CORN LIPIDS[1]

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ABSTRACT

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Corn oil is important as a commercial product for human nutrition and as a source of energy in livestock feed. The high quality of the oil is due to its high level of essential polyunsaturated fatty acids. Genetic modifications of oil content, fatty acid composition, and fatty acid placement in triglycerides are feasible in corn. Distinctive concentrations of lipid types and fatty acid compositions characterize the lipids from germ, endosperm, pericarp, tip cap, leaf and root. In addition to tissue specificity, each lipid class exhibits lipid specificity because each class, regardless of location, has particular fatty acid traits. The genotype of the plant also exerts some influence on the fatty acid composition of all lipids from all parts of the plant.

Corn is the most important crop in the United States, which produces nearly half of the world's corn. About 150 million metric tons or about 6 billion bushels are produced annually. Corn production is approximately three times wheat production and four times soybean production in the United States.

Average corn yields increased at an annual rate of 2 1/2 bu/A (1.6 q/ha) for 20 years (1). In 1975, Illinois led the nation in corn production with an average yield of 116 bu/A (73.6 q/ha), and one farmer in Illinois reportedly grew 338 bu/A (214 q/ha) for a new world record. The potential for continuing increases in corn yield certainly exists.

How do we use this bountiful corn crop? Domestic consumption in 1974 (Table I) amounted to 1,030 lb per person (2)—more than half a ton for each man, woman and child, and this did not include the 30% of the crop that was exported. In the United States, 90% of the corn crop was fed to livestock to produce meat, poultry, eggs, and dairy products. Only approximately 100 lb per person remained for industrial products, seed for replanting, and direct use in human food as in canned or frozen corn and corn on the cob. Wet millers used only about 7.5% of the total crop, and from this 75 lb per person, 3 lb of oil were extracted. Dry milling produced a little additional oil, but the amount of oil extracted from corn commercially was a small fraction of the total oil in the crop.

Because corn oil is high quality with about 60% polyunsaturates, the commercial oil commands a high price and is used mainly in food products. These include cooking oil, margarine, salad dressings, shortening, mayonnaise, potato chips, sauces, and soups. Corn oil also is used as a carrier for vitamins and other medicinals.

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CORN OIL QUANTITY

Breeders have selected for higher oil content in corn for many years. C. G. Hopkins started a classic plant breeding experiment at the University of Illinois in 1896 (3). After 70 generations of mass selection of ears with highest oil contents, the oil in the Illinois High Oil line increased from 4.7 to 17%. This experiment established that oil content is heritable in corn, but with selection only for oil, the yield of the line fell to about 30% of that of commercial hybrids.

Application of wide-line nuclear magnetic resonance spectroscopy to nondestructive analysis of oil content in single corn kernels (4–6) made selection for higher oil content more efficient. Selections made for oil content and yield produced hybrids with 6–8.5% oil content and grain yields equal to those of good commercial hybrids (7).

Since oil has 2.25 times more calories per unit weight than starch, increasing the oil content of corn should increase its energy value. Because corn is largely fed to livestock, an increase in energy value is desirable. Animal feeding experiments with high oil corn, however, produced variable results (6,8). Carefully controlled pig feeding experiments (8) with a higher oil corn (8% oil) increased feed efficiency and reduced the protein supplement needed. The higher oil corns have increased germ size and tend to have slightly higher levels of protein. The quality of the germ protein also is better than that of the zein from the endosperm.

Higher oil corn also should be profitable in corn milling, because corn oil is in strong demand and has the highest value per unit weight of any fraction of the corn kernel. The recent introduction of infrared grain analyzers that quickly determine corn oil concentration (9) may encourage farmers to grow higher oil hybrids. The analyzer could measure oil content at the grain elevator, and a premium price could be paid for higher than normal oil values.

