TABLE I
Variation in Bactericidal Activity of Pelargonic Acid

pH	Dilution	Time in Minutes		
		5	10	15
6	1: 500	—	—	—
	1: 1,000	+	+	+
5	1: 7,000	—	—	—
	1: 8,000	+	+	+
4	1: 11,000	—	—	—
	1: 12,000	+	+	+
3	1: 12,500	—	—	—
	1: 13,000	+	+	—
	1: 14,000	+	+	+
Phenol	1: 120	—	—	—
	1: 130	+	—	—
	1: 140	+	+	—
	1: 150	+	+	+

water-soluble and still possessed fair detergent properties.

The phenol coefficient of the acidic product had increased considerably. The actual value depended upon the pH of the test solution. Ten g. of the above oil was steam-distilled in the customary manner, and the oil obtained in the steam distillate was separated from the aqueous solution and dried. It had a b.p. of 250° C., and it gave a *p*-bromophenacyl ester melting at 66°C. At a pH of 4 it gave a phenol coefficient of 85 (see Fig. 1). Since pelargonic acid possessed identical physical constants (5), the active bactericidal principle in the polyethenoxy oleate ozonide was assumed to be pelargonic acid. In cases where the ozonide had been decomposed to carbonyl products, such as zinc dust, the bactericidal activity was considerably less.

Bactericidal Activity of Pelargonic Acid vs. pH. To 1 g. of pelargonic acid and 490 ml. of distilled water was added sufficient *N* sodium hydroxide solution to bring the pH to 9.5. The solution was diluted to 500 ml. with water, and from this stock solution further dilutions of sodium pelargonate were prepared (see Table I). Fifty-ml. fractions of each dilution were titrated separately with 20% aqueous acetic acid to pH values of from 3 to 6. In the actual phenol-coefficient test (6) 5 ml. of sodium pelargonate solution was placed in each test tube and the pH adjusted with 20% acetic acid from the data previously determined. The volume of acetic acid necessary to adjust the pH from 9.5 to from 3 to 6 was so small as to have a negligible effect on the concentration of pelargonic acid. The phenol coefficient tests were performed, using *Staphylococcus Aureus* as the test organism. The results of the bactericidal tests are recorded in Table I, and Figure 1 represents the phenol coefficient of pelargonic acid as a function of the acidity. Further results with other organisms are reported elsewhere (2).

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Yield and Chemical Composition of Sesame, Sesamum indicum L., as Affected by Variety and Location Grown[1]

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SESAME has been grown in the Eastern Hemisphere since time immemorial as a source of edible oil and nutritious protein food for human consumption. Sesame oil is noted for its excellent flavor and stability. The protein meal is especially rich in the amino acid methionine. Most of the sesame seed imported into the United States enters the confection and bakery trade as whole seed and is probably most familiar as a topping on hard rolls and French bread.

Budowski and Markley (2), in a review paper listing 258 references, discussed world production, imports into the United States, processing, and other topics as well as the chemical and physiologic properties of sesame oil. Swingle (9) prepared a library list of 216 references covering the literature on genetics, cultural practices, history of production, marketing statistics, chemistry, nutrition, and utilization of sesame and its derived products. More recent work with this species in the Western Hemisphere and India was reported at the First International Sesame Conference (7).

Sesame seed is well received by the oilseed processing industry of the United States. Sesame has not been grown on a commercial scale in this country because of the large amount of hand labor required in harvesting. In normal dehiscent (shattering) varieties the capsules open at maturity, and considerable care is required to prevent excessive loss of seed. It was only after the discovery of a single indehiscent plant by Langham (5) in 1943 that the complete mechanization of the crop became a possibility. The indehiscent character is under the control of a single recessive gene, but there must be several modifying genes. The future of sesame production in the United States is largely dependent upon the successful development of satisfactory indehiscent varieties. Breeding programs have been initiated, and progress is being made toward development of such varieties.

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The purpose of the investigations reported was to provide information of a preliminary nature relative to the area of adaptation of the crop, value of the strains tested as sources of germ plasm in the development of indehiscent varieties, the effect of variety and location on chemical composition of the seed, and interrelationships of the chemical measurements of the seed components which determine the economic value of sesame as an oilseed crop.

Materials and Methods

Twenty-four varieties of sesame were grown in the 1950 Regional Sesame Observation Nurseries at 23 locations in 16 states. Varieties were all of the dehiscent type and were derived from foreign introductions. Each variety was grown in a single unreplicated row 16 to 40 ft. long with 36 to 48 in. between rows. Data for various agronomic characters were obtained from most plantings, but only 14 locations reported reasonably complete yield data.

