The increase in triglycerides, though small, is significant at a level of $p < 0.05$. This is paralleled by an increase in the incorporation of glucose-^{14}C into glyceride–glycerol. Hence, it can be concluded that animals exposed to a single oral dose of dieldrin for 24 hr exhibit only a tendency to accumulate fat. It is likely that with continual exposure to the insecticide for long periods of time fatty changes in the liver would tend to become more severe. This facet of metabolism merits further investigation.

ACKNOWLEDGMENT

We extend our sincere gratitude to R. Ramanathan for the help during enzyme assays, C. K. Gupta and S. Gambhir for the statistical analysis, S. C. Sharma for the help and suggestions during the course of this work, and Shell Chemical Company, Rotterdam, for the generous gift of dieldrin.

LITERATURE CITED

Abraham, S., Matthes, K. J., Chaikoff, I. L., *J. Biol. Chem.* **235**, 2551 (1960).
Abramson, D., Blecher, M., *J. Lipid Res.* **5**, 628 (1964).
Bartlett, G. R., *J. Biol. Chem.* **234**, 466 (1959).
Bhatia, S. C., Sharma, S. C., Damodaran, V. N., Venkitasubramanian, T. A., *Indian J. Biochem. Biophys.* **8**, 57 (1971).
Bhatia, S. C., Sharma, S. C., Venkitasubramanian T. A., *Arch. Environ. Health* **24**, 369 (1972a).
Bhatia, S. C., Sharma, S. C., Venkitasubramanian, T. A., *Brit. J. Exp. Pathol.* in press (1972b).
Bhatia, S. C., Metabolic studies on the effect of dieldrin, Ph.D. Thesis, Delhi University, 1972.
Deamer, D. W., Kruger, F. A., Cornwell, D. G., *Biochem. Biophys. Acta* **97**, 147 (1965).
Entenman, C., *Methods Enzymol.* **3**, 299 (1957).
Fain, J. N., Scow, R. O., Chernick, S. S., *J. Biol. Chem.* **238**, 54 (1963).
Farber, E., *Advan. Lipid Res.* **5**, 119 (1967).
Folch, J., Lees, M., Stanley, G. H. S., *J. Biol. Chem.* **226**, 497 (1957).
Fredrickson, D. S., Robert, I. L., Robert, S. L., *N. Engl. J. Med.* **276**, 34 (1967).
Fritz, I. B., *Perspect. Biol. Med.* **10**, 643 (1967).
Good, C. A., Kramer, H., Somogyi, M., *J. Biol. Chem.* **100**, 485 (1933).
Hanel, H. K., Dam, H., *Acta Chem. Scand.* **9**, 677 (1955).
Isselbacher, K. J., Greenberger, N. J., *N. Engl. J. Med.* **270**, 402 (1964).
Judah, J. D., McLean, A. E. M., McLean, E. K., *Amer. J. Med.* **49**, 609 (1970).
Kennedy, E. P., *Fed. Proc.* **20**, 934 (1961).
Lieber, C. S., *Annu. Rev. Med.* **18**, 35 (1967).
Lombardi, B., *Lab. Invest.* **15**, 1 (1966).
Lowry, O. H., Rosebrough, N. J., Farr, A. L., Randall, R. J., *J. Biol. Chem.* **193**, 265 (1951).
Marinetti, G. V., *J. Lipid Res.* **3**, 1 (1962).
Misra, U. K., *Can. J. Biochem.* **46**, 697 (1968).
Montgomery, R., *Arch. Biochem. Biophys.* **67**, 378 (1957).
Nikkila, E. A., Ojala, K., *Life Sci.* **4**, 937 (1965).
Schwabe, U., *Arch. Exp. Pathol. Pharmakol.* **249**, 195 (1964).
Stein, Y., Shapiro, B., *Biochim. Biophys. Acta* **24**, 197 (1957).
Steinberg, D., "The control of lipid metabolism," Grant, J. K., Ed., Academic Press, London, 1963, p 111.
Street, J. C., *Ann. N.Y. Acad. Sci.* **160**, 369 (1969).
Vagelos, R., *Annu. Rev. Biochem.* **33**, 139 (1964).

Received for review March 24, 1972. Accepted May 31, 1972.