CORN OIL QUALITY

The high quality of corn oil has traditionally been attributed to its high content of diunsaturated linoleic acid (18:2, Table II). Corn oil's advantage over soybean

TABLE I
Domestic Corn Consumption in 1974[a]

Use	lb/Person	
Meat, poultry, eggs, etc. (~ 200 lb)	900	
Wet milling industry	75	
Formula feeds		24
Starch		12
Corn syrups, dextrose, dextrins		36
Corn oil		3
Dry milling and cereal industries	12	
Canned corn	6	
Corn on the cob	7	
Frozen corn	1	
Seed for replanting, industrial products, etc.	29	
Total consumption per person	1,030	

[a] Data from Liebenow (2).

oil is that it contains a lower level of the triunsaturated linolenic acid (18:3), which is highly subject to oxidation.

Commercial seed corn producers usually do not monitor the fatty acid composition of the hybrids they sell, and some evidence exists that the level of polyunsaturation in corn oil may be rising. A commercial processing company sampled oil from midwestern corn in 1964 and in 1968 (10,12). In each sampling period, the composition of the corn oil was relatively uniform, but from 1964 to 1968 the linoleic percentage changed from 58.7 to 61.9. We analyzed a commercial corn oil three years ago and again this year, and the level of linoleic acid was 2.7% higher this year. Evidence that introduction of new hybrids may have brought about these increases is shown in Table III. The level of linoleic acid was determined in the inbred lines of corn that have been released by public institutions and are widely used by commercial breeders. In 1964, Oh43 and C103 were the most widely used lines, and C103 had only 43% linoleic acid. In 1970, B37 with 60% linoleic acid was involved in 26% of the total seed produced. W64A

TABLE II
Fatty Acid Composition of Commercial Oils and Fats Before Hydrogenation[a]

	Fatty Acid Composition (wt %)				
Oil	**16:0[b]**	**18:0**	**18:1**	**18:2**	**18:3**
Corn	11.1	2.0	24.1	61.9	0.8
Soybean	10.5	3.2	22.3	54.5	8.3
Cottonseed	25.0	2.8	17.1	52.7	...[c]
Peanut	11.0	2.3	51.0	30.9	...
Palm	46.8	3.8	37.6	10.0	...
Lard	27.0	13.5	43.5	10.5	0.5

[a] Data from Reiners and Gooding (10) and Weiss (11).

[b] Fatty acids are identified according to number of carbon atoms and number of double bonds—palmitic (16:0), stearic (18:0), oleic (18:1), linoleic (18:2), and linolenic (18:3).

[c] No values reported.

TABLE III
Polyunsaturated Fatty Acid in Inbred Corn Used as Parental Sources for Hybrid Seed

	% of Total Seed[a]			
Line	**1964**	**1970**	**1975**	**Linoleic Acid wt %**
A632	0.0	7.4	15.2	66.6
Mo17	0.0	1.8	7.0	67.7
B37	2.0	25.7	6.8	60.2
A619	...	3.5	4.2	65.2
W64A	0.9	13.0	1.5	63.1
Oh43	15.7	11.7	0.9	66.0
C103	11.9	4.2	0.3	43.1

[a] Based on data from Sprague (13) and Zuber (14).

with 63% linoleic and Oh43 with 66% also were widely used as parental sources. In 1975, A632 with 67% linoleic acid and Mo17 with 68% were used in 22% of the hybrid seed. The trend appears to be toward higher levels of polyunsaturation in corn, not by design, but through selection for other agronomic qualities.

Selection for a desired fatty acid composition in corn oil should be possible. A great diversity exists in fatty acid composition among corn lines, particularly in oleic and linoleic acid levels. Jellum (15) surveyed a large number of U.S. and foreign lines and found 14–64% ranges for oleic acid (18:1) and 19–71% ranges for linoleic acid. These two fatty acids usually make up 80–90% of the fatty acids in corn oil and negatively correlate with each other (15,16). The first investigation of the inheritance of oleic and linoleic acids in corn involved crosses between related inbreds and indicated a dominant gene for high oleic and low linoleic (17). Later studies of unrelated lines (18,19) suggested more complicated inheritance patterns, but the levels of oleic and linoleic acids in corn oil are highly heritable, and the fatty acid composition of a hybrid can be predicted fairly accurately by analyzing the fatty acid contents of the parents and assuming an equal contribution from each parent (20). Genotypic factors have a much greater influence on fatty acid composition of corn oil than do environmental factors such as temperature, planting date or fertilization (21,22).

