C 3

Antioxidative properties of selected smoked meat products

H. DAUN

Department of Animal Food Products Technology, Technological University Gdansk
Poland

Among very many different meat products some have to have a prolonged storage life. Some products are exposed to an intensive contact with the surrounding atmosphere and they should have therefore good resistance to oxidative changes.

Smoke curing process is one of the oldest preservation methods and it is known from practice that among other attributes smoked products have antioxidative properties. The resistance to oxidative changes is one of the effects of complex physico-chemical phenomena which take place during smoking. All main stages of the smoke curing process i.e. smoke generation, aging and deposition on the surface of products, drying and heating in the hot smoke, penetration of smoke components and their interactions with the constituents of the substrate, may influence significantly the stability of smoked products.

Among the above stages, lately the smoke generation was more accurately examined. The antioxidative activity of vapour and particle smoke phases (Tilgner *et al.* 1965) as well the influence of factors, such as kinds of smoke sources, methods (Tilgner and Daun 1969) and parameters of smoke generation were investigated.

It was demonstrated that phenolic substances are mainly responsible for antioxidative properties of curing smoke (Kurko 1959; Tilgner *et al.* 1967) and that the method of separation of smoke components influences significantly their activity (Daun and Grabowska 1967).

Although in investigations of the stability of smoked products some progress has been achived (Lea 1933; White 1941, 1944; Smith *et al.* 1945; Grant and White 1949; Gaddis 1952; Watts 1954; Watts and Faulkner 1954; Erdman *et al.* 1954; Faulkner and Watts 1955; Watts 1956; Hougham 1960; Kemp *et al.* 1961) our knowledge in this field is still fragmentary. The examination of resistance to oxidative changes of smoked products is very difficult, because of complicated composition of substrate (Watts 1962), different smoke curing conditions, various concentrations of smoke constituents

in several layers of products, and possibilities of many chemical interactions. Additionaly, in spite of some progress (Watts 1962; Tilgner *et al.* 1967), there are methodological difficulties, since except of sensory evaluations, the main group of methods used for rancidity control in pure fats, cannot be applied for meat products without the separation of the fat from other meat constituents.

It was the object of this study to establish the resistance to oxidative changes of selected products smoked in industrial conditions and to compare chemical and sensorical results applying long storage as well high temperature rapid procedure.

EXPERIMENTAL

Choice and origin of products

Due to different production, packaging and marketing conditions in different countries the selection of meat products for testing the antioxidative properties was not an easy one. After detailed consideration we have chosen two typical products i.e. pork back fat and summer sausage — Juniper Smoke Variety (Polish »Jalowcowa»), representing meat products in which a prolonged storage-life is usually expected. All samples were from the normal commercial production according to standarized regulations of the meat combinate Gdanskie Zaklady Miesne to which we wish to express our words of appreciation for their kind cooperation. The pork back fat was smoked in cold smoldering type curing smoke for two hours at 70—80 % r.h. and 23° C, final salt content was about 1 %. For our experiments back fat was chosen from one carcass only to avoid individual differences. The juniper type summer sausage contained 80 % pork meat, 20 % beef, 20 % fat mixed with 0,3 % salt, 0.15 % black pepper, 0,2 % sugar, and was smoked at 90° C for 1,5 hour.

Storage conditions and sampling

Both products were stored in a hanging and unwrapped state at a temperature of 10° C $\pm$ 3° since it is known that these products are usually handled that way and have a long storage life. Samples from the back fat and summer sausage were drawn each month up to six months. The phenols content was also determined at the beginning of the storage i.e. smoked pork back fat 3,28 mg/100 g, smoked juniper sausage 2,65 mg (100 g expressed as guaiacol) determination by 2,6—dibromquinonchlorimid method).

This slow, long term procedure was supplemented by a accelerated oxidation test for both products.

The rancidity determinations in the back fat were made always in the outer layer (1 cm from the outside) and separately in the interior since the

progress of oxidatin was markedly different. In the summer sausages the fat particles had to be separated from the meat prior to rancidity determinations in order to avoid side reactions. Until this separation procedure was adopted the rancidity determinations did not give reliable results. In the accelerated test oxidation changes were followed in fresh unstored samples of back fat and summer sausage which were comminuted in a meat grinder (opening 4 mm diameter) and kept at 70° C in Petri dishes.

