BIO AVILABILITY OF LIPIDS FROM DIFFERENT ANIMAL SOURCES

ABDEL-SALAM, SAMIHA M. M., A. EL-SHIRBEENY AND SAHAR O. ALLAM

Food Technology Research Institute, A.R.C.

(Manuscript received 14 February 2005)

Abstract

Five types of animal fats were used in this investigation, i.e. bovine butter, buffaloes butter, bovine fat, buffaloes fat and sheep fat. Corn oil was also used as control.

Data showed that the rats preferred the sheep fat and buffaloes butter than other fats, and consequently stored the metabolized fats in its body. Deposition of the tested lipids on some organs, i.e. liver and brain were found on a significant level.

Determination of liver functions showed that fats deposit at the liver and formed fatty liver which affected the activity of alanine transaminase (ALT) and aspartate transaminase (AST). Type of fat seems to play an important role in the serum lipid fractions according to their saturation degree and also the main or predominant fatty acid. Further studies will be of great important.

INTRODUCTION

Most of Egyptian people especially villagers use lipids from animal sources in cooking. *Bahceci et al. (1999)* concluded that high fat diet that resulting in an increased body fat percentage in rats is associated with hyprleptinemia, hypercholesterolemia and hypertriglyceridemia. *Phan et al. (1999)* reported that the metabolism of chylomicrons derived from butter fat is more complex than expected and not necessarily related to the overall saturation of the butter fat sample. With less complex fats and oils, unsaturated (low melting) oils show fast clearances with higher hepatic uptakes, whereas saturated (high melting) fats have reduced cholesteryl ester clearance and hepatic uptake of chylomicron remnants. The lipolysis index (an indication of lipolysis) was not significantly differed between individual groups of chylomicrons, indicating that cholesteryl ester or remnant removal was most affected by specific dietary fats. *Kris Etherton, et al. (1984)* reported that dietary fat saturation had no effect on carcass and liver cholesterol concentrations. Since differences in hepatic lipoprotein production were not reflected in plasma lipoprotein patterns. These results suggest that extrahepatic lipoprotein metabolism differs in rats fed diets containing fatty acids of varying saturation.

The aim of this study was to clarify the effect of the different types of lipids from animal sources on serum constituents, liver and kidney in rats.

MATERIALS AND METHODS

Materials the main types of lipids from animal sources were obtained from the local market. These ones are: corn oil, sheep fat, buffaloes fat, bovine fat, buffaloes butter and bovine butter.

Biological experiment male albino adult rats (30 animals, initial weights 140 ± 10gm) were obtained from the Experimental Animal House, Food Technology Research Institute, A.R.C., Giza, Egypt. The experimental animal fed on a normal diet containing animal protein 20% as casein, corn oil 10%, cellulose 5%, salt mixture 4%, vitamin mixture 1% and corn starch 60% (A.O.A.C., 1995) The animals were randomly divided into sex groups (n=5) according to the following scheme.

Group I: fed basal diet contained 10% corn oil as control group (G1).

The other groups (25 rats) G2 to G6 fed basal diet with exchanging corn oil with the fat type as following:

10% sheep fat (G2), 10% buffaloes fat (G3), 10% bovine fat (G4), 10% buffaloes butter (G5) and 10% bovine butter (G6).

At the end of the experiment (8weeks), blood samples were collected from vineus pluxes and serum were obtained from each rat to determine total lipid and its fraction and liver functions.

The body weight gain and food efficiency ratio (FER) were calculated. The weight of liver, heart and brain were also recorded. Liver and brain were kept in formalin (10%, v/v) for histopathological examination.

Determination of liver function total protein was determined using the method of *Henry (1957).*Albumin was carried out according to *Doumas et al. (1971).* Alanine transaminase (ALT) and aspartate transaminase (AST) were measured according to *Bergmeyer and Horder (1986).*

Determination of total lipid and its fraction total lipids were analyzed using procedure of *Chabrol (1961).* Total cholesterol was quantified by using procedure of *Fasce (1982).*Low density lipoprotein (LDL) cholesterol was determined according to the method described by *Steinbery (1981).* High density lipoprotein (HDL) cholesterol was also estimated according to *Grove (1979).* Triglyceride was out lined by using the methods of *Young and Pestaner (1975).*

Liver and brain were removed and fixed in 10% formalin for 24 hours and prepared for histopathological by routine light microscopic according to the method of *Drury and Wallington (1980).* Statistical analysis of variance (t-test) within groups and between groups was conducted as described by *S.P.S.S (1990).*