Influence of Herbicides as Single Applications or Mixtures on Fatty Acid Composition of Cottonseed Oil

R. E. Wilkinson* and W. S. Hardcastle

Cottonseed (*Gossypium hirsutum* L. cv Atlas 67) oil composition from crops treated with 13 herbicides representing eight families of compounds was analyzed by gas–liquid chromatography. Minor changes in cottonseed oil fatty acid composition were caused by herbicide applications. However, none of the herbicides caused changes in the composition of cottonseed oil as large as were produced by season, edaphic characteristics, or location.

Current cotton (*Gossypium hirsutum* L.) production practices utilize several herbicides during the growing season. Due to the selectivity patterns of individual herbicides, use of several herbicides is often required to control a broad weed spectrum. Therefore, concomitant application of herbicides as mixtures often offers means of reducing machinery field time and the utilization of pesticides, giving a broad spectrum of weed control. Occasionally, when herbicides are applied as single-tank mixtures, reduced rates of the individual herbicides in a mixture result in weed control equivalent to higher rates of each herbicide independently. A continuous search goes on for new herbicides or improved application methods for established herbicides. Consequently, efficacy of herbicide mixtures or new compounds continues to be a major question on cotton production.

University of Georgia Agriculture Experiment Stations, Georgia Station, Experiment, Georgia 30212.

However, influence of herbicide mixtures or new compounds on crop quality and quantity are separate questions from herbicide efficacy. Increased crop yield resulting from herbicide applications would be of little consequence if the quality of the crop were adversely affected. Wilkinson and Hardcastle (1971) reported that individual applications of nine herbicides did not alter the fatty acid composition of cottonseed oil. Wilkinson and Hardcastle (1972) reported that the influence of eight sequential herbicide application patterns utilizing six commercial herbicides did not alter cottonseed oil composition. However, applications of herbicide mixtures could possibly cause a modification of cottonseed oil fatty acid composition not observed in single or sequential herbicide applications.

Therefore, combinations of established commercial herbicides and several promising new herbicides were applied to field-grown cotton. Values for cottonseed oil fatty acid composition are reported herein.

Table I. Soil Type, Location, and Year of Each Herbicide Application

Herbicide	Year	Soil type: Cecil[a]	Soil type: Cecil[b]	Soil type: Davidson[c]
Diuron	1968	X	X	
	1969	X	X	X
	1970		X	
Fluometuron	1968	X	X	
	1969	X	X	X
	1970		X	
Prometryne	1968		X	
	1969	X	X	X
	1970		X	
SD 16389	1978	X	X	
	1969	X		
SD 16391	1968	X	X	
	1969	X		
GS 14260	1968		X	
ER 5461	1969	X	X	X
	1970		X	
UC 22463	1968		X	
Chloropropham	1968	X	X	
	1969	X		
DCPA	1968	X	X	
	1969	X		
	1970		X	
BAS 40969	1968	X		
VCS 438	1969	X	X	X
	1970		X	
MBR 4400	1969	X	X	X
	1970		X	

[a] Cecil sandy clay loam, Experiment, Ga. [b] Cecil sandy clay loam, Eatonton, Ga. [c] Davidson sandy clay loam, Eatonton, Ga.

METHODS AND MATERIALS

Following land preparation and fertilization practices common to the area, cotton, variety Atlas 67, was planted on two soil types at two locations over a 3-year period. Soil types, locations, and year of production utilized for the individual experiments are shown in Table I. A plot sprayer (Futral, 1963) calibrated to deliver 187 l./ha total volume was used to make preemergence herbicide applications that were two rows wide (2 m) and 9.1 m long. Herbicides utilized are shown in Table II. Plot design was a randomized block with four replications. Cottonseed oil was extracted, methylated, and quantitated as previously described (Wilkinson and Hardcastle, 1971). The data were statistically analyzed on a randomized block design and the means were separated by the Duncan's multiple range technique (Le Clerg, 1957).