Analytical procedure

The following chemical determinations were conducted:

a. Jodic number (DGF Einheitsmethoden — Abteilung C — Fette, C — V 11 a (53) Stuttgart 1950).
b. Acid number (Bauer K. H.: »Analiza zwiazków organicznych» P.W.T. Warszawa, 1957, p. 251).
c. Peroxide content (American Oil Chemists Society. Official and Tentative Methods, II-nd ed. Chicago 1946).

Additionaly at regular monthly intervals sensory determinations of the aroma and flavour were determined by a pannel using descriptive methods.

RESULTS AND DISCUSSION

The results of oxidation changes are shown in fig. 1 and 2 for the prolonged

Table 1. *The development of rancidity in pork back fat comminuted and thermostated at 70° C*

Days of thermostating	*Peroxide content ME/KG*		
	with pyrogallol	*smoked*	*unsmoked*
	1	*2*	*3*
0	—	2,0	2,6
1	2,4	3,0	3,4
2	2,6	3,5	112,4
3	3,1	4,6	303,2
4	3,2	6,2	472,8
5	3,2	8,9	—
6	3,6	17,6	—
7	3,5	28,5	—
—	—	—	—
9	3,7	81,4	—
10	4,5	126,6	—

The results are arithmetical mean af 6 determinations

Table 2. *The development of rancidity in juniper sausage comminuted and thermostated at 70° C*

Days of thermostating	*Peroxide content ME/KG*		
	with pyrogallol	*smoked*	*unsmoked*
	1	*2*	*3*
0	3,8	5,3	9,7
1	4,2	6,6	15,7
2	4,8	8,5	26,6
3	4,8	—	95,0
4	5,1	9,7	153,0
5	3,9	—	220,4
6	4,3	13,3	260,0
7	4,5	—	290,0
9	6,0	25,8	313,0
10	4,3	—	344,0
11	5,6	47,0	303,0
12	3,8	36,6	302,0
14	4,3	14,6	260,0
17	5,0	24,6	228,5
26	4,7	25,1	—
34	6,9	33,4	—
44	11,8	122,5	—
54	52,6	198,0	—
64	79,2	232,7	—

The results are arithmetical mean of 6 determinations

storage (at 10° C) and for the rapid storage test of the comminuted samples (at 70° C) are presented in tabl. 1 and 2.

