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ALL-UNION RESEARCH INSTITUTE

OF THE MEAT INDUSTRY

U S S R

V.I. Piulskaya

THE INFLUENCE OF γ-RAYS AND THERMAL TREATMENT ON ANTIOXIDANTS DESTRUCTION IN INHIBITED PORK FAT

Moscow, 1961

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S U M M A R Y

The data was obtained concerning thermal destruction of butyloxianisole and butyloxitoluol in pork fat, on these antioxidants decomposition due to γ-radiation dose and to the process of storing.

Peroxides accumulation and antioxidants dissociation are simultaneous under thermal treatment of inhibited pork fat.

With the increase of γ-radiation dose these processes intensify.

Butyloxianisole proves to be the most effective inhibitor in the oxidizing of stored pork fat irradiated with I,000,000 and I,500,000 rad. Butyloxitoluol has no inhibiting power in similar conditions.

DAS ALLUNIONS-FORSCHUNGSINSTITUT DER FLEISCHWIRTSCHAFT UdSSR 187

EINFLUSS VON γ-BESTRANLUNG SOWIE WÄRMEBEHANDLUNG AUF DIE ZERSTÖRUNG DER ANTIOXYDANTIEN IM INHIBIERTEN SCHWELNEFETT

W.I.Piulskaja

ZUSAMMENFASSUNG

Es werden die Angaben hinsichtlich der Wärmezerstörung von Butyloxyanisol und Butyloxytoluol im Schweinefett sowie hinsichtlich des Zerfalls der erwähnten Antioxydantien je nach der Höhe der γ-Bestrahlung und während der Lagerung angeführt.

Durch die Wärmeeinwirkung auf inhibiertes Schweinefett wird die Anhäufung von Peroxyden und der gleichzeitige Zerfall von Antioxydantien hervorgerufen.

Bei der Einwirkung von γ-Strahlen werden diese Vorgänge mit der Zunahme von Bestrahlungsdosis verstärkt.

Als meist wirkungsvoller Oxydationsinhibitor bei der Lagerung von mit I und I,5 Mil. Rad bestrahltem Schweinefett erwies sich Butyloxyanisol. Butyloxytoluol übt unter diesen Bedingungen keine inhibierende Wirkung aus.

L'INSTITUT D'ETAT DE RECHERCHES SCIENTIFIQUES DE LA VIANDE

L' U R S S

L'INFLUENCE DES RAYONS GAMMA ET DU TRAITEMENT THERMIQUE SUR LA DESTRUCTION DES ANTIOXYDANTS DANS LA GRAISSE DE PORC INHIBITIVE

V.I.Pioulskaja

R É S U M É

Nous avons reçu les données concernantes la destruction thermique du butyle oxyanisole et du butyle oxytoluène dans la graisse de porc et la destruction de ces antioxydants en fonction de la dose des rayons gamma et aussi pendant la conservation.

L'action thermique sur la graisse de porc inhibitive provoque l'accumulation des peroxydes et la destruction simultanée des antioxydants.

L'action des rayons gamma intensifie ces procédés avec l'augmentation de la dose d'irradiation.

Le butyle oxyanisole c'est l'inhibiteur de l'oxydation le plus actif pendant la conservation de la graisse de porc irradiée des doses dr I.000.000 à I.500.000 ra.

Dans les conditions pareilles le butyle oxytoluène ne produit aucun effet inhibitif.

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THE INFLUENCE OF γ-RAYS AND THERMAL TREATMENT ON ANTIOXIDANTS DESTRUCTION IN INHIBITED PORK FAT

V.I.Piulskaya

Fats are easily subjected to chemical changes under atmospheric oxygen activity, especially at increased temperature or due to ionizing radiation. Oxidative processes in fats develop by free-radical chain mechanism. Chain oxidizing reactions can be easily broken by adding small amounts of antioxidants - special substances which are now practically used to inhibit the deterioration of fats by oxidation and to prolong their storage time (1-8).

Positive role of antioxidants reveales in reducing or eliminating the subsequent irradiation effect (9-15).

Due to the significance of antioxidants as inhibitors of oxidative processes in fats, γ-rays and thermal treatment influence on the destruction of antioxidants is of great interest.

In literature there are few papers concerning kinetics of antioxidants destruction in fats, and the question of the changes in antioxidants content in fats, while being irradiated, has not been touched upon at all. That is why it is of great interest.

Some authors confirmed antioxidants destruction. Golumbic (16) observed the reduction of tocopherols concentration in lard oxidized in a shelf at 60°.

