Fatty acid desaturation in lung: inhibition by unsaturated fatty acids[1]

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Abstract The activity of the enzyme system involved in desaturation of palmitic and stearic acid has been examined in lungs of rats fed fat-free diets supplemented either with 4% safflower oil (controls) or 4% tripalmitin (essential fatty acid (EFA) deficient) both in vivo and in vitro in lung slices. Desaturation, as measured by appearance of ^{14}C-labeled monounsaturated fatty acid in pulmonary total lipid and phospholipids, was significantly greater in vivo and in vitro in lung tissue from EFA-deficient rats. In vitro preincubation of lung slices for 1 to 4 hr with 1 mM oleic, linoleic, or linolenic acid reduced the extent of desaturation of $[1-^{14}C]$-stearic acid significantly in both dietary groups, but the effect was greater in EFA-deficient tissues. The effect of linoleic acid was always greater than that of oleic acid. Preincubation with palmitic acid and 16,16-dimethyl PGE_2 was without effect. Thus: 1) EFA deficiency has been shown to enhance desaturation of palmitic and stearic acid in lung; 2) in vitro addition of linoleic or linolenic acid inhibited desaturation significantly; and 3) oleic acid was inhibitory but to a lesser and more variable extent. Palmitic acid was not inhibitory.—**Balint, J. A., E. C. Kyriakides, and D. A. Beeler.** Fatty acid desaturation in lung: inhibition by unsaturated fatty acids. *J. Lipid Res.* 1980. **21:** 868–873.

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We have demonstrated that in rats fed diets deficient in essential fatty acids (EFA) there is a decreased content of disaturated phosphatidylcholine in lung tissue and lung lavage material, while the content of total phosphatidylcholine (PC) is not altered (1). Refeeding a similar diet supplemented with 4% by weight of safflower oil, rich in linoleate, led to reversal of these changes in 3–7 days (1). The changes produced by EFA deficiency in lung PC fatty acid composition are similar to those seen in premature infants who are at a high risk for developing the respiratory distress syndrome (2–4). The alterations in lung PC induced by EFA deficiency are associated with impaired lung stability and reduced surface tension lowering ability of lung lavage PC (5).

Previous work by others has demonstrated that feeding of diets supplemented with linoleate reduces the activity of $\Delta9$ desaturase in liver (6, 7). Montgomery (8) has reported the presence of $\Delta9$ desaturase activity in lung microsomes, and showed that this activity was enhanced by feeding a fat-free diet for 4 days. The present experiments were therefore undertaken with two main objectives in mind: 1) to determine whether EFA deficiency was associated with increased activity of $\Delta9$ desaturase in lung tissue, and 2) to examine the effects of in vitro incubation of lung tissue with oleic, linoleic, or linolenic acids on the activity of this enzyme system.

METHODS AND MATERIALS

Animals

Weanling male Sprague-Dawley rats obtained from Blue Spruce Farms, Altamont, NY, were fed fat-free test diets (U.S. Biochemical Corp., Cleveland, OH, standard fat-free test diet), containing 58% by weight sucrose, 20% casein, salt mixture, and vitamins. For 16–20 weeks, control animals were fed this diet supplemented with 4% by weight of safflower oil, while experimental essential fatty acid-deficient rats received the same diet, but supplemented with 4% tripalmitin. Fat content of the diets was confirmed after lipid extraction by thin-layer chromatography (TLC) and gas–liquid chromatography (GLC). Rats were housed in pairs at constant temperature and humidity. They were allowed free access to food and water.

In order to examine the effect of EFA deficiency on desaturation of palmitic acid in vivo, 15 control and 17 EFA-deficient rats were each injected between 9–10 AM via the tail vein with 10 μCi $[1-^{14}C]$-

palmitic acid bound to albumin and killed in groups of three to five at 1, 4, 8, and 23 hr later. For measurements of in vitro desaturase activity in lung slices, rats were killed by exsanguination during ether anesthesia between 9 and 10 AM in the fed state. Lungs were perfused in situ with 18 ml 0.15 M NaCl solution via the right ventricle and pulmonary artery. Lung and liver slices, 50 μm thick from the tissue of two or three rats in each group for each experiment, were prepared using a Stadie-Riggs tissue slicer, and incubated as described below.