RESULTS AND DISCUSSION

Table 1 shows the effect of different types of animal fats on body weight gain, food intake and food of efficency ratio (FER). These data indicated that , a remarkable increase in final weight due to feeding sheep fat amounted in 49g followed by buffaloes fat (21.5g), while the other treatments showed an increase ranged from 4.25 to 11g. In other words, the body weight gain increased and decreased significantly due to feeding sheep fat and buffaloes butter respectively, compared with other treatments. Similar trend was found regarding food efficiency ratio (FER). This trend means that animals preffered the sheep fat and buffaloes butter than other fats and consequently stored the metabolized fats in their body. *Bahceci et al. (1999)* concluded that high fat diet resulting in an increased body fat percentage in rats is associated with hyperleptinemia, hypercholesterolemia and hypertriglyceridemia.

The ratio between the organs and the final body weight was presented in Table 2. The data exhibited that there were no significant differences between treatments except that of control and that fed bovine butter for the heart, control and sheep fat, bovine fat and buffaloes butter for the liver meanwhile brain resulted in significant differences between control and sheep fat only.

Effect of diet lipid on liver functions is shown in Table 3. The data revealed that there were non significant differences regarding total protein and albumin as liver function affected with different types of animal fats. Meanwhile AST and ALT were found to be affected significantly due to the fat types. For examples buffaloes butter resulted in highly significant increase in AST compared with all treatments, while other treatments varied significantly (L.S.D. = 11.17). ALT showed the highest significant increase due to buffaloes butter feeding compared with other treatments meanwhile buffaloes fat and bovine fat showed the lowest significant reduction decrease similar to that of AST. This means that the fats deposit at the liver and formed fatty liver lead to a real effect on AST and ALT activity. The data were found to be in agreement with those of *Lambert et al. (2000).* They found that livers from rats fed on each of the fat enriched diets removed similar amounts (34-40%) of the cholesterol labeled remnants added, whereas livers from rats fed on the low fat diet removed significantly more labeled fish oil and butter fat remnants than olive, maize or palm- oil remnants.

Serum lipid fractions i.e., total lipids, triglycerides, total cholesterol, high density lipoprotein cholesterol (HDL) and low density lipoprotein cholesterol (LDL) were determined in order to show the effect of feeding animal fat on these lipid fractions. Results are shown in table 4. From which sheep fat, buffaloes butter and bovine butter resulted in serum total lipids amounted to 306±9.715, 317.67±8.075 and 301.67±8.916 mg/dL. This levels are significantly higher than those of control (155.77±4.78mg/dL), buffaloes fat (117±4.737mg/dL) and bovine fat (176±4.018). The first and the second groups showed non-significant differences between fat type (L.S.D. = 73.13). Serum triglycerides resulted in highly significant increase due to feeding sheep fat (114.67±1.017mg/dL). On contrary, feeding buffaloes butter lead to a highly significant decrease compared with sheep fat. Meanwhile, the other treatments proved the presence of non-significant differences compared with control. Serum total cholesterol (140±2.851mg/dL) of the control showed non significant differences compared with buffaloes fat (146±1.393mg/dL) and bovine fat (155.67±1.581mg/dL). On the other hand, total cholesterol increased significantly due to feeding sheep fat (208.33±2.371mg/dL) and bovine butter (213.36±2.89mg/dL) and the highest significant was related to buffaloes butter (262.33±1.651mg/dL). Serum HDL showed non significant differences between treatments namely sheep fat ,buffaloes fat and bovine fat in relation to the control except that buffaloes and bovine butters which increased significantly than the other treatments. Serum LDL showed an opposite trend as HDL with respect to buffaloes and bovine fats which resulted in non-significant differences compared with control. Meanwhile a significant increase was found due to feeding sheep fat and bovine butters and highly significant increase due to buffaloes butter (159.64±3.97, 159.45±1.713 and 210.36±0.734mg/dL, respectively) with L.S.D. of 6.60. subsequently feeding buffaloes and bovine butter increased significantly all serum lipid fractions except that of triglycride which showed non significant differences compared with control. Buffaloes and bovine fat increased non significantly all lipid fractions except total lipid at buffaloes fat. Sheep fat increased significantly all parameters except that of HDL. These results were in agreement with *Change and Huang (1999)* regarding the levels of plasma total and lipoprotein cholesterol and triacylglycerol (TAG). Increase in the plasma VLDL-C and

VLDL-TAG were related to increased monounsaturated fatty acid (MUFA) content in the diet.