Filer et al. (17), studied decomposition of the gallic and ascorbic acids in refined maize oil at 110°.

Lundberg et al. (18), observed the destruction of a number of antioxidants in lard oxidation which was kept at 100° with oxygen aeration.

Other investigators (19,20) watched propyl gallate and butyloxianisole dissociation in lard kept at 61° and also these and other antioxidants destruction in pie crust while storing at 61°.

Fat oxidation tests were carried out by accelerated kinetic method at increased temperature. 20 gm of fat were placed in oxidizing cell immersed into a thermostat , and through the porous glass filter soldered in the cell bottom air was blasted at the rate of 7 l/hr. In definite time intervals samples of oxidized fat were taken to determine peroxide number and antioxidants content.

In these experiments equimolecular quantities (0,00II M) of butyloxianisole and butyloxitoluol were added to fat. Fat analyses were conducted by the following methods:

peroxide number determination - by iodometric method (2I);

butyloxianisole determination - by Mahon and Chapman method (22);

butyloxitoluol determination - by Anglin et al. method (23).

A special unit served as a γ-radiation source.Radiation dose capacity was 2,000 r/hr. To irradiate the objects studied, doses of 300,000; 600,000; I,000,000 and I,500,000 rad. were used.

Pork fat was irradiated in Petri dishes. The same quantities of antioxidants were added as in the case of thermal treatment. Alongside with antioxidants determination, observations were made as to the changes of peroxides content in the same samples. Pork fat samples were kept in a thermostat at 20°.

Figures I and 2 show kinetic curves of inhibited pork fat and antioxidants decomposition. Oxidation temperature is II0°.

Judging by these figures it is obvious that peroxide accumulation in pork fat is accompanied by antioxidants destruction.

Tables I-4 and figures 3,4 represent changes in antioxidants content and the development of oxidative processes

It is obvious that the increase of radiation dose results in the increase of the degree of antioxidants decomposition. After being irradiated with 300,000 rad, the product retains 74% of antioxidants(butyloxianisole and butyloxitoluol); when the dose of I,500,000 rad is used, only 19-24% of their initial quantities is retained.

No antioxidants destruction was observed during 62-90 days' storage of fat samples irradiated with 300,000 to I,000,000 rad.

Table I. Antioxidants destruction and peroxides accumulation in the processes of pork fat irradiation with 300,000 rad and storage

	Before irra-diation	4 hrs	7 days	15 days	35 days	51 days	69 days	90 days
Peroxide number, % iodine	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Butyloxi-toluol, mg %	28.0	20.8	21.3	21.2	21.7	20.8	21.5	20.0
% anti-oxidant to initial quantity	100	74.2	76.0	75.7	77.5	74.2	76.7	71.4
Peroxide number % iodine	0.00	0.03	0.04	0.03	0.03	0.04	0.04	0.04
Butyloxi-anisole, mg %	20.3	15.0	14.5	14.5	15.0	15.3	15.0	15.0
% anti-oxidant to initial quantity	100	73.8	71.9	71.4	73.8	75.3	73.8	73.8
Peroxide number % iodine (fat without antioxi-dant)	0.00	0.179	0.88	3.05	8.38	8.69	8.27	8.92

Table 2. Antioxidants destruction and peroxides accumulation in the processes of pork fat irradiation with 600,000 rad and storage

	Before irradiation	5 hrs	9 days	20 days	36 days	54 days	75 days
Peroxide number, % iodine	0.00	0.09	0.09	0.08	0.08	0.09	0.09
Butyloxitoluol, mg %	27.7	13.2	15.7	13.8	14.2	12.7	13.7
% antioxidant to initial quantity	100	47.6	56.6	49.8	51.2	45.8	49.4
Peroxide number, % iodine	0.00	0.08	0.08	0.07	0.07	0.07	0.07
Butyloxianisole, mg %	19.3	II.3	12.3	10.0	10.3	10.7	10.3
% antioxidant to initial quantity	100	58.5	63.7	51.8	53.3	55.4	53.3
Peroxide number, % iodine (fat without antioxidant)	0.00	I.05	5.00	7.76	9.19	9.26	II.39

Table 3. Antioxidants destruction and peroxides accumulation in the processes of pork fat irradiation with I,000,000 rad and storage