Incubations

Incubations were carried out in 3 ml of a modified Krebs-Ringer bicarbonate buffer (pH 7.4) containing albumin, amino acids, and glucose as described by O'Neil and Tierney (9). The buffer was gassed with 95% O_2 and 5% CO_2 before use. Albumin-bound [1-^{14}C]stearic acid, 3 μCi/3 ml, was used as substrate, and was incubated with the tissue slices for 1 hr unless otherwise specified. In some experiments the tissues were preincubated in buffer containing either: *1*) No additions, *2*) 1 mM non-radioactive palmitate, *3*) 1 mM oleate, *4*) 1 mM linoleate, *5*) 1 mM linolenate, all bound to albumin, *or* 6) 2 nM 16, 16-dimethyl prostaglandin E_2 (10) for 1, 2, or 4 hr. The tissues were then transferred to buffer containing [1-^{14}C]stearic acid for assay of desaturation. At the end of the incubation the tissues were rinsed carefully in buffer without additions prior to extraction in chloroform–methanol as described below.

Analytical procedures

Tissues were extracted in chloroform–methanol as previously described (11), and the chloroform phase was taken to dryness and lipids redissolved in chloroform. An aliquot of the lipid extract was used to prepare the methyl esters of the fatty acids of the total lipids (TL), using boron trifluoride (11). Another aliquot was used to determine the ^{14}C content of the total lipids as described below. Total phospholipids (PL) were separated from the remainder of the extract by TLC on silica gel plates (500 μm thick) using a solvent system of n-hexane–ethyl ether–acetic acid 120:30:3 (v:v:v). Methyl esters of the fatty acids of the PL fraction were prepared (11). Methyl esters of TL and PL were separated into saturated, monounsaturated, and polyunsaturated species by argentation chromatography on thin layers of silica gel using a solvent system of n-hexane–ethyl ether 175:30 (v:v). Bands were visualized with 0.2% dichlorofluorescein under ultraviolet light. Fatty acid composition of the methyl esters was confirmed by GLC using a Hewlett Packard 5830 gas chromatograph equipped with a 6 ft

× 2 mm (ID) column packed with 10% SP2330 on 100/120 mesh chromosorb (Supelco Inc., Bellefonte, PA). In some experiments the distribution of ^{14}C in the monounsaturated methyl esters was determined using a stream splitter set to give a 1:4 split. Radioactivity in the total extract, PL fraction, and methyl ester species was determined in a Beckman LS-250 liquid scintillation system using a toluene-based scintillant as previously described (11).

Essential fatty acid status of all animals was confirmed by GLC analysis of fatty acid methyl esters of the total lipids of liver extracts and was found to be as previously reported by us (1). Uptake of substrate fatty acid, was expressed as dpm of ^{14}C taken up per g of tissue per hr. The degree of desaturation was calculated as dpm of ^{14}C in monounsaturated species of fatty acid methyl esters expressed as the percentage of ^{14}C in total methyl esters. Statistical significance of differences between groups was tested using Student's "*t*" test for unpaired variables. Data are presented as mean ± S.D.

Chemicals

[1-^{14}C]Palmitate (58.5 μCi/μmol) and [1-^{14}C]stearate (56.6 μCi/μmol) were obtained from Amersham Corp., Arlington Heights, IL, and were stated to be 99% pure. Purity was confirmed by TLC and GLC. Oleic acid, obtained from Nu-Chek-Prep Inc., Elysian, MN, was stated to be of greater than 99% purity. Palmitic, linoleic, and linolenic acids with a stated purity of greater than 99% were purchased from Sigma Chemical Co., St. Louis, MO. The purity of all these fatty acids was confirmed by GLC. These fatty acids were used without further purification. Albumin (bovine, fraction V) was purchased from Sigma Chemical Co., St. Louis, MO. 16,16-dimethyl prostaglandin E_2 was a generous gift of Dr. John Pike of the Upjohn Company, Kalamazoo, MI.

RESULTS

Both control and EFA-deficient rats gained weight but, at the time of experimentation, the EFA-deficient rats weighed about 25% less than controls even though equal daily quantities of diet were consumed (18–20 g/rat).