Table II. Common and Chemical Names for Herbicides Utilized

Common name	Chemical name
Diuron	3-(3,4-Dichlorophenyl)-1,1-dimethylurea
Fluometuron	1,1-Dimethyl-3-(α,α,α-trifluoro-*m*-tolyl)urea
Prometryne	2,4-Bis(isopropylamino)-6-(methylthio)-*s*-triazine
SD 16389	2-[4-(Ethylamino)-6-(methylthio)-*s*-triazin-2-yl-amino]-2-methyl propionitrile
SD 16391	2-[4-Isopropylamino-6-(methylthio)-*s*-triazin-2-yl-amino]-2-methyl propionitrile
GS 14260	2-*tert*-Butylamino-4-ethylamino-6-methylthio-*s*-triazine
ER 5461	*N*-*n*-Propyl-*N*-cyclopropylmethyl-4-trifluoromethyl-2,6-dinitroaniline
UC 22463	80% 3,4-dichlorobenzyl-*N*-methylcarbamate; 20% 2,3-dichlorobenzyl-*N*-methylcarbamate
Chloropropham	Isopropyl *m*-chlorocarbanilate
DCPA	Dimethyl tetrachloroterephthalate
BAS 40969	1-Phenyl-4-methoxy-5-iodine-pyridazone-(6) with 30% 5-bromo composition (I:Br = 1:3)
VCS	2-(3,4-Dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione
MBR 4400	Ethyl *N*-trifluoromethylsulfonyl-2,4-dichlorocarbanilate

RESULTS AND DISCUSSION

When diuron, fluometuron, or prometryne were tested alone or mixed with DCPA, two treatments resulted in statistically significant differences in oil quality from the untreated control (Table III). Prometryne (1.79 kg/ha) caused a significant increase in the concentration of linoleic acid and DCPA + diuron (8.96 + 0.84 kg/ha) also produced a significant increase in linoleic acid. These changes were 0.45

Table III. Influence of Herbicide Mixtures on Cottonseed Oil Composition

Herbicide	Rate, kg/ha	No. observations	Fatty acid composition, %: Myristic S[a]	Palmitic S	Palmitoleic U[b]	Stearic S	Oleic U	Linoleic U	Arachidic S	Linolenic U	Total: Saturated S	Total: Unsaturated U
Control		8	0.97ab[c]	24.19a	0.69a	2.25ab	16.57ab	55.09b	0.15a	0.05a	27.45a	72.55a
Diuron	1.56	8	0.92ab	23.71a	0.69a	2.32a	16.89ab	55.06b	0.22a	0.11a	27.19a	72.81a
Fluometuron	2.24	8	0.94ab	23.87a	0.69a	2.25ab	16.57ab	55.54b	0.20a	0.10a	27.24a	72.76a
Prometryne	1.79	8	0.87b	23.05a	0.66a	2.30a	15.90ab	56.84a	0.24a	0.10a	26.45a	73.55a
DCPA	11.20	8	0.96ab	23.95a	0.64a	2.27ab	16.94ab	55.01b	0.14a	0.09a	27.31a	72.69a
Chlorpropham	10.08	8	0.96ab	23.94a	0.82a	2.37a	17.01a	54.65b	0.21a	0.07a	27.49a	72.51a
DCPA + chlorpropham	5.60 3.36	8	1.00ab	23.99a	0.67a	2.29a	16.76ab	54.96b	0.17a	0.09a	27.51a	72.49a
DCPA + diuron	8.96 0.84	8	0.94ab	23.57a	0.76a	2.04b	15.44b	57.00a	0.17a	0.04a	26.71a	73.29a
DCPA + prometryne	8.96 1.68	8	1.02a	23.86a	0.76a	2.25ab	16.36ab	55.39b	0.21a	0.05a	27.12a	72.87a
Mean		72	0.96	23.79	0.71	2.26	16.50	55.50	0.19	0.08	27.16	72.84
Location[d] Ex		36	0.88b	23.49a	0.67a	2.19a	16.00a	56.57a	0.16a	0.04a	26.71b	73.29a
Ea		36	1.03a	24.09a	0.75a	2.33a	17.01a	54.44b	0.22a	0.12a	27.61a	72.39b
Retention time, min			1.4	2.3	2.8	4.1	4.7	6.0	7.7	8.1		

[a] S = saturated fatty acid. [b] U = unsaturated fatty acid. [c] Values in a column in a box followed by the same letter or letters are not significantly different at the 5% level. [d] Ex = Experiment, Ga.; Ea = Eatonton, Ga.