Several studies (6,16) indicate a weak but significant negative correlation between oil content and linoleic acid percentage, but higher oil hybrids (5.6–7.7% oil) have been developed that have commercially acceptable yields and levels of polyunsaturation (52–62% linoleic acid) (7).

Reduction in polyunsaturation may be desirable if higher oil corns are fed to pigs. The higher oil corns increase the level of linoleic acid in the fat (8). When 7% oil with 52% linoleic acid was fed, the backfat thickness did not increase, and meat packers judged the carcasses acceptable for conventional processing. When a normal corn diet was supplemented with 12% corn oil for a total of 16% oil with a linoleic acid level of 60%, the carcasses were soft, oily, and unsatisfactory for commercial processing.

Ability to alter the fatty acid composition of vegetable oils also may be important in improving human diets, although nutritionists have not determined optimum levels of unsaturated and saturated dietary fats. Concern has been expressed about possible health hazards of the *trans* fatty acids formed during hydrogenation of vegetable oils (23–27). A more saturated oil would reduce the hydrogenation required.

Nonpolar and Polar Lipids of Kernels

The nonpolar fraction in corn oil is the larger fraction, and it is composed mainly of triglycerides. For example, 60 days after pollination in the inbred H51, the average dry weight of the seed was 230 mg, and total lipids accounted for 4.3% of the dry weight. Of the total lipids, triglycerides made up 79%, sterols 4.5%, monoglycerides and diglycerides 3.9%, hydrocarbons-sterol esters 2.9%, free fatty acids 1%, and polar lipids 8.7% (28). The polar lipids were comprised of 66% phospholipids and 34% glycolipids. The relative proportions of the individual phospholipids and glycolipids (Table IV) were determined by phosphorus analysis of the phospholipids and sugar analysis of the glycolipids (29). Phosphatidylcholine was by far the predominant phospholipid at 64% of the total phospholipids. Phosphatidylinositol and phosphatidylethanolamine represented 10.8 and 7.4%, respectively. The major glycolipids were digalactosyldiglyceride, sulfolipid, and monogalactosyldiglyceride.

The fatty acid compositions of the triglycerides and phospholipids from

TABLE IV
Phospholipids and Glycolipids of Mature Corn Kernels of Inbred H51[a]

Phospholipid	% of Total Lipid P	Glycolipid	% of Total Lipid Sugar
Phosphatidylcholine	63.8	Digalactosyldiglyceride	27.3
Phosphatidylinositol	10.8	Sulfolipid[b]	24.5
Diphosphatidylglycerol[b]	8.4	Monogalactosyldiglyceride	18.6
Phosphatidylethanolamine	7.4	Cerebrosides[b]	10.9
Lysophosphatidylcholine	7.1	Steryl glycoside ester	9.1
Phosphatidic acid	1.6	Steryl glycoside	5.0
Phosphatidylglycerol	0.9		

[a] Based on data from Weber (29).

[b] Band scraped from thin-layer plate may contain other unidentified phospholipids or glycolipids.

TABLE V
Fatty Acid Composition of Triglycerides and Phospholipids From Mature Kernels of Four Corn Inbreds