Seed samples were obtained from each variety at each location. Analyses of oil content, protein content, and iodine value of oil were obtained for each variety from College Station, Tex. On the basis of these analyses 8 varieties, representing the range in chemical composition, were chosen from 9 additional locations for chemical analyses. Seed samples were carefully cleaned to remove foreign material. Moisture and oil contents of the seed were determined by the methods proposed by Stark and Hoffpauir (8). For nitrogen and iodine value the methods of the American Oil Chemists' Society (1) were employed. As no standard moisture content for sesame seed has been established, the data are reported on the moisture-free basis. Protein content was determined by multiplying percentage of nitrogen by 6.25 and reported as percentage of crude protein. The factor of 6.25 was used because of its wide application for this purpose in protein foods and feeds, but it should be noted that the factor of 5.3 suggested by Jones (4) for conversion of sesame seed nitrogen to protein is probably more accurate.

Discussion of Experimental Results

Reasonably complete yield data were obtained from 14 locations. These data are presented in Table I. Data on other agronomic characteristics will not be presented here, but the varieties grown in these tests represent a wide range of types differing in maturity, height, degree of branching, and other characteristics. Mean seed yield of all varieties at all locations was 506 pounds per acre. Varietal means ranged from 331 to 724 pounds per acre, and location means ranged from 142 to 1,004 pounds per acre. Both variety and location grown appear to exert marked influence on yield. Considerable loss of seed, due to shattering, was reported from some locations; therefore actual production of seed was somewhat higher than the reported data indicate. Differences in yield attributable to both varieties and locations exceeded the 1% level of probability as measured by analysis of variance, using the "variety $\times$ location" interaction as the error term. No error term was available for testing the significance of the interaction since plantings were not replicated; this does not however invalidate the variety or location comparisons.

While a critical evaluation of yielding ability and adaptation of the varieties tested cannot be obtained for any given location from the results of these preliminary tests, some general observations may be warranted. Yields of the better varieties were satisfactory at most locations, and it does not seem unreasonable to assume that the species is adapted to most fertile, well-drained soils in the southern one-half of the United States. While some of the strains tested seem to be better adapted to the growing conditions encountered at certain locations than at other locations, the better strains appear rather widely adapted. This indicates the possibility of developing indehiscent varieties with either wide adaptation or adaptation to specific growing conditions.

Data for oil and protein contents of the seed and for iodine value of the oil for 24 varieties grown at College Station, Tex., are presented in Table II. The ranges in oil and protein contents were 18.09% and 10.56%, respectively, while that for iodine value of the oil was 7.8. Oil and protein content of the seed and iodine values of the oil for 8 varieties grown at 10 locations are presented in Tables III, IV, and V, respectively. Mean oil content for varieties exhibited a range of 8.11% and for locations a range of 5.95%.

TABLE I

Yield in Pounds per Acre of 24 Varieties of Sesame Grown at 14 Locations

Variety	College Station, Tex.	Clarkedale, Ark.	Stillwater, Okla.	Auburn, Ala.	State College, N.M.	Experiment, Ga.	Leesburg, Fla.	State College, Miss.	Gainesville, Fla.	Chillicothe, Tex.	Charlotte Courthouse, Va.	Yuma, Ariz.	Baton Rouge, La.	Columbia, Mo.	Mean
N 1119-3	1577	647	1058	681	792	1047	594	876	669	669	778	176	359	206	724
K 9	1405	545	611	864	990	946	759	589	567	668	384	407	457	223	672
K 10	883	916	557	864	660	1058	768	523	628	645	645	331	218	235	638
K 8	843	743	521	919	330	662	870	497	576	655	635	435	508	236	604
N 57	1079	519	741	715	752	532	524	680	350	665	615	281	296	160	565
N 1032-1-1	1199	835	804	613	317	541	660	687	539	362	416	335	273	227	558
SC 4521	815	446	1309	721	633	891	330	811	406	521	236	191	185	87	542
Y 7	1379	884	725	885	508	578	534	131	330	693	196	465	142	47	536
N 1037	1015	722	1058	728	317	363	589	687	558	355	303	313	374	105	535
SC 4516	933	832	992	749	825	260	467	366	519	601	108	252	368	31	522
Venezuela 51	1137	595	592	504	1122	347	524	425	520	273	328	245	385	107	507
N 1040	967	718	941	613	336	473	464	634	544	315	230	349	359	130	505
Y 3	1113	584	557	796	924	473	414	163	381	691	198	331	254	109	499
N 1025-3	987	805	760	565	310	562	450	621	531	312	269	270	384	90	494
SC 4520	1325	448	568	510	792	571	484	536	443	646	379	58	46	65	491
N 413	799	912	525	721	237	409	525	595	581	395	220	248	392	94	475
Y 6	899	569	768	796	422	379	594	327	322	587	171	364	207	123	466
SC 4522	977	555	866	585	305	909	397	497	406	498	53	166	147	53	458
N 406-61-3-12	747	872	549	442	482	366	335	419	353	367	684	306	170	239	452
Early Russian	820	1035	494	327	171	171	479	706	391	273	412	173	154	219	416
N 2346	1069	738	263	354	409	427	498	379	484	239	271	248	141	198	408
N 124-9-1-1	448	686	686	286	......	446	249	301	329	397	429	288	168	79	372
N 2345	661	743	392	476	607	203	373	157	544	83	143	295	234	202	365
N 68-1	979	517	341	476	264	357	287	209	306	139	273	194	138	150	331
Mean	1004	703	695	633	544	540	507	492	470	460	349	280	265	142	506