Table IV. Influence of Triazine Derivatives on Cottonseed Oil Quality as Compared to Registered Cotton Herbicides

			Fatty acid composition, %									
											Total	
Herbicide	Rate, kg/ha	No. obser- vations	Myristic S[a]	Palmitic S	Pal- mitoleic U[b]	Stearic S	Oleic U	Linoleic U	Arachidic S	Lino- lenic U	Saturated S	Unsat- urated U
Control		12	0.85ab[c]	22.99ab	0.62a	2.32bc	16.67a	55.93a	0.30ab	0.11a	26.47ab	73.53ab
Diuron	1.57	12	0.82ab	22.71b	0.64a	2.32bc	16.65a	56.16a	0.35a	0.14a	26.34ab	73.66ab
Fluometuron	2.24	12	0.79b	22.72b	0.64a	2.28c	16.50a	56.53a	0.25b	0.14a	26.06b	73.94a
SD 16391	1.12	12	0.88a	23.19a	0.67a	2.37abc	16.44a	55.96a	0.26b	0.11a	26.70a	73.30b
	2.24	12	0.88a	22.72b	0.67a	2.41ab	16.72a	55.96a	0.28ab	0.12a	26.31ab	73.69ab
	4.48	12	0.83ab	22.67b	0.68a	2.42ab	16.77a	56.00a	0.28ab	0.11a	26.16b	73.84a
SD 16389	1.12	12	0.81b	22.92ab	0.66a	2.32bc	16.48a	56.11a	0.36a	0.15a	26.39ab	73.61ab
	2.24	12	0.86ab	23.03ab	0.66a	2.36bc	16.51a	55.99a	0.31ab	0.13a	26.56ab	73.44ab
	4.48	12	0.82ab	22.72a	0.65a	2.47a	16.40a	56.44a	0.29ab	0.12a	26.30ab	73.70ab
Mean		118	0.84	22.85	0.66	2.36	16.57	56.12	0.30	0.13	26.36	73.64
Year	Location[d]											
1968	Ex	36	0.90b	22.89b	0.64a	2.56a	17.79a	54.34b	0.34a	0.25a	26.71b	73.29b
	Ea	36	0.97a	23.72a	0.68a	2.40b	16.84ab	54.99b	0.24a	0.11b	27.34a	72.66c
1969	Ex	36	0.65c	21.95c	0.65a	2.13c	15.09b	59.03a	0.31a	0.02c	25.05c	74.95a
Retention time, min			1.4	2.3	2.8	4.1	4.7	6.0	7.7	8.1		

[a] S = saturated fatty acid. [b] U = unsaturated fatty acid. [c] Values in a column in a box followed by the same letter or letters are not significantly different at the 5% level. [d] Ex = Experiment, Ga.; Ea = Eatonton, Ga.

Table V. Influence of Three Experimental Families of Herbicides Compounds on Cottonseed Oil Quality as Compared to Registered Cotton Herbicides

			Fatty acid composition, %									
											Total	
Herbicide	Rate, kg/ha	No. obser- vations	Myristic S[a]	Palmitic S	Pal- mitoleic U[b]	Stearic S	Oleic U	Linoleic U	Arachidic S	Linolenic U	Saturated S	Unsat- urated U
Control		16	0.73b[c]	22.69b	0.77ab	1.98abc	15.65a	57.87a	0.20ab	0.02ab	25.62b	74.38a
Diuron	1.57	16	0.81ab	22.56b	0.67ab	1.96abc	15.71a	58.00a	0.15b	0.02ab	25.49b	74.51a
Fluometuron	2.24	16	0.81ab	22.31b	0.77ab	1.95bc	15.47a	58.27a	0.31a	0.01b	25.38b	74.62a
ER 5461	1.12	16	0.91a	23.99a	0.74ab	2.06abc	15.39a	56.61b	0.20ab	0.06a	27.16a	72.84b
MBR 4400	2.24	16	0.77b	22.60b	0.77ab	2.07abc	15.66a	57.81a	0.20ab	0.02ab	25.61b	74.39a
	2.80	16	0.80ab	22.93b	0.76ab	1.94bc	15.41a	57.86a	0.19ab	0.01b	25.92b	74.07a
	3.36	16	0.79b	22.71b	0.74ab	2.17abc	15.51a	57.76a	0.21ab	0.03ab	25.87b	74.12a
	4.48	16	0.75b	22.32b	0.73ab	2.20a	15.71a	57.99a	0.17ab	0.00b	25.44b	74.56a
VCS 438	2.24	16	0.81ab	22.57b	0.59b	1.99abc	15.51a	58.26a	0.17ab	0.01b	25.54b	74.46a
	3.36	16	0.81ab	22.44b	0.70ab	1.92c	15.84a	58.01a	0.18ab	0.02ab	25.31b	74.69a
	4.48	16	0.83ab	22.56b	0.81a	2.18abc	15.66a	57.69a	0.12b	0.02ab	25.62b	74.38a
Mean		176	0.80	22.70	0.73	2.04	15.59	57.83	0.19	0.02	25.73	74.27
Year Soil	Location											
1969 Cecil[d]	Ex[e]	44	0.64c	22.70b	0.58b	2.05a	14.10b	59.69a	0.14bc	0.01b	25.54b	74.46a
Cecil	Ea	44	0.79b	22.37b	0.77a	2.10a	15.94a	57.67b	0.26ab	0.01b	25.56b	74.44a
Davidson	Ea	44	0.77b	21.85b	0.81a	2.07a	16.25a	57.84b	0.27a	0.01b	24.95b	75.04a
1970 Cecil	Ea	44	1.00a	23.87a	0.77a	1.92a	16.08a	56.12c	0.10c	0.05a	26.85a	73.15b
Retention time, min			1.4	2.3	2.8	4.1	4.7	6.0	7.7	8.1		

