the bottom section was 228° F. The result was to produce a canary-colored soft cake having a lower extraction than had previously been obtained. The refining loss of the oil was reduced about 2 per cent due to the soapstock being firm and smooth compared with the soft soapstock that was normally obtained. In operating in this manner, there should be sufficient space above the meats in each section so that the open steam does not carry meats into the stack carrying the steam from the cooker. This plan can be varied to fit different moisture conditions. In general, the plan is to assist the evaporation of the excess moisture in the meats by means of open steam, either superheated or not.

R. H. FASH.

Gum Guaiac—A New Anti-Oxidant for Oils and Fats

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A New Antioxidant for Fats and Oils[1]

THE tendency of fats to undergo auto-oxidation, leading to physical and chemical changes, and to rancidity when they are exposed to atmospheric oxygen, has been a constant source of annoyance and loss to most industries in which fats are used or handled. A non-toxic antioxidant which prevents auto-oxidation in fats would have the function of preventing loss to the industries.

The most commonly accepted view concerning the mechanism of the auto-oxidation of fats postulates the intermediate formation of a highly reactive peroxide at the double bonds in unsaturated fatty acid radicals. This view was originally proposed by Engler and Wild[2], independently by Bach[3], and has been further elaborated upon by Milas[4] in his electronic interpretation.

A relatively large amount of this peroxide accumulates in a fat during auto-oxidation, before further reaction causes its break-down into other products, as is shown by the following tests:

1. By means of the oxygen absorption test, proposed by Greenbank and Holm[5], it can be shown that much oxygen is absorbed by fats during incubation, before the appearance of rancid odors which are due to the products of the decomposition of the peroxide.

2. The presence of peroxide in a fat after auto-oxidation has proceeded for some time can be demonstrated, quantitatively, by the peroxide oxygen test which was first proposed by Taffel and Revis[6], and further developed by others[7],[8]. This test is carried out by dissolving the fat in question in a solvent mixture, usually consisting of one volume of chloroform and two volumes of concentrated acetic acid, and adding a saturated solution of potassium iodide. The peroxide liberates its equivalent of iodine which is titrated with sodium thiosulfate.

3. The strong oxidizing effect of an auto-oxidized fat can be simply demonstrated by dissolving the fat in a suitable solvent, such as butyl alcohol, and adding phenylene-diamine which immediately darkens in color, showing that it has been oxidized.

It is evident from the above experiments that an auto-oxidized fat acts as a strong oxidizing agent under certain conditions.

The extensive works of Moreau and Dufraise, and co-authors, have demonstrated that certain compounds are enormously active in the prevention of auto-oxidation of oils and fats and certain other organic compounds. A review of this literature reveals that compounds acting as antioxidants prevent the accumulation of the highly reactive peroxide in the fat, and that rancidity under normal conditions does not develop until a considerable amount of peroxide has accumulated.

A large number of organic chemical compounds, all of which have reducing properties, act as anti-oxidants for fats. The ortho- and para-polyphenols, aromatic amines, and amino phenols are particularly active; so active, in fact, that .0001 of a per cent of pyrogallol or one part in 10,000,000 parts of dry fresh lard will have a noticeable effect in preventing the development of peroxide oxygen in the lard.

The author took up the study of anti-oxidants with the view in mind of making some practical use of anti-oxidants, either for edible or inedible fats. Several facts soon became manifest, however, that prevented immediate application:

1. Most anti-oxidants become ineffective when the fat to which the anti-oxidant has been added is washed with or exposed to water, particularly slightly alkaline water.
2. Many anti-oxidants have strong chemical odors and flavors.
3. Most anti-oxidants either have color or develop color shortly after addition to the fat—especially in the presence of weak alkali.
4. Much more of a given anti-oxidant is required for the protection of highly unsaturated vegetable oils than for the protection of lard or other animal fats.
5. Many of the known anti-oxidants are either poisonous or have unknown physiological effects.

The development of rancidity of fats after they have been incorporated into products of manufacture containing them is probably a greater source of annoyance than the development of rancidity in the fat itself during storage or marketing. Therefore, a successful anti-oxidant for edible fats must stabilize the fat after it is incorporated into products, such as crackers or other bakery products, that remain on the grocer's shelf during merchandising periods. After an examination of the known chemical anti-oxidants, we turned to some natural sources.

Pharmaceutical preparations of lard stabilized with gum benzoin have been known and prepared for many years. Gum benzoin is not sufficiently effective, however, to permit its use in food products, as appreciable quantities of gum benzoin impart an unpleasant, resinous odor to lard. We have tested, in addition to gum benzoin, many other natural gums and resins. Among those giving positive protection was gum guaiac, which proved successful not only in dry fats. but also in the presence of water, and in

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[2]Engler, C., and Wild, W.—Ber. *30* 1669 (1897).
[3]Bach, A.—Compt. Rend. *124* 951 (1897).
[4]Milas, N. A.—J. Phys. Chemi. *33* 1204 (1929).
[5]Greenbank, G. R., and Holm, G. E.—Ind. & Eng. Chem. *17* 625 (1925).
[6]Taffel, A., and Revis, G.—J. Soc. Chem. Ind. 1931—87-91 T.
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[8]Wheeler, D. H.—Oil and Soap, *9* : 89 (1932).