Experiment 1 (Table 1)

After intravenous injection of 10 μCi of [1-^{14}C]-palmitic acid via the tail vein in control and EFA-deficient rats, the percentage of ^{14}C present in monounsaturated species of fatty acids both in liver and lung rose to a plateau after about 8 hr. In both tissues

TABLE 1. Percentage of ^{14}C in monoenoic fatty acids in lung and liver total lipids after intravenous administration of [1-^{14}C]palmitic acid to rats fed essential fatty acid-deficient (EFAD) or safflower oil-supplemented (control) diets

Time		Lung			Liver		
		Control	EFAD	P	Control	EFAD	P
(hr)			(% ^{14}C in monoenoic fatty acid, mean ± S.D.)				
1	TL[a]	2.6 ± 0.6 (4)[c]	4.8 ± 1.6 (5)[c]	<0.05	4.3 ± 1.2 (4)[c]	12.8 ± 2.1 (5)[c]	<0.001
4	TL	3.2 ± 0.5 (4)	8.2 ± 1.6 (5)	<0.001	6.4 ± 2.8 (4)	16.6 ± 2.0 (5)	<0.001
8	TL	4.2 ± 0.4 (3)	11.5 ± 1.5 (3)	<0.01	4.6 ± 1.1 (3)	20.7 ± 6.2 (3)	<0.025
23	TL	1.0 ± 0.5 (4)	11.1 ± 3.9 (4)	<0.01	4.5 ± 1.9 (4)	22.7 ± 5.2 (4)	<0.01
8	PC[b]	2.0 ± 1.1 (3)	9.4 ± 1.9 (3)	<0.01			

[a] TL, total lipids.
[b] PC, phosphatidylcholine separated by TLC.
[c] Number of rats in parentheses.

and at each time period the percentage of ^{14}C in monounsaturated fatty acids was greater by a factor of 2–5 in EFA-deficient animals than in controls. Similar observations were made when the fatty acids of lung phosphatidylcholine were analyzed. However, the degree of unsaturation was always greater in liver tissue than in lung. It was, therefore, possible that the unsaturated ^{14}C-labeled fatty acid recovered from lung could have been incorporated into the fatty acids of lung from circulating plasma lipids. We therefore proceeded to study desaturation by lung tissue in an in vitro system.

In a preliminary experiment, liver and lung slices were incubated with [1-^{14}C]palmitic acid for 15, 30, and 60 min. The percentage of ^{14}C recovered in monounsaturated fatty acids was again greater in tissues from EFA-deficient rats than from controls, with liver again being more active in this respect than lung. However, the percent desaturation in lung slices was rather small and, therefore, further experiments were performed using stearic acid as substrate. In another preliminary experiment using [1-^{14}C]stearic acid as substrate, the percentage of ^{14}C in the monoenoic fatty acids of the phospholipids was found to be 12.6 ± 2.2% in lung slices from EFA-deficient rats (three rats, seven flasks) after 30 min of incubation compared to 6.8 ± 2.0% in controls (three rats, seven flasks) ($P < .01$). After 1 hr of incubation in a similar number of experiments, the respective values were 13.8 ± 1.2% and 8.4 ± 1.9% of ^{14}C in monoenoic fatty acids ($P < .01$). In subsequent studies therefore, a 1-hr period of incubation with [1-^{14}C]-stearate was used.

Experiment 2 (Table 2A)

As shown in Table 2A, preincubation of lung slices from EFA-deficient rats with 1 mM linoleate for 1 hr resulted in a small but significant ($P < .05$) reduction in appearance of ^{14}C in monounsaturated fatty acids as compared with preincubation with buffer containing no added fatty acids (9.3 ± 0.2% versus 11.0

±1.0%). Preincubation with 1 mM oleic acid was without effect. When preincubation was carried out for 2 hr with oleic acid, a significant reduction in conversion of [^{14}C]stearic acid to monoenoic acids was noted (8.5 ± 0.9% versus 11.4 ± 0.6%, $P < .05$) in lung slices from EFA-deficient rats. Preincubation for 2 hr with 1 mM linoleic acid resulted in a greater reduction of desaturation to 7.3 ± 0.7% ($P < .01$). In lung slices from control rats, preincubation with oleic acid also resulted in a significant ($P < .05$) reduction in desaturation. In each case, however, desaturation in slices from EFA-deficient rats was greater than in tissue from controls ($P < .01$).