[a] S = saturated fatty acid. [b] U = unsaturated fatty acid. [c] Values in a column in a box followed by the same letter or letters are not significantly different at the 5% level. [d] Cecil and Davidson sandy clay loam. [e] Ex = Experiment, Ga.; Ea = Eatonton, Ga.

and 1.91% increases of linoleic acid over the untreated control. However, certain cottonseed oil components from plants grown at two different locations on the same soil type varied more than the samples taken from herbicide-treated plants (Table III). Thus, location appeared to have had a greater influence on the percentage composition of myristic, linoleic, and total saturated fatty acids than did the herbicides (Table III), and it must be concluded that these herbicides or mixtures did not materially alter cottonseed oil composition.

Application of the triazine-type herbicide SD 16389 at 4.48 kg/ha resulted in an increased concentration of stearic acid which was equivalent to a 0.10% increase over the untreated control (Table IV). However, in 1968, cotton grown at two different locations on the same soil type resulted in significantly different concentrations of myristic, palmitic, stearic, linoleic, total saturated, and total unsaturated acids (Table IV). Also, different growing seasons resulted in significantly different concentrations or myristic, palmitic, stearic, oleic, linoleic, total saturated, and total unsaturated acids (Table IV). Thus, location and growing season resulted in greater differences in cottonseed oil quality than herbicide applications.

The substituted dinitroaniline-type herbicide (*i.e.*, ER 5461) resulted in significant increases of myristic, palmitic, and total saturated acids over the untreated control and significant decreases of linoleic and total unsaturated acids (Table V). There was, again, a greater variation in cottonseed oil composition from cotton grown at different locations

Table VI. Influence of Soil Type, Location, and Season of Production on the Percentage Fatty Acid Composition of Cottonseed Oil

Herbicide	Rate, kg/ha	No. obser-vations	Year	Soil type[a]	Location[b]	Fatty acid composition, %								Total	
						Myristic S[c]	Palmitic S	Palmitoleic U[d]	Stearic S	Oleic U	Linoleic U	Arachidic U	Lin-olenic U	Saturated S	Unsaturated U
Control		4	1969	C	Ex	0.62def[e]	23.50a–g	0.75a–f	2.27ab	14.00e	58.47c–h	0.27b	0.00a	26.67a–f	73.32c–h
		4		D	Ea	0.77c–f	22.05c–h	0.82a–f	2.09abc	16.02a–e	57.95c–j	0.22b	0.00a	25.15b–h	74.85b–g
		4		C	Ea	0.72def	21.68fgh	0.75a–f	2.02a–d	16.22a–e	58.22c–j	0.22b	0.00a	24.65e–h	75.35a–d
		4	1970	C	Ea	0.80cde	23.55a–f	0.75a–f	1.50d	16.35a–e	56.82f–k	0.08a	0.08a	26.00b–g	74.00b–g
ER 5641	1.12	4	1969	C	Ex	0.75c–f	22.70b–h	0.70a–g	2.05abc	14.40de	59.02b–f	0.25b	0.00a	25.75b–h	74.25b–g
		4		D	Ea	107ab	25.27a	0.77a–f	2.07abc	16.37a–e	54.20kl	0.15b	0.05a	28.57a	71.42h
		4		C	Ea	0.75c–f	22.70b–h	0.70a–g	2.05abc	14.40de	59.04b–f	0.25b	0.07a	25.75b–h	74.25a–d
		4	1970	C	Ea	1.08ab	25.27a	0.78a–f	2.08abc	16.38a–d	54.20l	0.15b	0.05a	28.57a	71.42h