Histopathological examination of sections of rats liver and brain confirmed the previous data. Figure 1 show sections of rat-liver of animals fed on:- corn oil as a control, - sheep fat, - buffaloes fat, - bovine fat,- buffaloes butter and - bovine butter.

Dilated sinusoids in between the liver cell groups were shown in section (A). sinusoidal dilation is seen with relatively intact liver cells in (B). Sinusoidal dilatation is seen, congestion both the portal and central veins. A dense infillerate of inflammatory cells is clearly seen in the portal area in (C). Slight sinusoidal dilatation is seen and expanded congested central vein is found in (D). No changes were observed in the hepatocytes and slight dilatation is detected in the sinusoids. in (E). Slight congestion of the control vein and slight sinusoidal dilatation some hepatocytes have pyknotic nuclei in (F).

Figure (2) shows sections of rat brain of animals fed on: corn oil, sheep fat, buffaloes fat, bovine fat, buffaloes butter and bovine butter. The brain cells are swollen and the capillories are surrounded with chronic inflammatory cells in (A). Slight odema is seen in (B). Intracellular and intercellular odema is observed in (C). Mild odema is seen in (D). No observed change is notice in (E). No change is present in (F).

Table 1. Effect of different types of animal fat on body weight gain, food intake and food efficiency ratio

Fat types	Initial weight	Final weight	Body weight gain		Food intake (60 days)	FER *
	gm	gm	gm	%	gm	
Corn oil	142.5±4.36^{a}	152±12.86^{b}	9.5±1.89^{bc}	6.67±2.33^{bc}	960±24.50^{d}	0.0098±0.0017^{bc}
Sheep fat	150±8.365^{a}	199±14.251^{a}	49.00±2.314^{a}	32.67±1.354^{a}	1230±45.321^{a}	0.0398±0.00142^{a}
Buffalos fat	147.5±13.25^{a}	169±13.674^{ab}	21.5±2.354^{b}	14.58±2.365^{b}	1065±54.321^{c}	0.0202±0.03142^{b}
Bovine fat	151.25±9.147^{a}	162.25±13.245^{b}	11.0±4.214^{bc}	7.27±1.321^{bc}	975±60.124^{d}	0.0113±0.01231^{bc}
Buffalos butter	145.5±13.62^{a}	149.75±16.321^{b}	4.25±5.314^{c}	2.92±2.314^{c}	1005±50.647^{cd}	0.004±0.01324^{c}
Bovine butter	145.5±14.36^{a}	154.75±15.641^{b}	9.25±5.612^{bc}	6.36±1.954^{bc}	975±61.321^{d}	0.0095±0.01781^{bc}
L.S.D at 5%	N.S	32.87	13.61	10.07	73.94	0.0104

• FER = Food Efficiency Ratio
Means within the same column ,with the same letters are not significantly different.

Table 2. Effect of feeding animal fats on organs ratio to final body weight (heart, liver and brain) of rats.

Fat types	Final weight	Heart weight		Liver weight		Brain weight	
	gm	gm	%	gm	%	gm	%
Corn oil	152±12.86^{b}	0.63±0.231^{a}	0.41±0.0142^{a}	4.49±1.241^{b}	2.95±1.324^{a}	1.73±0.984^{a}	1.14±0.741^{a}
Sheep fat	199±14.251^{a}	0.59±0.214^{ab}	0.30±0.0741^{ab}	5.26±1.654^{ab}	2.64±1.471^{b}	1.64±0.971^{a}	0.82±0.648^{b}
Buffalos fat	169±13.674^{ab}	0.57±0.145^{ab}	0.34±0.0162^{ab}	4.87±1.812^{ab}	2.88±1.214^{ab}	1.63±1.031^{a}	0.96±0.864^{ab}
Bovine fat	162.25±13.245^{b}	0.55±0.135^{ab}	0.34±0231^{ab}	4.46±1.374^{b}	2.75±1.245^{b}	1.62±1.014^{a}	1.00±0.713^{ab}
Buffalos butter	149.75±16.321^{b}	0.49±0.136^{b}	0.33±0.0514^{b}	4.56±1.654^{b}	3.05±1.412^{b}	1.52±1.094^{a}	1.02±0.751^{ab}
Bovine butter	154.75±15.641^{b}	0.56±0.174^{ab}	0.36±0.0436^{ab}	4.71±1.324^{ab}	3.04±1.181^{ab}	1.62±1.087^{a}	1.05±0.814^{ab}
L.S.D at 5%	32.87	0.108	0.079	0.927	0.575	N.S	0.231

Means within the same column, with the same letters are not significantly different.