		Fatty Acid Composition (mol %)				
Lipid	Inbred	16:0[a]	18:0	18:1	18:2	18:3
Triglyceride	H21	16.5	2.9	37.4	42.2	1.0
	IHO	12.9	2.1	35.4	48.8	0.8
	K6	11.3	1.1	22.1	64.2	1.3
	NY16	7.4	1.6	20.1	69.6	1.3
Phosphatidylcholine	H21	20.0	1.5	42.1	36.0	0.5
	IHO	19.0	1.5	37.5	41.4	0.6
	K6	23.9	1.8	28.3	45.2	0.8
	NY16	18.6	2.2	25.8	52.3	1.1
Phosphatidylinositol	H21	42.1	2.6	18.7	35.6	1.0
	IHO	39.5	2.2	20.6	37.4	0.3
	K6	40.2	1.9	12.3	44.1	1.5
	NY16	38.3	2.2	12.8	45.8	1.0
Phosphatidylethanolamine	H21	20.8	0.8	23.5	54.2	0.7
	IHO	25.1	1.0	18.9	54.3	0.7
	K6	24.0	1.0	15.3	59.0	0.7
	NY16	20.6	1.9	18.1	58.3	1.0
Phosphatidylglycerol	H21	36.3	2.0	19.7	40.3	1.7
	IHO	36.7	2.7	23.6	36.6	0.5
	K6	35.5	2.5	15.6	42.6	3.8
	NY16	34.2	3.6	16.6	44.3	1.4

[a] Fatty acids are identified according to number of carbon atoms and number of double bonds—palmitic (16:0), stearic (18:0), oleic (18:1), linoleic (18:2), and linolenic (18:3).

mature kernels of four inbreds are shown in Table V. Each lipid class had a characteristic fatty acid pattern. The triglycerides had low percentages of saturated palmitic acid (16:0) and high percentages of polyunsaturated linoleic acid. The phosphatidylcholines had the highest levels of oleic acid. Of the phospholipids, the phosphatidylethanolamines had the highest percentages of linoleic acid. Both the phosphatidylinositols and phosphatidylglycerols had high percentages of saturated fatty acids, but the phosphatidylglycerols tended to have more oleic and less linoleic than the phosphatidylinositols.

The genotype of the inbred affected the fatty acid compositions of the triglycerides and also of the phospholipids (Table V). When the inbreds were ranked in the same order for each class of lipid, increasing levels of linoleic acid generally were noted. The range was much larger for the triglycerides, from 42.2% for H21 to 69.6% for NY16, but the differences also were apparent in each phospholipid class. This effect of genotype on phospholipids that are integral components of membranes may have important consequences. The composition of its membranes may influence a seed's ability to resist desiccation (30), cold temperatures (31,32), and insects (33).

Fatty Acid Placement in Triglycerides of Corn Oil

In the triglyceride molecule, three fatty acids are esterified to the hydroxyl groups of the trihydric alcohol glycerol. When corn triglycerides were stereospecifically analyzed (34), a nonrandom distribution of fatty acids among the three positions was clear (Table VI). The saturated palmitic and stearic fatty acids predominately were esterified at the outer 1- and 3-positions, but a higher percentage of saturated fatty acids was found in position 1 than in 3. The 2-

TABLE VI
Stereospecific Analyses of Triglycerides From Three Corn Inbreds and a Cross of Two of the Inbreds[a]

		Fatty Acid Distribution (mol %)				
Strain	Position	16:0[b]	18:0	18:1	18:2	18:3
H51	1	26.0	3.4	30.8	38.8	1.0
	2	1.5	0.1	26.8	70.6	1.0
	3	25.4	2.0	36.1	34.9	1.6
C103	1	22.4	4.2	41.2	31.7	0.5
	2	1.0	0.3	40.4	57.5	0.8
	3	14.2	2.1	47.5	35.6	0.6
C103 × NY16	1	21.3	3.2	30.4	44.3	0.8
	2	0.6	0.2	27.6	70.8	0.7
	3	9.0	1.5	38.4	50.1	1.0
NY16	1	15.6	3.9	21.4	57.8	1.3
	2	0.7	0.2	21.6	76.6	0.8
	3	7.0	1.6	19.2	70.6	1.6

[a] Data from Weber and colleagues (34) and de la Roche and colleagues (35).

[b] Fatty acids are identified according to number of carbon atoms and number of double bonds—palmitic (16:0), stearic (18:0), oleic (18:1), linoleic (18:2), and linolenic (18:3).

position contained the most linoleic acid. Over 98% of the fatty acids at the 2-position were unsaturated.