TABLE II

Oil Content, Iodine Value of Oil, and Protein Content of 24 Sesame Varieties Grown at College Station, Texas (Moisture-Free Basis)

Variety	Oil, %	Iodine value of oil	Protein, %
Y 6	63.38	109.7	25.75
Y 3	63.38	109.4	17.00
K 8	62.17	111.5	18.44
K 9	61.78	111.5	19.00
Y 7	61.62	110.6	25.69
SC 4521	61.49	110.7	19.75
K 10	61.42	110.2	19.31
SC 4516	60.38	110.4	20.31
SC 4520	60.12	112.4	19.75
N 68-1	57.87	110.0	24.50
N 1040	57.45	111.0	23.12
N 1032-1-1	57.44	111.3	23.38
N 1037	57.41	109.0	23.06
N 2345	57.16	109.4	24.88
N 1025-3	57.11	110.3	23.31
N 413	56.85	110.0	23.06
N 57	56.83	109.6	21.81
Early Russian	56.61	109.3	16.69
SC 4522	55.75	109.9	23.25
Venezuela 51	55.31	108.6	19.06
N 1119-3	55.29	109.6	24.50
N 2346	55.21	105.7	27.25
N 406-61-3-12	54.65	113.5	25.00
N 124-9-1-1	45.29	111.1	25.62
Mean	58.00	110.2	22.28

Mean protein content for varieties exhibited a range of 3.12% and for locations a range of 7.25%. Mean iodine values showed a range of 7.3 units for varieties and 9.2 units for locations. Analyses of variance indicated that differences in oil and protein content of the seed and iodine value of the oil attributable to both varieties and locations exceeded the 1% level of probability.

It was possible to compare seed yields, calculated oil, and protein yield and calculated protein content of the oil-free residue (protein-feed), remaining after oil had been extracted from the seed, for certain varieties at certain locations. Data for the variety N 124-9-1-1 were omitted because of its low oil content, which is partially due to the fact that its rough seed coat makes up a much larger than usual proportion of total seed weight, making this strain more of a genetic curiosity than a potential source of germ plasm. Data from Yuma, Ariz., were omitted because it was definitely known that bird damage was a major factor contributing to differential seed yields at that location. No data on seed yields were obtained from Manhattan, Kans. Since data on seed yield for a variety at a single location were subject to considerable unmeasurable error, only variety and location means were used to obtain the values presented in Table VI. Although it will be noted that these data are from those locations reporting highest seed yields, the varieties do represent most of the range in yielding ability; varieties and locations both represent most of the range for oil and protein content of the seed. Mean yields of seed, oil, and protein were 662, 344, and 163 pounds per acre, respectively. Mean protein content of the oil-free residue was 57.28%.

While considerable variation in chemical composition of the seed was apparent, all values (with the possible exception of oil content of the strain N 124-9-1-1) fell within the acceptable range. Several crops possessing much lower oil and protein content of the seed than sesame have found a place in the oilseed processing industry. In terms of yield of oil per acre, the over-all average yield of oil for seven varieties grown at eight locations was estimated at 344 pounds per acre (Table VI). Markley (6) reported average production for flaxseed, soybeans, peanuts, and cottonseed as 172, 170, 205, and 70 pounds of oil per acre, respectively. The range in iodine value of the oil reported here was 101.4 to 116.5. This property of the oil is of minor importance at the present time. The observed ranges in oil and protein content of the seed due to both varieties and locations suggest opportunities for improvement both from the standpoint of genotypic and environmental control.