	Before irradiation	4 hrs	5 days	12 days	26 days	62 days
Peroxide number, % iodine	0.00	0.18	/0.38/	0.21	0.22	0.93
Butyloxitoluol, mg %	27.4	8.6	10.4	8.9	6.9	8.3
% antioxidant to initial quantity	100	31.3	37.9	32.4	25.1	30.2
Peroxide number, % iodine	0.00	0.12	0.11	0.11	0.11	0.10
Butyloxianisole, mg %	19.3	7.0	7.0	6.3	7.6	7.0
% antioxidant to initial quantity	100	36.2	36.2	32.6	39.3	36.2
Peroxide number, % iodine (fat without antioxidant)	0.00	0.92	1.94	4.22	0.23	8.59

Table 4. Antioxidants destruction and peroxides accumulation in the processes of pork fat irradiation with I,500,000 rad and storage

	Before irradiation	4 hrs	4 days	13 days	27 days	63 days
Peroxide number, % iodine	0.00	I.39	I.06	I.82	2.35	7.27
Butyloxitoluol, mg%	27.4	6.6	6.7	6.5	5.4	4.4
% antioxidant to initial quantity	100	24.0	24.4	23.7	19.7	16.0
Peroxide number, % iodine	0.00	0.21	0.20	0.17	0.18	0.17
Butyloxianisole, mg %	19.3	3.7	/2.6/	3.5	3.3	2.7
% antioxidant to initial quantity	100	19.1	/13.4/	18.1	17.0	13.9
Peroxide number, % iodine (fat without antioxidant)	0.00	1.91	2.80	4.99	8.31	10.05

Peroxides accumulation during 90 days' storage (at 20°) of fat samples, irradiated with 300,000 rad, is completely inhibited. The same is observed if the radiation dose is 600,000 rad.

Butyloxitoluol does not inhibit oxidative processes during 62-63 days' storage of fat samples irradiated with I,000,000 and I,500,000 rad; whereas butyloxianisole does inhibit these processes.

C O N C L U S I O N S

I. In rendered pork fat, inhibited with equimolecular amounts of butyloxitoluol and butyloxianisole, under thermal treatment peroxides accumulation is observed accompanied by antioxidants decomposition.

2. The antioxidants dissociate under ionizing irradiation of pork fat inhibited with butyloxianisole or butyloxitoluol; this process is intensified with the increase of the radiation dose.

3. While storing pork fat, irradiated with I,000,000 and I,500,000 rad, butyloxianisole is the most effective inhibitor; whereas butyloxitoluol has no inhibiting power in

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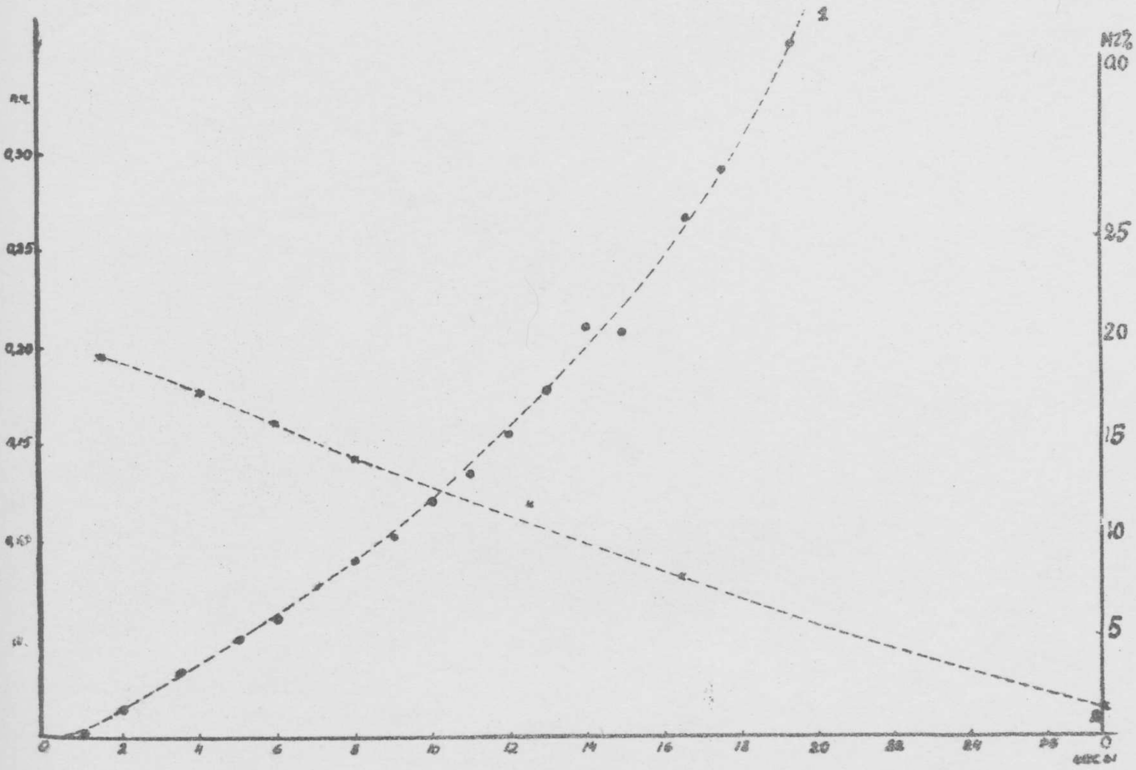