Table 3. Effect of feeding different animal fats types on serum total protein, albumin and liver function of rats

Fat types	Total protein		Albumin		AST		ALT	
	g/dL	%	g/dL	%	IU/L	%	IU/L	%
Corn oil	6.61 ± 0.214^{b}	100 ± 0.00^{b}	5.4 ± 0.214^{ab}	100 ± 0.00^{ab}	43.33 ± 2.314^{d}	100 ± 0.00^{d}	23.67 ± 1.24^{c}	100 ± 0.00^{c}
Sheep fat	6.31 ± 0.578^{b}	95.46 ± 4.351^{b}	3.79 ± 0.754^{b}	70.18 ± 14.681^{bc}	41.00 ± 4.215^{d}	94.62 ± 0.0^{d}	37 ± 4.689^{b}	156.32 ± 16.21^{b}
Buffalos fat	5.91 ± 0.981^{b}	89.41 ± 6.521^{b}	4.50 ± 1.354^{ab}	83.33 ± 14.78^{abc}	24.33 ± 1.25^{c}	56.15 ± 1.98^{c}	19 ± 1.542^{c}	80.27 ± 4.321^{c}
Bovine fat	6.27 ± 0.871^{b}	94.86 ± 5.614^{b}	4.61 ± 1.352^{ab}	85.37 ± 15.63^{abc}	23.67 ± 5.32^{c}	54.63 ± 9.36^{c}	14.67 ± 4.365^{c}	61.98 ± 17.981^{c}
Buffalos butter	5.92 ± 0.00^{b}	89.56 ± 0.0^{b}	3.65 ± 0.712^{b}	67.59 ± 13.26^{bc}	106.67 ± 8.99^{a}	246.18 ± 25.47^{a}	76 ± 7.841^{a}	321.08 ± 51.25^{a}
Bovine butter	6.01 ± 1.365^{b}	90.92 ± 25.35^{b}	3.37 ± 1.35^{b}	62.40 ± 14.67^{c}	82.33 ± 4.22^{b}	190.01 ± 15.43^{b}	44 ± 5.984^{b}	185.89 ± 26.57^{b}
L.S.D at 5%	N.S	N.S	1.87	34.26	11.17	25.89	9.84	40.88

Means within the same column ,with the same letters are not significantly different.

Table 4. Effect of feeding animal fats on the serum lipid fraction

Fat types	Total lipids		Triglyceride		Total cholesterol		HDL		LDL	
	mg/dL	%	mg/dL	%	mg/dL	%	mg/dL	%	mg/dL	%
Corn oil	155.77 ± 4.78^{b}	100 ± 00^{b}	84 ± 1.326^{bc}	100 ± 0.00^{bc}	140.00 ± 2.851^{c}	100 ± 0.00^{c}	25.88 ± 1.017^{b}	100 ± 0.00^{b}	97.32 ± 0.936^{c}	100 ± 0.00^{c}
Sheep fat	306.00 ± 9.715^{a}	196.53 ± 3.659^{a}	114.67 ± 1.017^{a}	136.51 ± 1.981^{a}	208.33 ± 2.371^{b}	148.81 ± 3.82^{b}	25.76 ± 0.817^{b}	99.54 ± 1.811^{b}	159.64 ± 3.97^{a}	164.04 ± 8.58^{a}
Buffalos fat	117.00 ± 4.737^{b}	75.14 ± 3.825^{b}	98.33 ± 1.931^{bc}	117.06 ± 1.071^{bc}	146.00 ± 1.393^{c}	104.29 ± 1.597^{c}	27.80 ± 0.451^{b}	107.42 ± 0.983^{b}	9853 ± 1.92^{c}	101.24 ± 8.713^{c}
Bovine fat	176.00 ± 4.018^{b}	113.04 ± 3.019^{b}	86.67 ± 1.098^{bc}	103.18 ± 0.501^{bc}	155.67 ± 1.581^{c}	111.19 ± 1.931^{c}	29.95 ± 0.919^{b}	115.73 ± 1.817^{b}	108.39 ± 1.81^{c}	111.37 ± 6.81^{c}
Buffalos butter	317.67 ± 8.075^{a}	204.03 ± 4.118^{a}	81.67 ± 1.073^{bc}	97.23 ± 0.981^{c}	262.33 ± 1.651^{a}	187.38 ± 1.881^{a}	35.64 ± 0.981^{a}	137.71 ± 1.397^{a}	210.36 ± 0.734^{b}	216.15 ± 2.983^{b}
Bovine butter	301.67 ± 8.916^{a}	193.75 ± 3.917^{a}	102.33 ± 2.617^{ab}	121.82 ± 2.99^{ab}	213.36 ± 2.89^{b}	152.40 ± 2.617^{b}	33.44 ± 1.017^{a}	129.21 ± 2.981^{a}	159.45 ± 1.713^{a}	163.84 ± 2.018^{a}
L.S.D at 5%	73.13	40.12	15.84	17.64	48.50	47.39	5.65	21.45	6.60	12.13

