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Effect of Some Dietary Oils and Fats on Serum Lipid Profile, Calcium Absorption and Bone Mineralization in Mice

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Abstract: Amount and type of fats in the diet have an important effect on bone health and lipid profile. This study was conducted to investigate the effect of different types of dietary oils and fats on lipid profile, calcium absorption and bone mineralization in male mice. Mice weighing 25±5 g were divided into nine groups and fed on diets without oils or fats (control group) and containing soybean oil, corn oil, olive oil, palm oil, sunflower oil, butter, animal fat or margarine. Mice fed on diet containing soybean oil or olive oil had the lowest levels of TG, TC, LDL-c and HDL-c as compared to the other groups. Diets with palm oil, olive oil, sunflower oil, butter, animal fat or margarine caused significant decreases in the serum level of calcium as compared to the effect of diet without oils or fats. Mice fed diet containing olive oil, butter or animal fat had significant increase in bone density, while those fed diet containing soybean oil, corn oil, sunflower oil or margarine had significant decreases in femur bone density, compared to the control group. The apparent calcium absorption was significantly increased by feeding diets containing soybean oil, corn oil, palm oil, olive oil, sunflower oil, butter or animal fat. Dietary intake of vegetable oils improved lipid profile while butter, animal fat and margarine had the opposite effect. Butter and animal fats increased calcium and phosphorus deposition in femur bone more than vegetable oils.

Key words: Oils, fats, lipid profile, calcium, bone density

INTRODUCTION

Bone is a connective tissue, which continuously undergoes remodeling. Bone remodeling involves bone formation by osteoblasts and bone resorption by osteoclasts. Bone undergoes continuous remodeling with regular resorption and deposition of calcium into newly deposited bone (AAPCN, 1998). The bone matrix is composed of organic and inorganic components. The organic components include collagen and glycoprotein while the inorganic components include minerals such as calcium and phosphorus. Both the organic and inorganic components provide strictness and strength to the bone (Annemieke *et al*., 1997). Adequate calcium intake is recommended for the development of high peak bone mass and for the prevention of osteoporoses (Kanis, 1999). On the other hand, consideration should be given not only to the intake of adequate calcium, but also, to the absorptive efficiency of the ingested calcium, because intestinal calcium absorption is influenced by many factors (Mjyazawa and Yoshida, 1991).

Dietary fats and oils are known as macronutrients and provide concentrated source of energy for human metabolic processes. In addition, they are the main source of fat-soluble vitamins (Sanchez-Muniz and Bastida, 2006). Dietary oils and fats are composed of different types of Fatty Acids (FA). Fatty Acids are Saturated (SFA), Monounsaturated (MUSFA) and Polyunsaturated (PUSFA). Evidence has been demonstrated that dietary fats can have important effects on bone health. Studies in animals indicate that high-fat diets can adversely affect bone (Hoffman *et al*., 1999). Saturated fatty acids in particular, may have effects that could weaken bone health (Parhami, 2003). A number of study founded that long-chain polyunsaturated fatty acids influence bone mass in various animal models (Watkins *et al*., 2000). A variety of mechanisms may account for the effects of dietary fats on bone, including alterations in calcium absorption, prostaglandin synthesis, osteoblasts formation and lipid oxidation (Haag *et al*., 2003).

It is well known that, the amount and the type of fats in the diet can have important effects on bone health and lipid profile. Therefore, the main objective of the present study were to investigate the effect of adding different types of oils and fats to the diet on serum lipid profile, calcium absorption and bone mineralization in male mice.

MATERIALS AND METHODS

Animals: Male mice of Swiss strain weighing 25±5 g were purchased from Laboratory Animal Colony, Ministry of Health and Population, Helwan, Egypt.

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Oils and fats: Soybean oil, corn oil, olive oil, palm oil, sunflower oil, butter, animal fat and margarine were purchased from the local market, Cairo, Egypt.

Kits: Kits for biochemical analysis of serum lipid profile, calcium, phosphors and magnesium were obtained from the Gamma Trade Company for Pharmaceutical and Chemicals, Dokki, Giza, Egypt.

Preparation of basal diet: The basal diet (AIN-93G) (Reeves *et al*., 1993) was formulated without oils or fats. The following oils or fats were added to the diet: soybean oil, corn oil, olive oil, palm oil, sunflower oil, butter, animal fat and margarine. Diets were formulated to meet recommended nutrients levels for mice as showed in Table 1.

Table 1: Composition of the modified AIN-93G diet

Ingredient	Content (g/kg)
Casein	200.000
Maize starch	529.486
Sucrose	100.000
*Oil or fat	70.000
Fibers	50.000
Mineral mix.	35.000
Vitamin mix.	10.000
L-Cystine	3.000
Choline chloride	2.500
Butyl hydroquinone	0.014

*Oils or fats were: Soybean oil, Corn oil, Olive oil, Palm oil, Sunflower oil, Butter, Animal fat, Margarine and without any source of oils or fats

Experimental design: The experiment was carried out on forty-five male mice, weighing approximately 25±5 g. Mice were housed in an air-condition room at 22-25°C, under 12-light/dark cycle, fed on the basal diet and tap water *ad libitium*. Animals fed on the basal diet for one week for acclimatization before starting the experiment. After acclimatization period, mice were divided into nine groups, of five animals each, and fed on the following experimental diets: (I) diet without oils or fats source and without change in total calories by replacing calories of fats by starch and sucrose (control group), (II) diet contains soybean oil, (III) diet contains corn oil, (IV) diet contains palm oil, (V) diet contains olive oil, (VI) diet contains sunflower oil, (VII) diet contains butter, (VII) diet contains animal fat, (IX) diet contains margarine.