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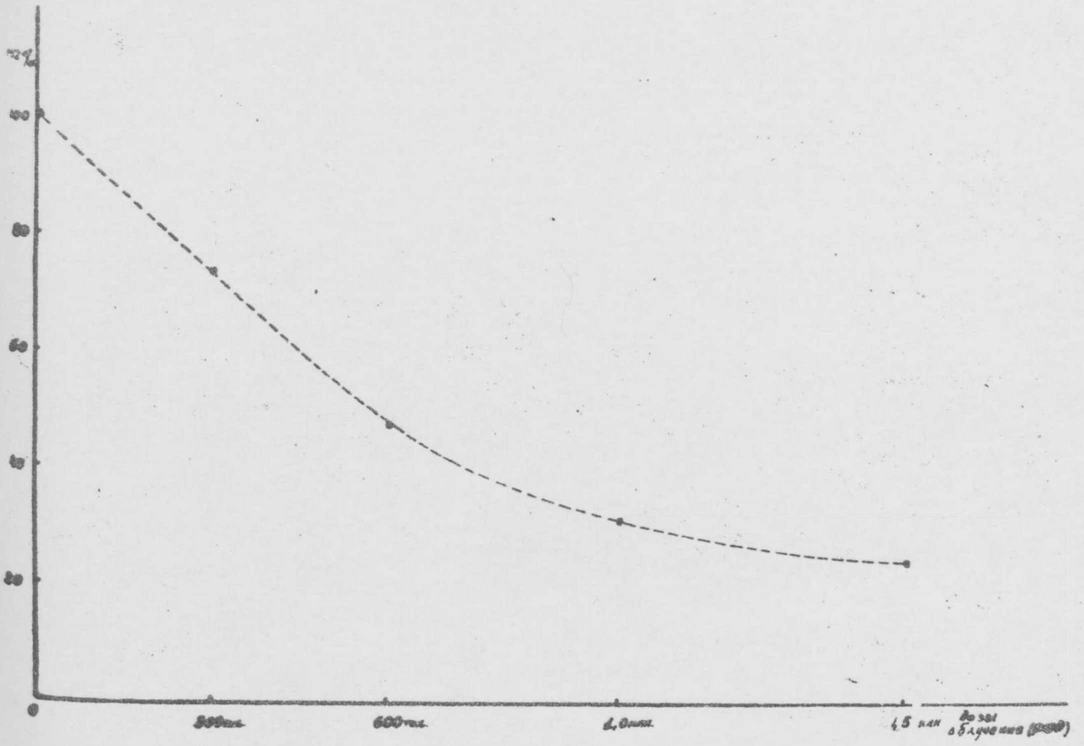
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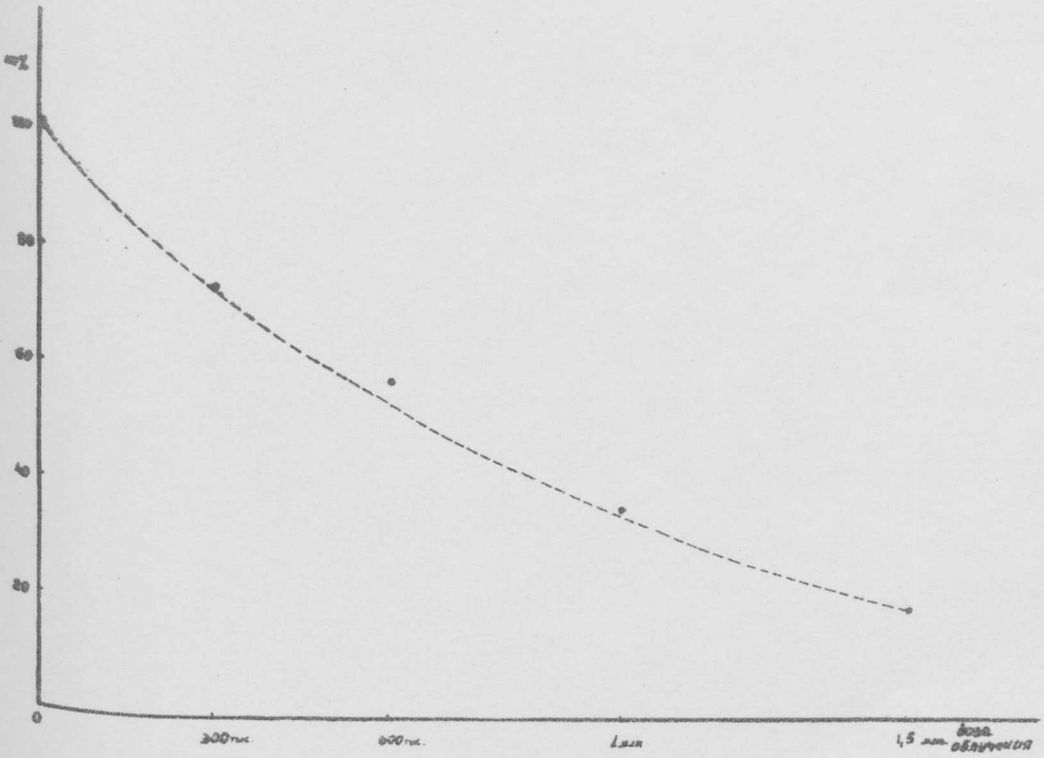
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L I T E R A T U R E

