizontal axis.

3. Determination of the Smoke Density.- The density of the smoke generated was measured by the equipment operating on the principle of photo-cells, which we constructed for this purpose. The equipment is constructed for measuring five degrees of smoke density, with the common scale divided into 2o equal degrees. Measurement was made in the delivery pipe introducing the smoke into chamber for electrostatic smoking (at the temperature of 6o°C).

4. Smoke Washing Procedure.- For determining the quantity of the major water soluble smoke components we employed the method of conducting the smoke through two units for gas washing connected in a series. The units, immersed in ground ice, were cooled from 0 to +1°C. Both friction smoke and diluted friction smoke were absorbed from the chamber for electrostatic smoking and conducted through the washing units filled with 1oo ml of redistilled water each. The absorbtion of the smoke from the chamber was done by connecting the washing units with Wolf's tube (with a capacity of 1o liters), connected with the vacuum pump attached to the tap. In every experiment 3o liters of smoke

was conducted through washing units (Wolf's tube was emptied three times).

5. Determination of pH.- The pH value was meausured by Metrohm AG pH - meter.

6. Total acids content was determined by titration with o,ool n NaOH in the presence of phenolphthalein and expressed as acetic acid.

7. Phenols were determined colorimetrically with 2,6 - dichlorchinonchlorimid (7). The colour intensity was measured by Beckman DU spetrophotometer, at the wavelenght of 635 millimicrons. The results obtained are expressed throught guaiacol. The standard curve obtained is presented in Fig.1.

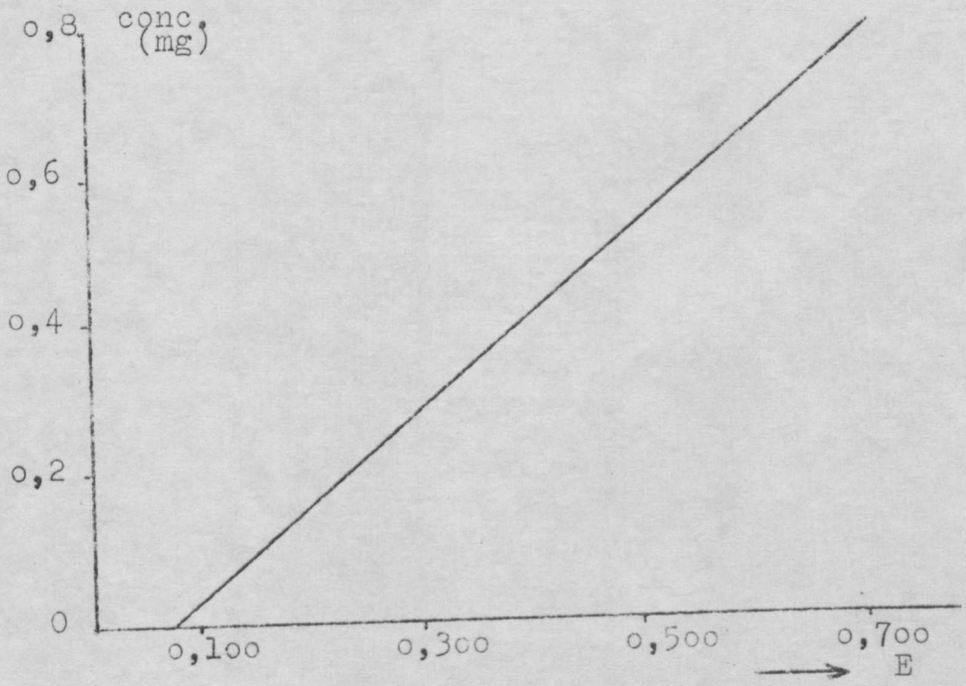

Fig.1. Standard curve for guaiacol

8. Determination of Formaldehyde in the smoke solution was done colorimetrically with the chromotropic acid (lo;

whereas in meat products it was made by means of pheryl-hydrazine-hydrochloride. Extinction was determined by Beckman DU spectrophotometer, at the wavelength of 57o millimicrons. The result obtained was expressed in formaldehyde micrograms.