Experiment 3 (Table 2B)

It has been reported that the half life of the Δ9 desaturase enzyme system in liver is about 4 hr (12). Therefore, an experiment to compare the effects of preincubation of lung slices for 2 and 4 hr with and without addition of 1 mM linoleic acid was performed. As in previous experiments, the extent of desaturation of [1-^{14}C]stearic acid by lung slices from EFA-deficient rats greatly exceeded that observed in the tissues obtained from control rats under all experimental conditions ($P < .01$). Increasing the time of preincubation from 2 to 4 hr without linoleic acid resulted in a fall in desaturase activity, with the percentage of ^{14}C recovered in monoenoic fatty acids declining from 7.6 ± 0.8% to 6.3 ± 0.7% in controls, a decrease of 17%. In slices from EFA-deficient rats, the respective values were 15.0 ± 2.5% and 11.4 ± 2.0%, a decrease of 24%. With both control and EFA-deficient lung slices, preincubation with linoleic acid for both 2 and 4 hr resulted in significant reduction ($P < .01$) in the extent of desaturation as compared with the appropriate control experiments using preincubation without linoleic acid. Thus, although desaturase activity did decrease with time of incubation, the effect of preincubation with linoleate was not altered. In the slices from EFA-deficient rats, preincubation with linoleate resulted in a 39% reduction in the percent of ^{14}C

TABLE 2. Percentage of ^{14}C in monoenoic fatty acids of phospholipids: effect of preincubation of lung slices in medium containing various fatty acids or prostaglandin E_2 (di-me-PGE_2) on the conversion of [1-^{14}C]stearate to monounsaturated fatty acids (mean ± S.D.)

Preincubation Time	Addition	Control	EFA-Deficient	P
(hr)			(% ^{14}C in monoenoate)	
A. Experiment 2				
1	None		11.0 ± 1.0 (4)[a]	
1	1 mM oleate		10.6 ± 0.8 (4)	
1	1 mM linoleate		9.3 ± 0.2[b] (3)	
2	None	7.1 ± 0.4 (3)	11.4 ± 0.6 (4)	<0.01
2	1 mM oleate	5.7 ± 0.3[b] (3)	8.5 ± 0.9[b] (4)	<0.01
2	1 mM linoleate		7.3 ± 0.7[c] (6)	
B. Experiment 3				
2	None	7.6 ± 0.8 (6)	15.0 ± 2.5 (6)	<0.01
2	1 mM linoleate	6.3 ± 1.0 (6)	10.0 ± 1.4[c] (6)	<0.01
4	None	6.3 ± 0.7 (6)	11.4 ± 2.0 (6)	<0.01
4	1 mM linoleate	3.9 ± 0.5[c] (6)	7.0 ± 2.0[c] (6)	<0.01
C. Experiment 4				
2	None	9.8 ± 1.3 (9)	19.5 ± 1.2 (4)	<0.01
2	2 nM di-me-PGE_2	8.9 ± 1.0 (6)	19.2 ± 1.2 (6)	<0.01
2	1 mM palmitate	11.4 ± 1.4 (4)	20.4 ± 2.8 (4)	<0.01
2	1 mM linoleate	7.4 ± 0.5[b] (3)	13.7 ± 1.0[c] (3)	<0.05
2	1 mM linolenate	7.3 ± 1.2[b] (3)	14.4 ± 0.5[c] (6)	<0.01

[a] Two or three rats from each group were used to provide 300–500 mg of lung tissue slices per flask for the number of flasks shown in parentheses.
[b] $P < 0.05$ for differences compared to results with tissue preincubated with no additions.
[c] $P < 0.01$ for differences compared to results with tissue preincubated with no additions.

in monoenoic fatty acids after 4 hr compared to a 34% reduction after 2 hr of pretreatment. The respective reductions in control slices were 38 and 17%.

The monoenoic species of the fatty acid methyl esters in this experiment were further analyzed by GLC using a stream splitter. In both control and EFA-deficient experiments, 80–90% of ^{14}C was found to be in oleic acid as judged by comparison of retention times of the radioactive peaks with those of authentic standards.

Experiment 4 (Table 2C)

The possibility that any fatty acid by providing a source of acyl CoA might produce an inhibitory effect had to be examined. Two hours of preincubation with 1 mM palmitic acid had no effect on desaturation of [1-^{14}C]stearic acid in either control or EFA deficient lung slices. However, preincubation with 1 mM linoleic acid or linolenic acid produced the expected degree of inhibition of desaturation of stearic acid. Linoleic and linolenic acids might produce their inhibitory effect by providing a precursor for prostaglandin synthesis. It was therefore of interest to observe that, at the one concentration and time period tested, dimethyl PGE_2 had no effect. The baseline values for desaturation in this series of experiments were somewhat higher than those seen in other experiments. The reason for this finding is not clear, but the percent inhibition of desaturation observed was comparable to those seen in the other experiments.