Determination of calcium balance: During the last week of the experimental period, all mice were housed in individual metabolic cages containing a grid-floor and a facility for separate collection of feces and urine. To acclimatize the mice in the new environment, they were housed in these cage two days before the beginning of four days metabolic study for the determination of net dietary calcium absorption. During the last 4 days, food consumption was determined on a daily basis over the 4-d metabolic balance-study period. Urine and fecal samples (24 h) of each animal were collected. The urine volume for each animal was recorded. Portions of the urine samples were acidified with 12 M HCL and stored at -20°C until required for analysis. The fecal samples of each animal were dried for 12 h at 100°C. The diets and dried fecal samples were ash-dried at 700°C for 12 h. The diet and fecal ashes were solubilized with 6N HC1 solution (Yang *et al*., 2008). Calcium concentrations were measured using atomic absorption spectrophotometer (model 3300) (Perken, 1982).
Apparent Ca absorption, apparent Ca-absorption rate, and apparent Ca balance were calculated using the following equations respectively:

Apparent Ca absorption = Ca intake in diet - Fecal Ca

$$\text{Apparent Ca absorption rate (\%)} = \frac{\text{Ca absorption}}{\text{Ca intake in diet}} \times 100$$

Apparent Ca balance = Ca intake in diet - (fecal Ca + urinary Ca)

Determination of femur length, volume and density: The soft tissue in the right femur was removed and the length of each right femur was measured with a vernier caliper. Femur volume and density were calculated using Archimedes' principle. In brief, the femur was cut out at the mid-diaphyses and the marrow was washed out. Each bone was placed in an unstoppered vial filled with deionized water, and the vial was placed for 90 min in a vacuum desiccator. The desiccator was agitated periodically to ensure that the trapped air completely diffused out of the bone. The bone was removed from the vial, dried by blotted paper, weighed, and placed again in the vial containing deionized water. The bone was reweighed in a suspended vessel and should be not completely immersed in water before equilibrated at room temperature, and the density (g per cm^3 of bone volume) was calculated (Doyle and Cashman, 2003).

Determination of femur mineral contents: The right femur was dried overnight at 100°C. The femur was then incinerated for 12 h at 1000°C in Muffle apparatus to obtain ash. Then, ash was solubilized with 6 N HCL (Yang *et al*., 2008), quantitatively transferred into volumetric flask and completed to 100 ml HCL. The solutions were used for analysis of Ca and Mg concentrations using atomic absorption spectrophotometer (model 3300). However, phosphorus content was determined Spectrophotometericily (Perken, 1982).

Biochemical analysis: At the end of the experimental period (6 weeks), animals were fasted for 12 h then killed. Blood samples were collected from the portal vein into dry clean centrifuge tubes and left to clot at room

temperature. Serum was separated using centrifuge at 3000 rpm for 15 min. Serum was used for the estimation of lipid profile as Triglyceride (TG), Total Cholesterol (TC), Low-density Lipoprotein (LDL-c) and High-density Lipoprotein (HDL-c) as well as minerals such as Calcium (Ca), Phosphorus (P) and Magnesium (Mg).

Statistical analysis: Results were expressed as mean±SE. All data from the experiment were examined statistically by one-way analysis of variance with computerized SPSS package program (SPSS 9.00 software for Windows) by ANOVA test. A p-value <0.05 was considered statistically significant (Snedecor and Cochran, 1980).

RESULTS

Serum lipid profile: The results in Table 2 showed that mice fed on diets supplemented with corn oil, butter, animal fat or margarine had significant increases in serum TG levels, whereas groups fed on diets supplemented with soybean oil, palm oil, olive oil or sunflower oil had significantly lower in T.G levels than in the control group. Soybean oil and olive oil diets caused significantly lower in T.C; however, butter, animal fat and margarine diets caused significantly higher level as compared to non-oils or fats diets. There were not significant differences for groups fed on diets containing corn oil, palm oil and sunflower oil as compared to control group. Fed on diets containing soybean oil, corn oil, palm oil and olive oil caused a significant decreased in LDL-c, while fed on diets containing butter, animal fat and margarine caused a significant increased as compared to fed on diet without oils or fats. The serum HDL-c level appeared to be more significantly lower of mice fed on diets supplemented with soybean oil, palm oil, olive oil, butter, animal fat and margarine, however there was significantly higher of mice fed on diet containing sunflower oil as compared to mice fed on diet without oils or fats.