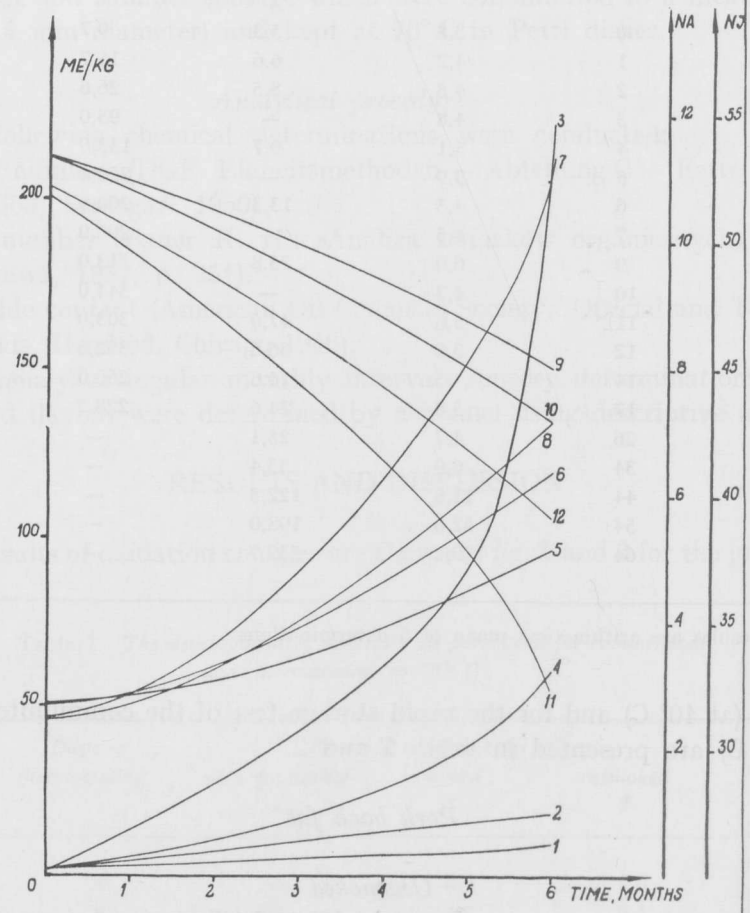
Pork back fat

Unsmoked

In the long storage experiment at 10° C the first visual signs of rancidity are noticeable after 1 month storage in the outer layer (1 cm) by slightly yellowish irregular spots. During further storage these spots discoloured in size and after four months the whole exterior layer showed a distinctly different colour as smell as compared with the interior parts. The later showed the first visually noticeable changes after three months storage and the changes proceeded at much slower rate than the exterior layers of the back fat. By chemical determinations the induction period to the peroxide value of 20 ME/KG i.e. the sensoric rancidity threshold amounts to 1 month in the outer fat layer and to two months in the inner layer.

Fig.1 Chemical determination in pork back fat thermostated at 10°C ± 3

	peroxide content	acid number	iodic number
smoked fat ext.	1	5	9
" fat int.	2	6	10
unsmoked fat ext.	3	7	11
" fat int.	4	8	12

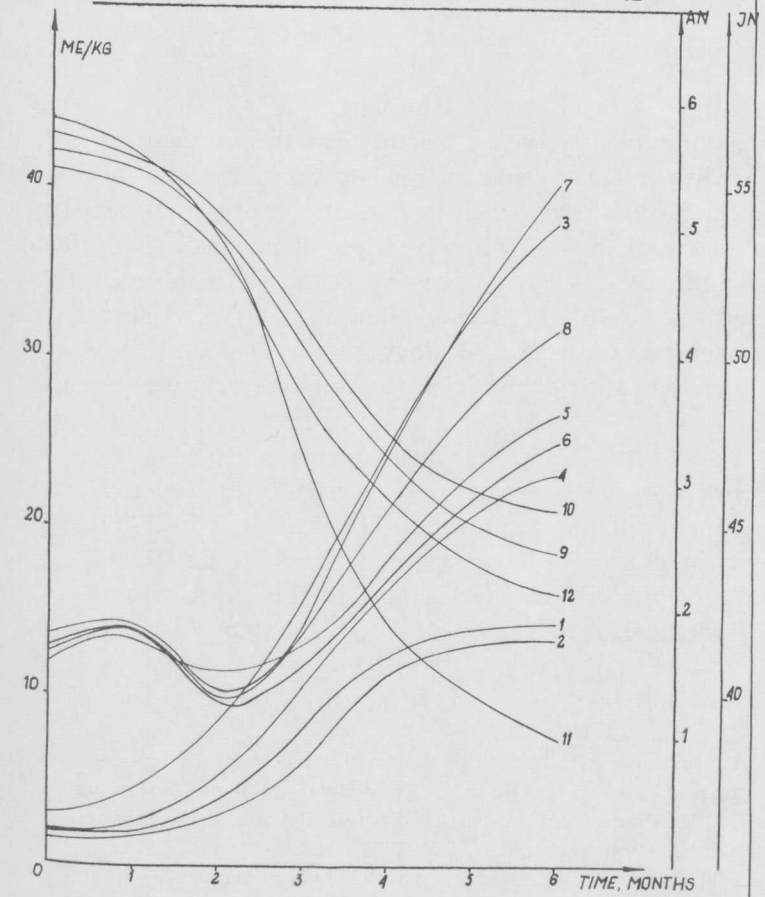


Smoked

The oxidation process is considerably slowed down. Especially the exterior layer (1 cm) shows a great resistance and even after four months of storage no sign of rancidity were noticeable, while in the interior parts the first slight discolorations appear after three months. These oxidative changes are

Fig. 2 Chemical determination in juniper type dry sausage thermostated at 10° C ± 3

	peroxide content	acid number	iodic number
smoked fat ext.	1	5	9
" fat int.	2	6	10
unsmoked fat ext.	3	7	11
" fat int.	4	8	12



verified by the chemical results. In the accelerated test the fat melted at 70° C from the back fat shows a corresponding lower stability as compared with the samples stored at 10° C. The storage life of the smoked back fat amounts to 6 days and of the unsmoked fat only 1—2 days. It hence may

be assumed that the smoking process increases the stability of pork back fat 3—6 times.