The economic value of sesame seed is dependent upon its oil content and to a lesser degree upon its protein content. Value of the residue remaining after

TABLE III

Percentage of Oil of Eight Varieties of Sesame Grown at 10 Locations (Moisture-Free Basis)

Location	Variety: Y 6	SC 4520	K 10	Early Russian	N 2346	N 1119-3	Venezuela 51	N 124-9-1-1	Location mean
College Station, Tex	63.38	60.12	61.42	56.61	55.21	55.29	55.31	45.29	56.58
State College, Miss	56.17	56.55	57.08	55.84	57.11	58.17	55.83	47.20	55.49
Stillwater, Okla	58.44	57.74	57.35	56.22	55.05	54.94	54.28	48.91	55.37
Experiment, Ga	55.27	56.32	54.59	54.74	54.27	54.62	54.13	48.83	54.10
Clarkedale, Ark	55.01	56.55	55.67	55.26	55.61	54.20	53.09	47.05	54.06
Auburn, Ala	56.63	54.88	54.41	54.50	53.76	53.33	51.69	48.68	53.49
Manhattan, Kans	53.12	53.72	52.66	54.83	54.05	53.43	51.63	48.08	52.69
Leesburg, Fla	53.60	53.13	53.63	53.25	51.98	51.91	50.37	46.88	51.84
State College, N. M	51.50	52.44	51.30	50.89	50.07	49.29	49.39	....	50.70
Yuma, Ariz	51.39	50.75	51.98	54.90	52.02	49.33	49.53	45.15	50.63
Variety mean	55.45	55.22	55.01	54.70	53.91	53.45	52.53	47.34	53.53

TABLE IV

Percentage of Protein of Eight Varieties of Sesame Grown at 10 Locations (Moisture-Free Basis)

Location	Variety: N 2346	Venezuela 51	N 1119-3	N 124-9-1-1	K 10	Early Russian	Y 6	SC 4520	Location mean
State College, N. M	31.06	31.50	29.88	....	29 12	28.75	28.19	27.94	29.49
Leesburg, Fla	31.56	31.25	29.44	27.75	29.44	29.50	27.69	28.75	29.42
Yuma, Ariz	29.31	29.06	27.50	27.44	27.94	26.50	27.81	27.94	27.94
Manhattan, Kans	27.94	29.44	26.31	25.56	27.69	26.69	26.19	27.12	27.12
Auburn, Ala	28.25	29.75	26.44	25.81	25.75	26.00	23.88	26.25	26.52
Experiment, Ga	28.25	26.94	26.25	26.31	26.50	26.38	25.50	25.38	26.44
Stillwater, Okla	27.94	28.12	25.31	26.88	25.00	26.00	23.56	23.62	25.80
Clarkedale, Ark	26.25	27.50	24.44	25.69	24.88	25.62	24.88	22.75	25.25
State College, Miss	24.31	23.31	19.12	21.94	23.06	24.56	23.00	21.38	22.58
College Station, Tex	27.25	19.06	24.50	25.62	19.31	16.69	25.75	19.75	22.24
Variety mean	28.21	27.59	25.92	25.89	25.87	25.67	25.64	25.09	26.24

TABLE V

Iodine Value of Oil of Eight Varieties of Sesame Grown at 10 Locations

Location	N 2346	Early Russian	Y 6	N 1119-3	Venezuela 51	K 10	SC 4520	N 124-9-1-1	Location mean
	Variety								
State College, N. M.	102.4	103.1	103.5	103.4	106.1	106.0	105.5	....	104.3
Yuma, Ariz.	101.4	106.6	104.3	105.3	106.3	106.6	105.6	109.0	105.6
Leesburg, Fla.	105.7	107.0	108.3	107.6	109.2	109.3	109.3	112.5	108.6
College Station, Tex.	105.7	109.3	109.7	109.6	108.6	110.2	112.4	111.1	109.6
Manhattan, Kans.	107.0	110.2	109.6	110.6	111.0	111.3	112.5	114.0	110.8
Stillwater, Okla.	108.7	110.0	111.0	111.0	110.4	111.8	111.9	113.3	111.0
Auburn, Ala.	107.3	108.1	111.4	111.4	111.7	111.4	111.3	115.0	111.0
Experiment, Ga.	107.1	110.4	112.0	111.3	112.3	112.7	113.3	114.8	111.7
State College, Miss.	108.0	111.1	112.8	113.9	113.8	113.5	114.6	116.5	113.0
Clarkedale, Ark.	109.7	112.5	113.4	113.5	112.6	114.6	115.7	116.0	113.5
Variety mean	106.3	108.8	109.6	109.8	110.2	110.7	111.2	113.6	110.0