9. Determination of Sensitive Dilution Index of Smoke.- Smoke was diluted by means of redistilled water. Maximum smoke dilution in which smoke odour and flavour could be detected, namely, sensitive dilution index, was determined.

1o. Preparation of Products for smoke curing.- In our experiments we used back fat (3o x 45 x 2,5 cm) and fresh sausage made of meat emulsion and spices, stuffed into the small sheep intestines 35-4o mm in diameter. Prior to putting it into the chamber for electrostatic smoking the back fat was given a hot water shower, drained and exposed to infrared rays.

11. Techniques of product smoke curing.- Smoke curing was carried ont (1o-15 minutes) in the electrostatic chamber, constuction of our own by means of friction smoke and diluted friction smoke. The distance between the electrodes was kept constant - 35 cm. During the experiment the voltage was 55 kV and the electric energy consumption was o.2 to o.5 mA. The processed products were hung on a negatively charged hook in the central part of the chamber. Since the hook can rotate vertically, fresh sausage was rotated (14 r/min.) during smoking period.

12. Organoleptic Analysis of Products.- Colour, tasle, odour and tenderness of products were evaluated by 5 judges after 24 hours storage.

RESULTS AND DISCUSSION

For the sake of clarity, the results of our study will be presented in two parts.

1. Analysis of Friction Smoke

The tentative chemical and organoleptic analyses of full friction smoke i.e. of air-smoke mixture, made immediately after its natural formation and the analysis of the same mixture actively diluted by air show certain interesting characteristics. The density of original air-smoke mixture leaving the friction generator was 5 - 15 units of the second order, while the density of actively diluted friction smoke was only 8 - 15 units of the first order. According to that, the original smoke was characteristically dense, friction smoke, while the air-smoke mixture was so much diluted that the difference between the two was readily observable.

In Table 1 are shown the results of the tentative analysis of the most important water soluble components of the original and diluted beech friction smoke. Contrary to expectations, the concentrations of phenol and especially of formaldehyde were evidently higher, even to a considerable extent, in diluted than in the original air-smoke mixture.

ORIENTATIVE CHEMICAL ANALYSIS OF WATER SOLUBLE FRICTION SMOKE COMPONENTS

Table 1.

	water soluble components (g) friction smoke density				redestilled water
	I/5-15		II/8-15		
	1st washing	2nd washing	1st washing	2nd washing	
pH of water solution of smoke	4,8	5,4	5,o	6,o	6,9
phenols in 1 litre of smoke	322	48,1	363	58	-
formaldehyde in 1 litre of smoke	22,42	4,86	31,4	6,55	-
acids in 1 litre of smoke	77,2	45,o	71,5o	42,5o	in traces

The fact that the diluted friction smoke has a higher phenol and formaldehyde content than the original, i.e. full smoke, is directly related to the fact that the smoke generated in open hearth (when pyrogenic destruction is slower and the flow of air more free) contains almost identical quantities of these components. Both facts indicate that the more free flow of air, especially at the moment of thermal destruction, namely immediately following the generation of smoke, is an important factor not only from the point of view of physical structure and rough composition of smoke but also from the point of view of absolute and relative concentrations of the most important chemical components of smoke. It is, of course very difficult to explain the exact mechanism of this phenomenon; this would require numerous and complex studies. For the practical aspect of meat technology, however, there remains an important conclusion that by diluting the friction smoke at the right time before it gets cooled, we obtain the air-smoke mixture which is identical in composition with the smoke generated in open hearth.

Unlike phenol and formaldehyde, the acid concentration in smoke is reduced by dilution (Table 1), which can be seen from both the absolute content of acids per 1 litre of smoke and the pH value of water solution of smoke.