Summer sausage — Juniper Smoke Variety

Unsmoked

Loss of sensory quality was detectable after 1 month storage at 10° C. These changes proceeded quickly and after three months the product was not any longer suitable for sensory examination.

Smoked

No signs of rancidity were detectable in the sausages after five months of storage while a sensory loss of quality was noticeable already after two months in the form of a soft, melting consistency of the fat particles contained in the sausage, a change of colour and loss of juiciness. The chemical determinations confirmed the above sensoric changes. In the accelerated test the comminuted stuffing of the sausage showed at 70° C a storage life of some 20 days in comparison with 2—3 days for the unsmoked product. Thus the smoking increases the stability of the sausage stuffing some 10 times.

Acknowlegments

This work was partly financed by Agricultural Research Service of the US Department of Agriculture in Project UR-E-21-(60)-24. Principal investigator in charge of Project: Prof. Dr. D. J. Tilgner.

The help of Mrs. H. Kopacz in part of the experimantal work is greatfully acknowledged.

LITERATURE

1. Daun, H,. Grabowska, J. The antioxidant activity of smoke components as influenced by the method of separation. Roczniki Technologii i Chemii Zywnošci, 14, 109 (1967).
2. Erdman, A. M., Watts, B. M., Ellias L. C. Smoke flavor and ascorbic acid as preservatives for fatty fish. Food Technol., 8, 320 (1954).
3. Faulkner, M. B., Watts, B. M. Deteriorative changes in frozen shrimp and their inhibition. Food Technol., 9, 632 (1955).
4. Gaddis, A. M. Effect of pure salt on the oxidation of bacon in freezer storage. Food Technol., 6, 294 (1952).
5. Grant, G. A., White, W. H. Keeping quality enhanced by curing and smoking poultry. Food in Canada, 9, (5), 14; (8), 27 (1949).
6. Hougham, D. F. Control of oxidative changes in irradiated hams. Food Technol., 14, 170 (1960).
7. Kemp, J. D., Moody, W. G., Goodlett, J. L. The effects of smoking and smoking temperatures on the shrinkage, rancidity development, keeping quality and palatability of dry-cured hams. Food Technol., 15, 267 (1961).
8. Kurko, W. Antioxidative properties of curing smoke components. Mjasnaja Industrija, 30, (3), 19 (1959).

9. Lea, C. H. The effect of smoking and influence of atmospheric humidity on keeping properties of bacon. J. Soc. Chem. Ind., 52, 57 T (1933).
10. Smith, F. H., Brady, D. E., Comstock, R. F. Rancidity of bacon, effect of antioxidant. Ind.Eng.Chem., 37, 1208 (1945).
11. Tilgner, D. J., Sikorski, Z. E., Daun, H., Rudnicki, A. Antioxidative activity of the dispersed and dispersing phase of curing smoke. XX-lecie Politechniki Gdanskiej-Sesja Naukowa No Ch 45, p. 344, 1965.
12. Tilgner, D. J., Daun, H., Kopacz, H. The application of measurable sensory evaluation of antioxidative properties of curing smoke and it's phases. Roczniki Technologii i Chemii Zywnošci, 14, 119 (1967).
13. Tilgner, D. J., Daun, H., Rudnicki, A. Antioxidant activity of phenolic compounds present in curing smoke. Roczniki Instytutu Przemyslu Miesnego, 4, (1), 15 (1967).
14. Tilgner, D. J., Daun, H. Antioxidative properties of curing smokes obtained by three different smoke generation methods. In press.
15. Watts, B. M. Oxidative rancidity and discoloration in meat. In »Advances in Food Research» 5, 1 (1954).
16. Watts, B. M., Faulkner, M. Antioxidant effect of liquid smokés. Food Technol. 8, 158 (1954).
17. Watts, B. M. Freeze curing of bacon. Food Technol, 10, 101 (1956).
18. Watts, B. M. »Meat Products» chapter 11 in »Lipids and Their Oxidation». The AVI Publ. Company, Inc. Westport, Connecticut, 1962.
19. White, W. H. Rancidity in pork fat after frozen storage and conversion to bacon. Can. J.Res. 19D, 96 (1941).
20. White, W. H. Smoked Meats. II. Development of rancidity in smoked and unsmoked Wittshire bacon during storage. Can. J. Res., 22F, 97 (1944).