Means within the same column ,with the same letters are not significantly different.

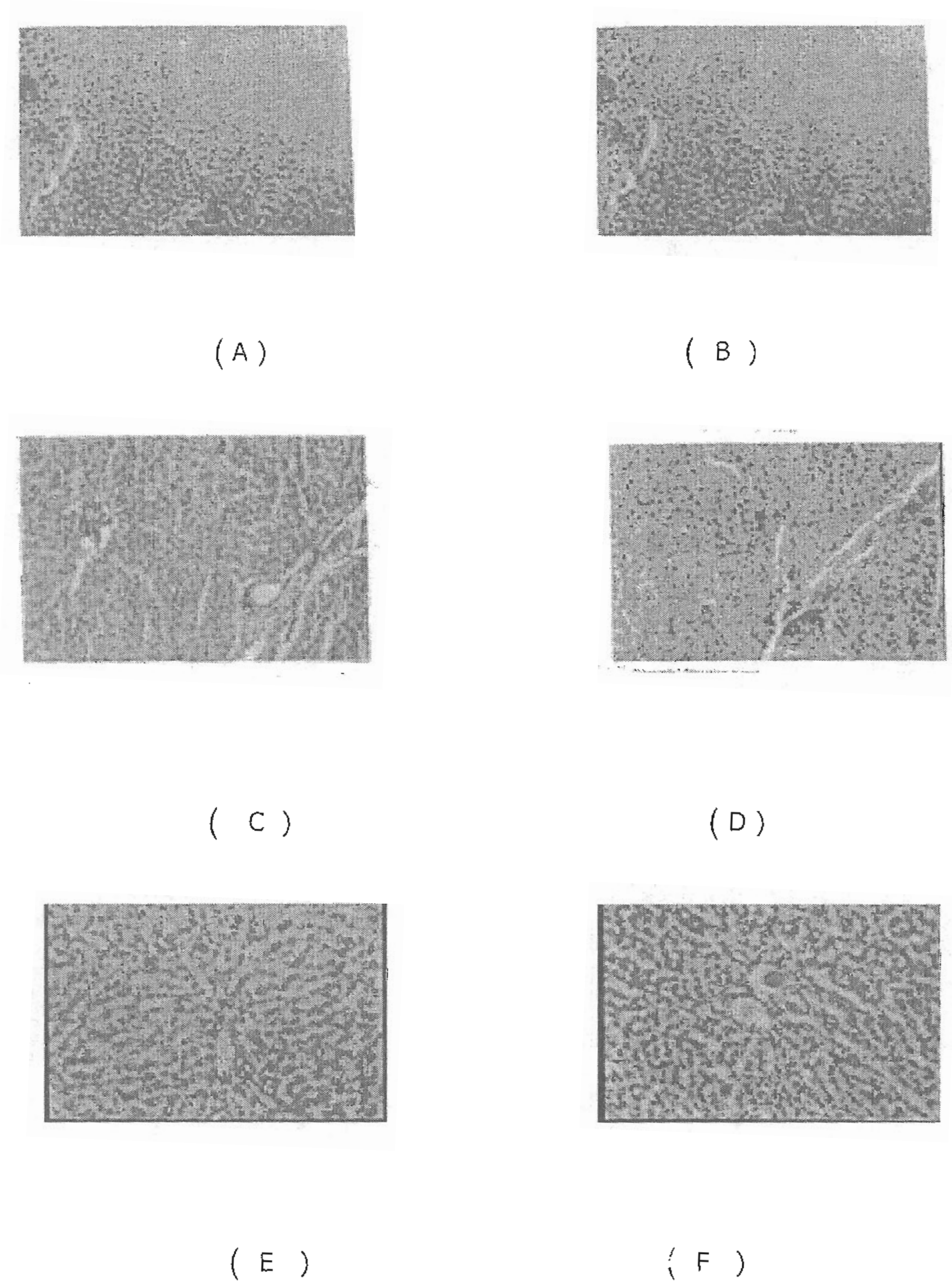
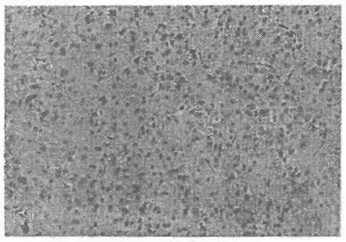
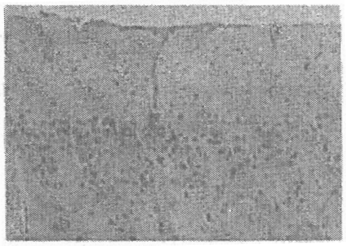