I. Kraybill H.R., Dugan I.R., J.Agr. and Food Chem., 1954, v. 2, p. 81.

2. Dugan L.R., Hoffert E., Marx L., Knickel D., Amer. Meat Inst., Found; Bull., 1953, No. 16, p. 35.

3. Rutkowski A., Panstwowego Zakladu Hg., 1953, v.3, p. 1953.

4. Korobkina G.S. "Voprosy Pitania", 1954, 13, 5, p. 33.

5. Emanuel N.M., Knorre D.G., Lyaskovskaya Yu.N., Piulskaya V.I. "Meat Industry", 1955, 6, p. 47.

6. Tollenaar F.D., Vos H.J. Fette, Seifen. Anstrichmit., 1956, Bd. 58, s. 12.

7. Lebedeva Z.K. "Masloboyno-zhirovaya promyshlennost", 1958, 4, p. 12.

8. Karpluke I.A. "Voprosy Pitania", 1960, I, p. 67.

9. Astrack A., Serbye O., Brasch A., Huber W. Food Research, 1952, v. 17, p. 571.

10. Huber W., Brasch A., Waly A. Food Technol., 1953, v. 7, p. 109.

II. Polister B.H., Mead J.F.J. Agr. Food Chem., 1954, v. 2, p. 199.

I2. Hannan R.S. Research on the Science and Technology of Food Preservation by ionizing radiations, Chemical Publishing Co., Inc., New York, 1956.

13. Tarladgis B.G., Younathan M.T., Watts B.M. Food Technol., 1959, v. 13, p. 635.

14. Caldwell H.M., Glidden M.A., Kelley G.G., Mangel M. Food Research, 1960, v. 25, p. 139.

15. Hougham D.F. Food Technol., 1960, v. 14, p. 170.

16. Golumbic C. Oil and Soap, 1943, v. 20, p. 105.

200

17. Filer L.J., Mattil K.F., Longenecker H.E. Oil and Soap, 1944, v. 21, p. 289.

18. Lundberg W.O., Dockstader W.B., Halvorson H.O. J.Am.Oil Chem. Soc., 1947, v. 24, p. 89.

19. Mahon J.H., Chapman R.A., J.Am.Oil Chem. Soc., 1953, v. 30, p. 34.

20. Mahon J.H., Chapman R.A. J. Am. Oil Chem. Soc., 1954, v. 31, p. 108.

21. "ГОСТ" ("State all-union standards") 8285-57. Rendered animal fats. Sample selection and research methods. Standartgiz.

22. Mahon J.H., Chapman R.A. Analyt. Chem., 1951, v. 23, p. 1120.

23. Anglin C., Mahon J.H., Chapman R.A. J. Agr. Food Chem., 1956, v. 4, p. 1018.