In all the in vitro incubations, the uptake of [1-^{14}C]-stearate by lung slices as judged by total dpm in the tissues was comparable in slices from control and EFA-deficient rats, being 24.2 ± 3.2% of the dose/g wet weight of tissue in controls and 21.5 ± 2.5% in EFA-deficient slices. Thus total ^{14}C in total fatty acid methyl esters ranged from 880 to 1190 × 10^3 dpm. Corresponding values in total PL methyl esters were 518 to 621 × 10^3 and in monoenoic FA 41 to 105 × 10^3 dpm. Thus the differences in degree of desaturation, as measured by the percentage of ^{14}C in monoenoic fatty acids in tissue phospholipids, were not due to differences in available [^{14}C]stearate. Furthermore, when the ^{14}C in monoenoic fatty acids in total lipids was examined, the difference between control and EFA-deficient tissues was similar to that reported here for PL fatty acids. The data for phospholipid fatty acids are reported since these represent the degree of desaturation in esterified fatty acids and thus exclude artifacts due to adsorbed and adherent fatty acids which have not entered the metabolizable pool within the tissue.

DISCUSSION

The results of this study confirm the presence of desaturase activity in lung tissue previously characterized in lung microsomes by Montgomery (8). As previously shown in microsomes from lung by Montgomery (8), stearate was more actively desaturated

than palmitate. The activity of this desaturase was reported to be increased about two-fold in rats fed a fat-free diet for 4 days (8). We observed a similar increase in stearate desaturation in lungs from rats fed the EFA-deficient diet as compared to controls. In the present studies, control and EFA-deficient rats both received the fat-free diet used by Montgomery (8), however the diet of controls was supplemented with safflower oil, while the EFA-deficient diet contained tripalmitin. Food intake was similar in the two dietary groups. Thus the two differences between the two groups were the presence or absence of linoleic acid in their diets and the fact that the EFA-deficient group received only saturated fat. Therefore, the increase in activity of the desaturase in EFA-deficient rats may have been related to the lack of linoleate in the diet. Montgomery (8) reported that the desaturase enzyme present in lung microsomes was similar in its characteristics to $\Delta 9$ desaturase in liver microsomes. The product of the action of this enzyme on stearic acid was oleic acid (8), suggesting that it was indeed $\Delta 9$ desaturase. The results reported here also suggest that the enzyme activity measured by us was that of $\Delta 9$ desaturase, since 80–90% of ^{14}C recovered in monoenoic fatty acids was oleic acid as judged by GLC.

It has been established that the activity of $\Delta 9$ desaturase is closely linked to that of the fatty acid synthetic system:acetyl CoA carboxylase and fatty acid synthetase (7). Linoleic acid has been shown to influence the activity of fatty acid synthetase and acetyl CoA carboxylase (7, 13). When rats were fed an EFA-deficient diet for 19 days, fatty acid synthetase was greatly increased in hepatic cytosol (13). Refeeding corn oil or linoleate, but not oleate or palmitate, inhibited this increase in enzyme activity (13). Starved rats when refed fat-free diets showed a marked increase in fatty acid synthesis by cytosol from liver using [1-^{14}C]acetate (14). As fatty acid synthesis increased so did the incorporation of [^{14}C]acetate into palmitoleate and oleate, thus indicating the close link between fatty acid synthesis and $\Delta 9$ desaturation (14). These observations strongly suggest that linoleate may either directly or indirectly influence the activity of $\Delta 9$ desaturase. Evidence that linoleate may influence the activity of $\Delta 9$ desaturase directly was presented by Inkpen, Harris, and Quackenbush (6). These investigators demonstrated that refeeding fasted rats a sucrose or saturated fat diet resulted in marked increase in microsomal $\Delta 9$ desaturation, and that this increase could be inhibited by refeeding diet containing linoleate (6).