Figure 1. A section of rat liver of animals fed on : - corn oil , the control,(A),- sheep fat (B),-buffaloes fat (C),- bovine fat (D),- buffaloes butter (E), and bovine butter (F) .



(A)



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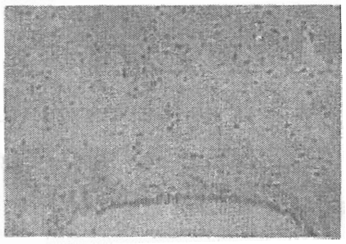

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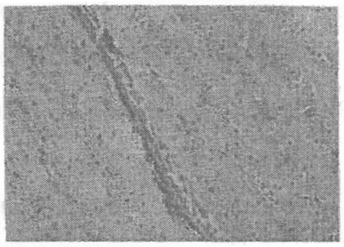

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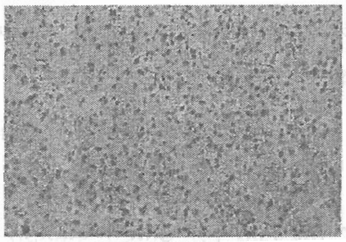

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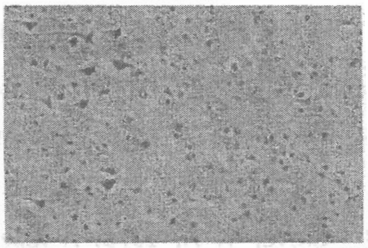

(F)

Figure 2 . A section of rat brain of animals fed on : - corn oil , the control, (A)،- sheep fat (B)،-buffaloes fat (C)،- bovine fat (D)،- buffaloes butter (E)، and bovine butter (F) .

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الإتاحة الحيوية للدهون من مصادر حيوانية مختلفة

سميحة محمد محمد عبد السلام ، احمد الشربينى ، سحر عثمان علام

معهد بحوث تكنولوجيا الأغذية – مركز البحوث الزراعية

أستخدم فى هذا البحث، خمسة أنواع من الدهون الحيوانية وهى: الزبد البقرى والجاموسى والدهن البقرى والجاموسى ودهن الضأن بالإضافة إلى زيت الذرة كعينة قياسية.

وقد أشارت النتائج إلى أن فئران التجارب تفضل طعم العليقة التى يدخل فى تركيبها دهن الضأن أو الزبدة البقرى، وترتب على ذلك تخزين نواتج هذه الدهون فى أجسامها، وقد تبين هذا عند تحليل وفحص كل من الكبد والمخ.

أظهرت تجارب تحديد كفاءة وظائف الكبد ارتفاع نواتج تحليل الدهون، وظهور الكبد الدهنى الذى أثر على نشاط الانزيمات الدالة على ذلك، وهى انزيمات ناقلة للاحماض الامينيه (الحامض الامينى الانين ALT) و (الحامض الامينى الاسبارتيت AST) . وغالباً ما يلعب المصدر الدهنى فى العليقة دوراً هاماً فى صورة دهون الدم ومكوناتها ، حيث يختلف تأثيره تبعاً لدرجة تشبع الأحماض الدهنية ونوعيتها، وفى هذا الصدد يلزم عمل دراسات أخرى.