TABLE VI

Summary of Data on Yield of Seed, Oil, and Protein and of Protein Content of Oil-Free Residue for Seven Varieties of Sesame Grown at Eight Locations

	Yield in pounds per acre: Seed[a]	*Oil*[b]	*Protein*[b]	Protein content of oil-free residue, %[b]
Variety means				
N 1119-3	909	465	221	55.59
K 10	779	411	187	57.08
Venezuela 51	656	330	169	57.64
SC 4520	654	348	152	55.42
Y 6	594	318	143	58.08
Early Russian	525	273	127	55.98
N 2346	517	265	138	61.20
Location means				
College Station, Tex.	1101	611	228	52.38
Clarkedale, Ark.	706	368	168	56.03
State College, N. M.	624	298	174	59.80
Stillwater, Okla.	614	329	150	58.64
Auburn, Ala.	577	296	146	58.03
Experiment, Ga.	571	297	143	58.59
Leesburg, Fla.	563	281	159	62.50
State College, Miss.	539	290	116	52.32
Mean of all varieties at all locations				
	662	344	163	57.28

[a]Air-dry basis.
[b]Moisture-free basis.

oil extraction is largely dependent upon its protein content. Correlation coefficients, presented in Table VII, were calculated to indicate relationships among oil and protein content of the seed, protein content of the oil-free residue, and iodine value of the oil for seven varieties grown at 10 locations. Data for the strain N 124-9-1-1 were omitted from these calculations since it was believed to belong to a population entirely different from the others insofar as relationship of oil and protein components of the seed were concerned.

A negative relationship between protein and oil content of the seed is apparent and expected since the mean sum of these two varieties comprises approximately 80% of the total seed composition. Synthesis and storage of oil and protein in the seed may also be considered processes that compete for carbohydrates translocated to the developing seed. It appears that protein synthesis and storage was favored at the expense of oil synthesis and storage as the genetic constitution of the variety or environmental conditions resulted in an increased supply of nitrogen to the seed. Eaton and Ergle (3) made a similar suggestion on the basis of data obtained from the cotton plant. It is suggested that very high oil content of sesame seed such as that observed at College Station, Tex., is likely to be encountered only when nitrogen supply becomes a limiting factor in protein synthesis, particularly late in the season, while other environmental conditions remain favorable for high carbohydrate accumulation. Considering protein content of the seed the independent variable and oil content the dependent variable, the regression coefficient indicated that for each 1.0% average increase in protein content there was a corresponding 0.85% average decrease in oil content. Variability in protein content of the seed accounted for approximately 58% (r^2) of the variability in oil content.

Protein content of the oil-free residue is positively associated with protein content of the whole seed and negatively associated with oil content of the whole seed. While the correlation coefficient of protein content of the oil-free residue and oil content of the whole seed exceeds the 1% level of probability, it is too small to have much predictive value; only about 10% of the variability in protein content of the oil-free meal could be accounted for by variability in oil content. The correlation between percentage of oil in the whole seed and percentage *protein* in the oil-free residue is the result of the interaction of two relationships, one negative and one positive (*i.e.*, as oil content increases, the total protein per unit of whole seed weight decreases, but the weight of oil-free residue per unit of whole seed weight, upon which percentage protein on oil-free residue basis is calculated, also decreases). Thus a 1% average increase in oil content results in only a 0.18% average decrease in protein content of the oil-free residue.

TABLE VII

Correlation Between Various Pairs of the Chemical Measurements Made on Sesame Seed and the Components of Sesame Seed

Correlation between	Calculated r[a]
Percentage of oil and % protein in whole seed	−0.76
Percentage of oil in whole seed and iodine value of oil	0.58
Percentage of oil in whole seed and % protein in oil-free residue	−0.31
Percentage of protein in whole seed and iodine value of oil	−0.56
Percentage of protein in whole seed and % protein in oil-free residue	0.85

[a]All r values exceed the 1% level of probability.

Summary

Observation nurseries including 24 varieties of sesame were grown at 23 locations in 16 states. Data for yield, oil and protein content of the seed, and for iodine value of the oil were obtained from certain locations.