Gellhorn and Benjamin (15) demonstrated that hepatic microsomal $\Delta 9$ desaturase was depressed in diabetic rats and that the activity of this enzyme was restored by treatment with insulin. These authors also showed that, when synthesis of new enzyme protein was inhibited by in vivo administration of puromycin, enzyme activity decayed with a half life to 2.5–5 hr, while the half life of the controlling mRNA was 19 hr (12). These observations were confirmed and extended by Oshino and Sato (16), and Prasad and Joshi (17), who showed that these changes in $\Delta 9$ desaturase activity were not associated with any changes in microsomal electron transport components, but only with content of the terminal component (cyanide-sensitive factor) of the enzyme complex. This suggests that activity of the enzyme complex is controlled by modulating the content of the labile terminal component. The data of Inkpen et al (6), suggest that linoleic acid may act directly on this terminal component.

The rats used in the present studies were fed diets containing large amounts of sucrose. It has been shown that feeding diets containing fructose in place of dextrin, or a supplement of saturated fatty acids, resulted in an increase in activity of $\Delta 9$ desaturase in liver both in vivo and in vitro (18). Thus the enhanced activity of $\Delta 9$ desaturase observed in our studies in EFA-deficient rats may have been due in part, to the combination of the high sucrose content of the diet which contained only saturated fatty acids. However, since the control rats received the same diet, except that fat was provided as safflower oil, the data presented strongly suggest that the higher rate of desaturation of stearic acid by lung tissue from the EFA-deficient rats was related to the deficiency of EFA. Preincubation of lung slices with oleate for 2 hr reduced the activity of $\Delta 9$ desaturase in both control and EFA deficient tissues. However, this effect was not observed in lung slices from EFA-deficient rats after 1-hr preincubation. It is possible that this effect of oleic acid is secondary to product inhibition related to the presence of the cis-$\Delta 9$ double bond. It is of interest that while in vivo linoleate has been shown to inhibit synthesis and enhance degradation of hepatic fatty acid synthetase, oleic acid had not such effect (19). In the present in vitro experiments, the effect of linoleate in inhibiting $\Delta 9$ desaturation was consistently greater than that of oleate. Thus, the present evidence suggests that the mechanisms of action of oleate and linoleate on $\Delta 9$ desaturase in lung are different.

The finding that preincubation of the slices with 1 mM linoleic acid resulted in a significant (30–39%) reduction in desaturation of stearic acid confirms the importance of linoleic acid in controlling the activity of $\Delta 9$ desaturase. This appears to be the first demonstration of this effect in lung tissue and the first time that linoleic acid has been shown to exert a controlling influence on $\Delta 9$ desaturase in an in vitro system. Our data do not permit definition of the mechanism of

action of linoleic acid in this system. However, the fact that a 30–39% inhibition was produced in as little as 2 hr suggests that inhibition of de novo enzyme synthesis may not be the explanation. This conclusion is supported by the lack of effect in both control and EFA-deficient tissues of preincubation with palmitic acid (Table 2C), since others have suggested that saturated fatty acid feeding increases enzyme synthesis (18).

We considered the possibility that linoleic and linolenic acid produced their effect by providing substrate for prostaglandin synthesis. It has been shown that EFA deficiency results in impaired prostaglandin synthesis in rat lung (20). We therefore preincubated slices with dimethyl PGE$_2$, but were unable to demonstrate any effect on the desaturation of stearic acid in either control or EFA-deficient tissues (Table 2 C). We chose a concentration of PGE$_2$ that had been found effective in guinea pig lung slices in increasing cyclic AMP levels secondary to stimulation by acetyl choline. Since only a single prostaglandin, at a single concentration and for only a single time period was used, no firm conclusions as to the role of prostaglandins in modulating the activity of Δ9 desaturase can be drawn from these experiments. However, inasmuch as linoleic and linolenic acid reduced the activities of Δ9 desaturase in lung slices from control rats fed safflower oil by about 25% (Table 2 C), it seems unlikely that the effect of these fatty acids can be explained on the basis of increased PGE production, since the control rats had normal levels of linoleate and arachidonate in their tissues (1). This conclusion is consistent with the observation of Flick, Chen, and Vagelos (19) that inhibition of PGE synthesis had no effect on fatty acid synthetase in the liver.

Thus the results of the experiments reported here confirm that EFA deficiency does result in increased activity of Δ9 desaturase in lung tissue. It is, therefore, possible that the alternations in lung and surfactant PC composition produced by deficiency in EFA may be due to the increased activity of this enzyme in this condition.∎

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