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The Effect of Temperature and Relative Humidity on the Phenolic Fractions of Smoke Samples Collected in Water-Filled Cellulose Casings.

The phenolic fraction of wood smoke has been shown to contribute to the typical surface color of smoked meat and also to the characteristic flavor and aroma of smoked foods (Jensen, 1954; Tilgner *et al.*, 1962). Of the many variables associated with the smoking operation, temperature and relative humidity are the most closely controlled conditions in modern smoke houses. This study was made to determine if relative humidity and temperature had an appreciable effect on the qualitative profile of the phenolic fractions of smoke samples collected in water filled artificial casings.

A small (14.8 cubic meters) commercial air conditioned smokehouse that had about 5 air changes per minute was used for the study. Smoke was provided by smoldering dampened sawdust, predominantly hard maple wood (*acer saccharum*). Two hour collection periods were used which required 13 - 14 kg of the dampened sawdust. Relative humidities of 7, 20, 30 and 60 % were used with a smokehouse temperature of 83°C during humidity trials. Temperatures of 27, 38, 66 and 93°C were studied when the relative humidity was maintained at 30 %.

Smoke samples were collected by the method of Simon *et al.* (1966). Cellulose frankfurter (Nojax casing, size 24, Union

Carbide Corp., Food Products Division) and bologna (Clear-Zip #/ 5, Tee Pak) casings were filled with distilled deionized water. The water (1 liter) filled Nojax casings were 2,9 meters in length and 2,1 cm in diameter, while the water (2 liters) filled bologna casings were 36 cm in length and 8,6 cm in diameter.

Phenols were extracted from the collected smoke samples in a series of steps that involved the use of ether, 1N NaOH, saturated NaHCO_3 solutions, and concentration under vacuum. Identification of the phenol fractions was accomplished by gas liquid chromatography (GLC), thin layer chromatography (TLC) and paper chromatography. Comparisons between unknown and known phenols as to retention time (GLC), color and R_f values (TLC and paper chromatography) were made to identify the phenols found in the collected smoke samples. The method of Tucker (1942) was used to determine "total phenols" which are expressed as phenol.

Results

The collected smoke samples showed small qualitative differences in phenolic fractions. Those present in largest amounts were pyrogallol, resorcinol, hydroquinone, catechol, 3-methoxycatechol, 2,6-dimethoxyphenol, 2,6-dimethoxy-4-methylphenol, and guaiacol. The last three fractions were used to characterize the effects of temperature and humidity as they gave distinctive peaks in the GLC analysis. The relative percentages shown in Table 1 were calculated from the contribution that each peak area made to the total of the 3 peak areas.

The data in Table 1 show that the smokehouse collection temperature altered the relative quantities of guaiacol and the higher boiling 2,6-dimethoxyphenol in the phenolic fraction collected. The high relative amount of guaiacol at the lower temperature was probably due to the

condensation of a considerable portion of the higher boiling compounds in the smokehouse before they reached the water filled casings. These results of the temperature phase of the study indicate that collection (smokehouse) temperature had a definite effect on the qualitative nature of the phenolic fraction.

Varying the relative humidity and maintaining the same collection temperature of 83°C had the most effect on the amount of water lost from the water-filled casings. Water loss decreased as relative humidity in the smokehouse increased. There was little difference in relative amounts of the three phenolic fractions studied. Differences in "total phenols" between the two kinds of casings may have been due to differences in casing thickness as well as surface to volume ratios.

References

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Table 1. Water loss, total phenols and relative quantities of guaiacol, 2,6-dimethoxyphenol and 2,6-dimethoxy-4-methylphenol as affected by smokehouse temperature and relative humidity.

Casing type	Relative humidity %	Temperature °C	Water loss %	Total phenols mg/100 ml	Relative quantities (%'s)		
					GA	2,6-DMP ^b	2,6-DM-4-MP ^c
(Frankfurter)							
Nojax	30	27	6,5	3,3	41	36	22
Nojax	30	38	13,0	3,8	17	57	25
Nojax	30	66	28,0	4,6	6	59	33
Nojax	30	93	68,5	6,0	5	63	30
(Frankfurter)							
Nojax	7	83	77,5	5,5	5	52	42
Nojax	20	83	53,5	5,5	3	53	43
Nojax	40	83	32,0	4,5	2	56	40
Nojax	60	83	22,0	3,6	3	55	41
(Bologna)							
Clear-Zip	7	83	18,5	2,0	7	52	40
Clear-Zip	20	83	15,0	1,3	5	53	41
Clear-Zip	40	83	7,5	1,2	2	55	42
Clear-Zip	60	83	5,5	1,1	4	57	38

^aGuaiacol

^b2,6-dimethoxyphenol

^c2,6-dimethoxy-4-methylphenol