Sesame seems reasonably well adapted on the better soils of most of the southern one-half of the United States. Average seed yield for varieties at 14 locations was 506 pounds per acre. Average yield of seed, oil, and protein per acre for seven varieties grown at

eight locations was 662, 344, and 163 pounds per acre, respectively.

The chemical composition of the seed was found to be well within the acceptable range but was markedly influenced both by the varieties and by the locations where they were grown. The average oil and protein contents on a moisture-free basis were 53.53% and 26.25%, respectively. The average iodine value of the oil was 110.0. Average protein content on the moisture- and oil-free basis was 57.28%.

The genetic and environmental influences that affect protein content of the seed also inversely affected the oil content. It was suggested that in sesame protein synthesis is favored over oil synthesis as the nitrogen supply to the seed increases.

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Behavior of Antioxidants During the Baking and Storage of Pie Crust

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A previous study on the behavior of propyl gallate and butylated hydroxyanisole in lard stored at 61°C. (6) has been extended to include a study of these and other antioxidants in pie crust stored at 61°C. Previous work in this field has been conducted by means of static experiments, that is, the time, under given conditions, for the baked material to develop organoleptic rancidity or for the fat fraction to attain a given peroxide value.

The present study involved the addition of a number of antioxidant combinations to lard employed in the preparation of pie crust. The keeping quality of the pie crust and the content of added antioxidants were determined periodically by extracting the fat from a portion of the pie crust and analyzing it for the added antioxidants and for peroxide value.

Preparation and Storage of Pie Crust

Mixing of Dough. A dough consisting of 100 parts flour, 60 parts lard, and 50 parts water was employed. Commercial pastry flour (not enriched), fresh steam-rendered lard and distilled water were used. No sodium chloride was added because it has been demonstrated that this material may function as a prooxidant due to the traces of other metals it may contain (1).

The antioxidants and/or acidic synergists were dissolved in a few drops of propylene glycol and thoroughly mixed into the lard at 45°C. The lard was cooled rapidly to 18°C. and employed in the preparation of dough.

The flour and lard were cooled to approximately 18°C., and the lard was creamed with half of the flour. The remainder of the flour was then mixed with the creamed portion, followed by the water, also at 18°C., which was mixed in lightly.

Baking of Pie Crust. The dough was spread, ¼ in. thick in rectangular aluminum trays (11 in. x 10 in. x ⅜ in.) and baked in a 205°C. oven until lightly browned. To avoid scorching of the pie crust near the edge of the trays, the turned-up edge was only ⅜ in. high because this edge served as an additional surface for heat absorption. Also the layer of dough was slightly thicker near the edge of the tray in order to utilize this additional heat input. In order to obtain reliable keeping times, uniformly baked pie crust is of the utmost importance.

Storage of Pie Crust. The pie crust was stored in a 61°C. oven. At intervals the fat from a portion of the pie crust was extracted and analyzed for added antioxidants and peroxide value.

Analytical Methods

Reagents. Light Petroleum (34-38°C.). Shake Skellysolve A (28-38°C.) with 1/10 of its volume of concentrated sulphuric acid for 2 to 3 minutes. Run off the acid layer and wash the light petroleum with water and dilute alkali until free of acid. Distill through an all-glass fractionating column and collect the 34 to 38°C. fraction.

Light Petroleum (60-100°C.). Distill Skellysolve H in all-glass apparatus.

Acetone. Distill in all-glass apparatus.

Sodium Carbonate. Prepare a 1% solution of anhydrous sodium carbonate in water.

Extraction of Fat from Dough or Pie Crust. Place 55 g. of dough or 45 g. of pie crust into a Waring Blendor. Add 150 ml. of 34 to 38°C. light petroleum, cover, and blend for 30 seconds. Transfer the contents of the Blendor to a 250-ml. centrifuge bottle, stopper, and centrifuge at 1,000 r.p.m. for 5 minutes. Decant the slightly turbid light petroleum phase into a double 15-cm. Whatman No. 54 filter and collect the filtrate in a 250-ml. flask. Remove the light petroleum under reduced pressure, employing a water pump while warming the flask in a 40°C. water bath. Remove the last traces of light petroleum with a vacuum pump. This extraction procedure recovered approximately 90% of the fat in dough and 85% of that in pie crust.

Analysis of Antioxidants. The extracted fat was analyzed for one or more of the following antioxidants, propyl gallate, total butylated hydroxyanisole (BHA), 2-tert-butyl-4-hydroxyanisole (2-BHA), 3-