The distribution of fatty acids in the triglycerides differed for each inbred. For example (Table VI), in H51 and C103, the percentage of oleic acid was higher in position 3 than in 1, but in NY16, it was higher in 1. In H51, the level of linoleic acid was higher in 1 than in 3, whereas in the other two inbreds, it was higher in 3 than in 1.

Crosses of inbreds indicate some heritability of fatty acid placement within the triglyceride molecule (35,36). Table VI shows the fatty acid patterns of C103, NY16 and their cross, C103 × NY16. The percentages of the major fatty acids at each position of the triglycerides of the cross were intermediate to those of the parents.

The particular type of fatty acid at each position of the triglyceride is important for several practical reasons. First, the fatty acids in the outer positions of the triglyceride are more susceptible to oxidation (37–39) and hydrogenation (40) than the fatty acid in the 2-position. Second, animals largely incorporate in their lipids the fatty acids at the middle position of dietary triglycerides (41). During digestion of a triglyceride, pancreatic lipase cleaves the fatty acids from the outer positions, and the intestinal wall absorbs the resulting 2-monoglyceride. The free fatty acids are metabolized or reesterified. The fatty acid in the monoglyceride remains bound and is resynthesized into triglycerides or other lipids. If breeding could concentrate the saturated fatty acids at the outer positions of the triglycerides and the polyunsaturated fatty acids at the middle position, oxidation should be minimized and efficient dietary use of the essential polyunsaturated fatty acids ensured.

LIPIDS OF GERM, ENDOSPERM, LEAF AND ROOT

Study of lipids from various parts of the corn plant has begun. The kernel has been separated into germ, endosperm, pericarp, and tip cap fractions. Jellum (42,43) showed that germ, endosperm, and pericarp have different fatty acid compositions, but the amounts and types of lipids in these fractions have not been determined. The lipids of the endosperm and germ also are of interest because breeding corn for altered protein or carbohydrate biosynthesis may alter the lipids. Various endosperm mutants such as opaque-2, floury-2, waxy, sugary, and high amylose (44–46) affect the oil content and fatty acid composition of whole kernel corn. The genetic origin of kernel fractions differs. The genetic composition of the pericarp is similar to that of the maternal plant that produced the seed; the hereditary makeup of the endosperm is two-thirds maternal and one-third paternal, but the germ has equal inheritance from both parents.

An obvious reason for studying corn leaves is that some corn is used for silage, and little is known about the nutrient composition of the leaves. As food becomes scarcer, perhaps use of vegetative parts of plants will increase. A better understanding of the biochemistry of leaves and roots also may help us find ways to increase the plant's ability to store oil and other nutrients in the seed or to withstand stress such as drought or cold temperatures.

When the corn kernels were hand-dissected, the germ made up 10.8%, endosperm 82.4%, pericarp 6.1%, and tip cap 0.7% of the whole grain (Table VII). These proportions are similar to those reported by Earle and co-workers

(47) for seed from 11 hybrids. The total lipids were extracted with a mixture of chloroform, methanol, and water (28). All the lipid fractions were quantitated by gas chromatography of the methyl esters of the fatty acids containing methyl heptadecanoate as an internal standard (48). In the germ, the total lipids comprised 32.5% of the dry matter, which means that the germ contains

TABLE VII
Lipid Fractions From Corn Plant Parts of Inbred H51

Plant Part[a]	Dry wt (%)	% of Kernel	Total Lipids (% of dry wt)	Triglycerides (% of Total Lipids)	Polar Lipids (% of Total Lipids)
Kernel	94.9	...	4.3	82.4	3.2
Germ	...[b]	10.8	32.5	89.9	2.5
Endosperm	...	82.4	1.0	55.9	4.6
Pericarp	...	6.1	0.2	...	...
Tip cap	...	0.7	0.3	...	...
Root	18.9	...	0.3	11.3	63.1
Leaf	30.5	...	2.6	2.1	77.0

[a] Kernels were harvested 60 days after pollination of the ears. Leaf and root samples were collected 30 days after pollination.
[b] Not determined.