[a] C = Cecil sandy clay loam; D = Davidson sandy clay loam. [b] Ex = Experiment, Ga.; Ea = Eatonton, Ga. [c] S = saturated. [d] U = unsaturated. [e] Values in a column followed by the same letter or letters are not statistically different at the 5% level.

or in different growing seasons than were found to be present in seeds from herbicide-treated plants.

Seed fatty acid composition is normally considered to be responsive to temperature (Harris and James, 1969) but is not readily influenced by soil type (Anderson and Worthington, 1971). When the composite fatty acid composition data in Table V were examined by herbicide, soil type, and year, one compound exhibited an interesting soil type–herbicide interaction. Although there were no statistically significant differences in the cottonseed oil constituents of untreated cotton grown on Davidson and Cecil sandy clay loams at Eatonton, Ga., in 1969 which corroborates the work of Anderson and Worthington (1971), there were significant changes in the oil quality of cotton grown on these two soil types and treated with ER 5461 (Table VI). Myristic, palmitic, linoleic, total saturated, and total unsaturated acids were significantly different in cotton treated with ER 5461 and grown on these two soil types within a kilometer of each other. This soil type–herbicide interaction with a substituted aniline on seed oil composition corroborates previous observations of soil type–herbicide interactions with an analog of ER 5461 [*i.e.*, trifluralin (α,α,α-trifluoro-2,6-dinitro-*N*,*N*-dipropyl-*p*-toluidine)] (Thompson and Hardcastle, 1965). Additionally, these data show differences between growing seasons of production in cotton treated with the same herbicide on the same soil type at the same location. One other soil type–herbicide interaction was found. The application of diuron (1.16 kg/ha) caused an increase of oleic acid (1.33%) in cotton grown on Cecil sandy clay loam as compared to cotton grown on Davidson sandy clay loam. In neither treatment were the concentrations of oleic acid significantly different from the untreated control.

Three additional herbicides were tested for a single season. These were representatives of triazine, carbamate, and pyridazone types of herbicides. Neither BAS 40969 (3.36 and 5.60 kg/ha), UC 22463 (8.96 kg/ha), nor GS 14260 (1.68 kg/ha) caused major variations in cottonseed oil composition when compared to the untreated control or the standard registered cotton herbicides diuron or fluometuron.

These data conclude a series of experiments designed to measure the influence of herbicides on cottonseed oil fatty acid composition. Ten families of herbicidal compounds have been evaluated and several herbicide application methods have been examined. The influence of sequential herbicide applications utilized to give season-long weed control, tank mixtures applied concomitantly, or individual herbicides have not shown an alteration of cottonseed oil quality as great as the normal variation of cottonseed oil composition due to location of growth, soil type on which the crop was grown, or the season of production. Thus, it would appear that when applications of herbicides to cotton are restricted to registered compounds, rates, and methods, there is no major alteration of the quality of edible oils derived from cottonseed following treatment from these herbicides.

LITERATURE CITED

Anderson, O. E., Worthington, R. E., *Agron. J.* **63,** 566 (1971).
Futral, J. G., *Amer. Soc. Agr. Eng. Paper* **63,** 102 (1963).
Harris, P., James, A. T., *Biochem. J.* **112,** 325 (1969).
Le Clerg, E. L., U.S. Dept. Agr., Agr. Res. Serv. ARS-20-3 (1957).
Thompson, J. T., Hardcastle, W. S., *Proc. S. Weed Conf.* **18,** 79 (1965).
Wilkinson, R. E., Hardcastle, W. S., J. Agr. Food Chem. **19,** 851 (1971).
Wilkinson, R. E., Hardcastle, W. S., J. Agr. Food Chem. **20**(2), 293 (1972).

Received for review March 10, 1972. Accepted May 17, 1972.