The analyses of flavour and odour (Table 2) are in agreement with the chemical analysis of original smoke an

MAXIMUM FRICTION SMOKE DILUTIONS IN WHICH CHARACTERISTIC FLAVOURS MAY BE DETECTED

Table 2.

friction smoke	sensitive dilution index	1st washing		2nd washing	
		taste	odour	taste	odour
ORIGINAL	1:100	+++	+	+	+
	1:150	++	-	+	-
	1:200	+	-	-	-
	1:250	-	-	-	-
DILUTED	1:100	++++	++	++	+
	1:150	+++	++	++	-
	1:200	++	+	+	-
	1:250	+	-	-	-
	1:300	-	-	-	-

\+ threshold
++ slight smoke flavour
+++ moderate smoke flavour
++++ strong smoke flavour

diluted air-smoke mixture. They show that the sensitive dilution index for the characteristic flavour of the solution of original friction smoke is 1:2oo, while for the solution of the diluted smoke it is found to be even 1:3oo. These differences are even greater in odour, for which the sensitive dilution index in the original smoke was 1:1oo, while in diluted smoke it was even 1:2oo.

2. Study of Friction Smoke Effect on Products

In order to determine the degree and the rate of deposition of smoke consituents in meat products, we smoke cured some meat products electrostatically by means of original and diluted friction smoke. We selected back fat and fresh sausage. The former was selected for its high fat content, the latter for the high concentration of water.

The results shown in Table 3 might induce the conclusion which seems to be in contradiction with the data shown in Table 1. Namely, the phenol and formaldehyde contents are higher in diluted than in the original friction smoke, while in smoked products the situation is almost reverse. This can be easily explained if we remember that the original friction smoke is considerably denser than the diluted smoke and therefore the original smoke contains larger quantities of smoke constituents. This accounts for a considerably higher ionization of its particles in the electrostatic field, which in turn causes the sedimentation to be faster.

PHENOL CONTENT AND FORMALDEHYDE ONE IN BACK FAT AND FRESH SAUSAGE TREATED WITH FRICTION SMOKE

Table 3.

product	friction smoke	minutes	mg %	
			phenols	formaldehyde
BACK FAT	original	1o	o,o18	o,o41
		15	o,o26	o,o5o
	diluted	1o	o,o12	o,o26
		15	o,o17	o,o45
FRESH SAUSAGE	original	1o	o,o18	o,175
		15	o,o26	o,235
	diluted	1o	o,o16	o,14o
		15	o,o25	o,31o

Because of that, on the products treated with original smoke, larger quantities of all smoke consitituents are found. Therefore, the fact that in both back fat and fresh sausage smoked by means of diluted friction smoke, phenol and formaldehyde contents are lower, is not in contradiction with the reverse proportions of these constituents found in air-smoke mixtures.

The changes in the surface colour (Table 4) of smoked products are in perfect ageement with the above statement, since back fat and fresh sausage treated with original smoke have as a rule a darker colour than the products treated with diluted air-smoke mixture. A similar conclusion may be drawn as regards the flavour of the products smoked by means

ORGANOLEPTICAL PROPERTIES OF BACK FAT AND FRESH SAUSAGE TREATED WITH FRICTION SMOKE

Table 4.

product	friction smoke	minutes	colour	smoke taste	smoke odour	tenderness
BACK FAT	original	1o	brown	++	++	moderate
		15	dark brown	+++	++	"
	diluted	1o	light yellowish brown	+	+	"
		15	golden yellow	++	++	"
FURESH SAUSAGE	original	1o	light reddish brown	+-	++	gummy
		15	dark reddish brown	+	++	"
	diluted	1o	light reddish brown	+-	++	"
		15	dark reddish brown	+	++	"

+- very slight smoke flavour
\+ slight smoke flavour
++ moderate smoke flavour
+++ strong smoke flavour

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of original or diluted smoke (Table 4). Finally, the fact that the above organoleptic changes are more readily observable on back fat than on fresh sausage is quite natural and is also in accord with the above conclusion.

Finally, we wish to point out a fact which is of importance for the technology of smoking. Namely, that the concentrations of formaldehyde are considerably higher in fresh sausage than in back fat, it is not the case with the phenol. This may be due to the well-known fact that formaldehyde is soluble especially in water, while phenols are soluble almost equally well in water and in fats.

CONCLUSION

1. The concentrations of phenol and formaldehyde in diluted friction smoke are higher than in original full smoke. This can be proved by both chemical and organoleptic analyses. The concentrations of acids are reduced in proportion with the dilution of smoke.

2. The concentrations of phenol and formaldehyde of products smoked in the electrostatic field increase in proportion with the absolute density of smoke.