TABLE VIII
Fatty Acid Compositions of Lipid Fractions from Parts of Mature Corn Inbred H51

		Fatty Acid Composition (mol %)				
Lipid Fraction	Plant Part	16:0[a]	18:0	18:1	18:2	18:3
Total lipids	Kernel	17.7	1.2	29.9	50.0	1.2
	Germ	17.1	0.9	31.4	50.0	0.6
	Endosperm	20.4	1.9	24.2	50.0	3.5
	Pericarp	31.9	4.4	21.9	39.0	2.8
	Tip cap	38.2	5.7	22.0	32.5	1.6
	Root	24.9	7.9	7.6	51.9	7.7
	Leaf	15.8	0.8	1.1	13.1	69.2
Triglycerides	Kernel	16.1	1.5	31.7	49.6	1.1
	Germ	16.5	1.1	31.9	49.8	0.6
	Endosperm	17.0	3.3	30.1	46.3	3.3
	Root	18.1	8.2	27.8	38.3	7.6
	Leaf	14.5	1.9	3.8	29.9	49.9
Polar lipids	Kernel	23.8	0.8	29.7	44.6	1.1
	Germ	23.0	0.8	30.5	44.8	0.9
	Endosperm	22.8	1.8	29.7	43.4	2.3
	Root	26.8	4.3	3.3	58.0	7.6
	Leaf	14.3	0.7	0.8	10.7	73.5

[a] Fatty acids are identified according to number of carbon atoms and number of double bonds—palmitic (16:0), stearic (18:0), oleic (18:1), linoleic (18:2), and linolenic (18:3).

approximately 80% of the kernel lipids. The total lipids were fractionated on thin-layer plates with petroleum ether (bp 60–68°):diethyl ether:acetic acid (80:20:1, v/v/v). The major fraction of the germ (90% of the total lipids) was the triglyceride fraction. The polar lipids included only the glycolipids and the phospholipids, and of the total lipids in the germ, 2.5% were in the polar lipids fraction. The endosperm had a low content of total lipids, 1%. The endosperm also had a lower level of the storage lipids, triglycerides (56%), and a slightly higher level (4.6%) of polar lipids than germ. Free fatty acids constituted about 20% of the endosperm total lipids and 0.8% of the germ total lipids. The free fatty acids of the endosperm may be bound to the starch of the endosperm (49). The physiologic significance of these free fatty acids and their effect on the storage life of endosperm products are unknown.

Corn leaves and roots were harvested from mature plants 30 days after pollination of the ears. The chloroform-methanol-water extraction of the leaves and roots was preceded by a hot isopropanol extraction to inactivate the lipolytic enzymes that are active in these tissues. Total lipid content of roots (0.3%) and leaves (2.6%) was low. Phospholipids and glycolipids were the predominant lipids; they represented 63% of the total lipids in roots and 77% in leaves.

The fatty acid composition of the total lipids was unique to the part of the plant analyzed (Table VIII). The germ had high levels of oleic and linoleic acids. Endosperm lipids had slightly more saturated acids and less oleic acid than the germ lipids, but the most distinctive feature of endosperm lipids was the higher percentage of linolenic acid. This higher level of the triunsaturated acid may affect the shelf life of commercial products made from endosperm. The lipids from the pericarp and tip cap were highly saturated. In the roots, the percentages of palmitic and stearic acids were high. Root lipids also had 8% linolenic acid, which was higher than in any of the kernel fractions. Leaf lipids had 60% linolenic acid, reflecting the highly unsaturated glycolipids of the chloroplasts.

The fatty acid compositions of the triglycerides of the whole kernel and germ were similar to those of the total lipids because the triglycerides made up a large

TABLE IX
Fatty Acid Composition of Polar Lipids From Mature Leaves of Corn Inbred H51