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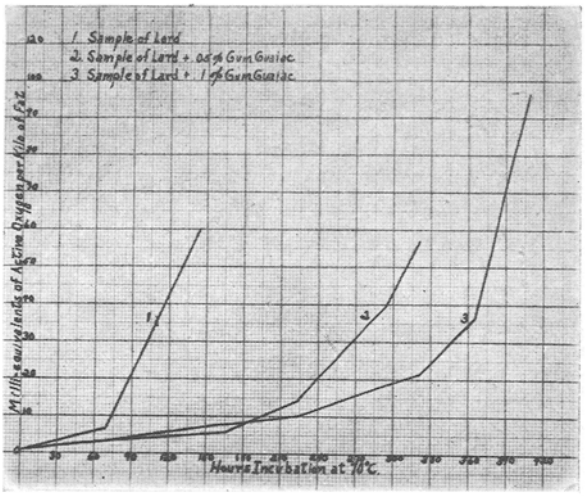

bakery goods. The effectiveness of gum guaiac in bakery goods is so pronounced in comparison with all other anti-oxidants we have tried that it deserves a special report. To illustrate: .05 to .1% of pyrogallol added to fresh, dry lard preserves it almost indefinitely under ordinary storage conditions, but if this same lard containing pyrogallol is made into a pie crust or crackers, it is not stabilized to any appreciable extent beyond the natural stability of the lard itself. The same amount of gum guaiac in dry lard will retard the development of rancidity for a period three to five times as long as required for untreated lard to become rancid, and the stabilizing effect is equally manifest after the lard is made into bakery products, as the following data will indicate:

TABLE I

Incubation at 70° C.
Sample of lard, —1.
Sample of lard + .05% gum guaiac, —2.
Sample of lard + .1% gum guaiac, —3.

Hours Incubation at 70° C.	Milli-Equivalents of Active Oxygen per Kilo of Fat 1	2	3
0	1.0	1.0	1.0
65	6 0	..	..
70	8.0	3.0	3.0
93	*26.0	..	..
142	60.0	5.0	7.0
165	..	6.0	8.0
220	..	14.0	10.0
240	..	14.0	13.0
289	..	*38.0	18.0
316	..	56.0	22.0
363	..	..	*36.0
405	..	..	94.0

*Faintly rancid.

Samples of gum guaiac were obtained from three different dealers and tested for their stabilizing action. The following data will indicate that gum guaiac is quite uniform in this respect:

TABLE II

Sample	Days Incubation at 70° C. to Become Faintly Rancid	Days Incubation at 70° C. to Become Strongly Rancid
Lard	3	5
Lard + .05% gum guaiac purchased from Source No. 1	11	12
Lard + .05% gum guaiac purchased from Source No. 2	11	12
Lard + .05% gum guaiac purchased from Source No. 3	11	12

TABLE III

Incubation at 35° C.
Lard Control—Rancid in 94 days, active oxygen 40.5.
Lard + .01% gum guaiac—Rancid in 168 days, active oxygen 90.0.
Lard + .1% gum guaiac—Not rancid in 538 days, active oxygen 30.0.

TABLE IV

Incubation of Pie Crusts at 70°

Sample	Days to Become Faintly Rancid	Days to Become Strongly Rancid
Control pie crust made of lard	1	2
Pie crust made of lard containing .1% gum guaiac	10	14
Control pie crust made of lard	1	2½
Pie crust made of lard containing .05% gum guaiac	4	5
Control crackers made of lard	2	3
Crackers made of lard containing .1% gum guaiac	8	9

TABLE V

Incubation of Crackers and Pie Crusts at 35° C.

Sample	Days to Become Faintly Rancid	Days to Become Strongly Rancid
Control pie crust made of lard	7	9
Pie crust made of lard containing .05% gum guaiac	55	65
Control pie crust made of lard	14	17
Pie crust made of lard containing .1% gum guaiac	330	360
Control crackers made of lard	28	37
Crackers made of lard containing .1% gum guaiac	196	..

While many anti-oxidants, such as the polyphenols and the amino phenols, are so enormously effective in lard and beef fats, we find them quite ineffective when used in the same proportions in cottonseed oil or other highly unsaturated oils. Much higher proportions of any anti-oxidant must be used to protect cottonseed oil from auto-oxidation than in the case of lard. Gum guaiac is no exception to these observations, and has been found to be too ineffective to be of much value as an anti-oxidant for cottonseed oil protection.

A non-poisonous anti-oxidant may be used to good advantage in several other products:

Cracklings

Cracklings are the tissues left after rendering lard by the dry rendering process. They contain from 80-85% protein and 10-20% fat and are valuable as food. The storage of cracklings from the season of maximum production to that of sale and consumption has been a difficult problem in that cracklings become rancid very quickly. Cracklings held at 35° C. usually become rancid in 20-30 days. Cracklings to which .05% gum guaiac has been added have been held at 35° C. for 565 days without a trace of rancidity developing.

Stock Foods

Dry stock foods containing fats are susceptible to rancidity. Gum guaiac has a pronounced effect on the rate at which stock foods become rancid. Samples of tankage containing no gum guaiac, .05% and .1% gum guaiac were incubated at 37° C. and examined after 112 days. The samples containing gum guaiac had a fresh odor, while the sample containing no gum guaiac smelled old and rancid.

Toxicity of Gum Guaiac

A review of the literature reveals that gum guaiac in the powdered form, or in solution in alcohol or in alkali, has been taken internally as remedies for such varied ailments as gout, rheumatism, syphilis, colds, etc. The medicinal use of gum guaiac has been quite largely abandoned, however, as its curative effects are questioned. No symptoms of poisoning by gum guaiac have been recorded. Complete toxicity studies are being made.