3. The concentrations of formaldehyde are higher in products with high moisture contents; phenol concentrations do not depend on the content of fat and water.

4. Diluting still warm friction smoke in time the air smoke mixture is obtained the composition of which matches the smoke of the open hearth.

EFFECT OF FRICTION SMOKE DENSITY ON ORGANOLEPTIC PROPERTIES OF ELECTROSTATICALLY SMOKED PRODUCTS

Summary

Tentative chemical and organoleptic examinations of full friction smoke, that is the air-smoke mixture immediately after its natural formation and the same mixture actively diluted with air current show that concentrations of phenols and formaldehyde in the diluted friction smoke are higher than in the original smoke of full composition. Acid concentrations decrease with smoke dilution. Diluting still warm friction smoke in time the air-smoke mixture is obtained the composition of which matches the smoke of the open hearth.

On purpose to study the degree and rate of collection of smoke components in meat products; electrostatical smoke curing by original and diluted friction smoke was carried out with products with high fat content - back fat and products with high water content - fresh sausage. These examinations indicate that formaldehyde concentration is higher in moisture-rich products, phenols concentration are the same regardless of fat content and water. Phenol concentration and formaldehyde one in products smoke cured in the electrostatic field increase with the absolute smoke density.

INFLUENCE DE LA DENSITE DE LA FUMEE DE FRICTION SUR LES PROPRIETES ORGANOLEPTIQUES DES PRODUITS FUMES ELECTROSTATIQUEMENT

Résumé

Les examins d'orientation chimiques et organoléptiques de la fumée de friction pleine, c'est à dire du mélange fumée-air immédiatement après sa formation naturelle et de ce même mélange activement répartie par le courant d'air démontrent que les concentrations du phénole et du formaldéchyde dans la fumée diluée de friction sont supérieure que dans celle de composition pleine. Les concentration des acides baisses avec la dilution de la fumée. Par la dilution au moment juste, de la fumée de friction encore chaude on obtient un mélange fumée-air qui est, par sa composition congruente à la fumée du foyer ouvert.

Dans le but de l'examen du degré et de la rapidité de concentration des composantes de la fumée dans les produits de viande, des essais on été fait par la méthode électrostatique et avec la fumée originale et diluent sur des produits contenant une quantité importante de graisse - lard dorsal et des produits ayant une grande concentration d'eau - saucisses. Ces examens démontrent que les concentrations du formaldéhyde sont plus grandes dans les produits riches en humidité, les concentrations des phénoles sont égales sans égard au contenu en graisse ou eau. Les concentrations des phénoles et formaldéhydes dans les produits fumés dans un champ électrostatique augmentent avec la densité absolue de la fumée.

ВЛИЯНИЕ ГУСТОТЫ КОПТИЛЬНОГО ДЫМА, ПОЛУЧАЕМОГО В ФРИКЦИОННЫХ ДЫМОГЕНЕРАТОРАХ НА ОРГАНОЛЕПТИЧЕСКИЕ СВОЙСТВА ПРОДУКТОВ ЭЛЕКТРОСТАТИЧЕСКОГО КОПЧЕНИЯ

Р Е З Ю М Е

Ориентировочные химические и органолептические исследования полного фрикционного дыма, т.е. дымо-воздушной смеси непосредственно после ее естественного образования и той же смеси активно разреженной воздушной струей показывают, что концентрация фенола и формальдегида в разреженном фрикционном дыму больше чем в оригинальном дыму полного состава. С разрежением дыма концентрации кислот понижаются. Своевременным разрежением еще горячего фрикционного дыма получается дымо-воздушная смесь, по своему составу соответствующая дыму открытых топок.

В целях испытания степени и скорости отложения компонентов дыма на поверхности мясных продуктов, было проведено электростатическое копчение оригинальным и разреженным фрикционным дымом продуктов с большим содержанием жира-спинного шпика и продуктов с большой концентрацией воды-сосисок. Эти исследования показывают, что концентрации формальдегидов больше в сырых продуктах; концентрации фенола одинаковые несмотря на содержание жира т.е. воды. В продуктах копченых в электрическом поле высокого напряжения концентрации фенола и формальдегида возрастают с абсолютной густотой дыма.

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