Lipid	Fatty Acid Composition (mol %)					
	16:0[a]	trans-3[b] 16:1	18:0	18:1	18:2	18:3
Phosphatidylcholine	24.9	...[c]	2.0	3.4	32.1	37.6
Phosphatidylethanolamine	28.0	...	1.9	2.1	39.8	28.2
Phosphatidylinositol	48.9	...	2.2	1.6	16.2	31.1
Phosphatidylglycerol	38.6	22.1	1.2	3.6	12.1	22.4
Sulfolipid	34.8	...	1.9	1.0	10.0	52.3
Monogalactosyldiglyceride	0.9	...	0.1	0.4	3.2	95.4
Digalactosyldiglyceride	6.4	...	1.1	0.4	2.6	89.4

[a] Fatty acids are identified according to number of carbon atoms and number of double bonds—palmitic (16:0), stearic (18:0), oleic (18:1), linoleic (18:2), and linolenic (18:3).
[b] *trans*-3-hexadecenoic acid.
[c] Not detected.

proportion of the total lipids. Endosperm and root triglycerides had lower percentages of palmitic and linoleic acids and higher oleic acid than the total lipids. The leaf triglycerides differed the most from the triglycerides of the other plant parts because of their high content of linolenic acid (49.9%), although the level of linolenic acid in triglycerides was lower than that in the total lipids and polar lipids of the leaves. The polar lipids of the germ, endosperm and root had higher levels of the saturated palmitic acid than did the total lipids.

The individual phospholipid and glycolipid classes were isolated from the polar lipids of leaves. The fatty acid compositions of these lipids (Table IX) were very similar to those observed by Leech and colleagues (50) in seven day old corn leaves except that the percentages of linolenic acid were all higher, as might be expected in mature leaves with more chloroplasts. The *trans*-3-hexadecenoic acid (16:1) of phosphatidylglycerol, another indicator of chloroplast development, also increased. In addition to the tissue specificity evidenced by the high polyunsaturation of the lipids from leaves, a comparison with the phospholipids of the kernel (Table V) also indicates a lipid specificity for fatty acid composition. As in the kernel, leaf phosphatidylethanolamine had the highest linoleic acid level, and phosphatidylinositol and phosphatidylglycerol had higher percentages of saturated palmitic acid.

One reason for our original interest in leaf lipids was our hope that the triglycerides from young corn shoots would have a fatty acid composition similar to that of the oil in the grain. If so, differences in fatty acid composition could be analyzed earlier—in shoots—instead of waiting for the plant to grow and produce seed. Table X shows the results of analyses of triglycerides from the seed of three inbreds and of triglycerides from the green shoots eight days after planting. The three inbreds showed the same ranking in decreasing percentages of saturated acids and oleic acid and in increasing percentages of linoleic and linolenic acids for both the seed and the shoots. The genotype did affect the triglycerides of the seed and the leaves, but the differences in fatty acid composition were much smaller in shoots than in the seed. With the small differences in fatty acids and the low concentration of triglycerides in leaves, the use of shoots for fatty acid screening was considered impractical.

The fatty acid compositions of the lipids of the corn plant appear to be affected

TABLE X
Fatty Acid Composition of Triglycerides From Seed and Green Shoots

		Fatty Acid Composition (mol %)				
	Inbred	**16:0**[a]	**18:0**	**18:1**	**18:2**	**18:3**
Seed	IHO	12.2	1.0	36.7	49.4	0.7
	C103	13.8	1.5	32.5	51.2	1.0
	NY16	7.3	1.0	21.4	69.0	1.3
Green shoots	IHO	19.1	4.7	15.1	53.2	7.9
	C103	19.0	3.9	13.1	53.9	10.1
	NY16	17.7	3.4	11.5	55.4	12.0

[a] Fatty acids are identified according to number of carbon atoms and number of double bonds—palmitic (16:0), stearic (18:0), oleic (18:1), linoleic (18:2), and linolenic (18:3).

by several factors: First, the part of the plant in which the lipid is located greatly influences its fatty acid composition. This tissue specificity must be related to tissue function. Analyses of lipids from specific organelles such as chloroplasts, mitochondria, and microsomes may clarify the picture. Second, each lipid class has its own distinguishing fatty acid characteristics, regardless of location. This lipid class specificity may be related to the role of the lipid in membranes. Third, the genotype of the plant superimposes variations in fatty acid compositions on all the lipids.

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