Serum calcium, phosphorus and magnesium: The effect of some dietary oils or fats on serum calcium, phosphorus and magnesium is depicted in Table 3. Results demonstrated that diets supplemented with palm oil, olive oil, sunflower oil, butter, animal fat or margarine caused significant decreases in the serum level of calcium in mice, whereas diet supplemented with corn oil had no effect as compared to the effect of diet without oils or fats. Diet supplemented with soybean oil caused a significant increase of serum calcium level as compared to the other groups. With regard to serum phosphorus level, data showed that mice fed on diets containing soybean oil, corn oil, palm oil, olive oil, sunflower oil, animal fat or margarine had significant decrease as compared to mice fed on diet without oils or fats and that containing butter. Serum levels of magnesium were significantly decreased in groups fed on soybean oil, olive oil, animal fat or margarine, while significantly increased in groups fed on diets containing sunflower oil or butter as compared to groups fed on diets without oils or fats, corn oil or palm oil.

Table 2: Effect of some dietary oils and fats on serum TG, TC, LDL-c and HDL-c in mice

	Parameters as Mean±SE			
Groups	TG (mg/dL)	TC (mmol/L)	LDL-c (mg/dL)	HDL-c (mg/dL)
Group (1) diet without oils or fats	254.20±1.46^{e}	14.05±0.79^{cd}	234.25±10.85^{b}	147.60±10.63^{b}
Group (2) diet with soybean oil	153.80±1.28^{g}	8.38±0.57^{f}	113.80±3.20^{e}	82.50±2.89^{d}
Group (3) diet with corn oil	282.80±1.39^{d}	11.88±0.54^{de}	170.40±13.07^{d}	132.20±7.41^{bc}
Group (4) diet with palm oil	236.00±0.32^{f}	11.22±0.37^{def}	173.40±10.40^{d}	123.00±1.82^{c}
Group (5) diet with olive oil	154.20±1.28^{g}	10.80±1.12^{ef}	128.80±6.36^{e}	120.40±10.30^{c}
Group (6) diet with sunflower oil	236.00±1.76^{f}	14.90±0.02^{c}	218.60±5.46^{bc}	217.00±11.14^{a}
Group (7) diet with butter	420.00±5.39^{c}	22.62±2.08^{b}	292.40±14.14^{a}	121.20±5.46^{c}
Group (8) diet with animal fat	433.20±0.74^{b}	22.26±1.15^{b}	292.50±7.35^{a}	114.20±6.55^{c}
Group (9) diet with margarine	479.60±3.14^{a}	27.64±0.58^{a}	293.40±17.01^{a}	110.80±6.39^{c}

Means±SE in each column with different superscript letters differ significantly at p<0.05

Table 3: Effect of some dietary oils and fats on serum calcium, phosphorus and magnesium in mice

	Parameters as Mean±SE		
Groups	Calcium (mg/dL)	Phosphorus (mg/dL)	Magnesium (mg/dL)
Group (1) diet without oils or fats	8.05±0.32^{b}	24.28±0.42^{a}	1.64±0.01^{c}
Group (2) diet with soybean oil	11.58±0.30^{a}	18.87±0.36^{b}	0.77±0.004^{d}
Group (3) diet with corn oil	7.65±0.31^{b}	17.50±1.17^{b}	1.54±0.13^{c}
Group (4) diet with palm oil	6.40±0.59^{cd}	17.56±0.80^{b}	1.72±0.15^{c}
Group (5) diet with olive oil	4.60±0.42^{ef}	12.53±0.28^{c}	0.93±0.03^{d}
Group (6) diet with sunflower oil	6.56±0.41^{c}	19.66±0.43^{b}	2.78±0.02^{b}
Group (7) diet with butter	5.36±0.15^{de}	24.70±1.75^{a}	4.45±0.34^{a}
Group (8) diet with animal fat	4.21±0.19^{f}	9.77±0.40^{d}	0.29±0.003^{e}
Group (9) diet with margarine	4.49±0.41^{ef}	17.29±0.56^{b}	0.95±0.05^{d}

Means±SE in each column with different superscript letters differ significantly at p<0.05

Femur bone length, volume and density: Effects of dietary oils and fats on femur bone length, volume and density in mice are recorded in Table 4. Data showed that mice fed on diet containing soybean oil had a shorter femur bone length (18.00±0.47 mm) than the control group (20.40±0.51 mm) that fed diet without oils or fats. Mice fed on the other tested oils and fats showed no significant changes in femur bone length. Concerning femur bone volume, mice fed different oils or fats had a significant decrease in femur bone volume as compared to those fed on diet without oils and fats, while those fed on diet containing margarine had non-significant increase in femur bone volume. With regarded to femur bone density, there were significant increase in bone density in mice fed diet containing olive oil, butter or animal fat. While those fed diet containing soybean oil, corn oil, sunflower oil or margarine had significant decreases in femur bone density, compared to the control group fed diets containing no oils and fats.

Concentrations of calcium, phosphorus and magnesium in femur bone of mice: As shown in Table 5, feeding mice on diets containing soybean oil, palm oil, olive oil, sunflower oil, butter or animal fat caused significant increases in calcium concentration in femur bone compared to the control group fed diet without oils and fats. Regarding concentrations of phosphorus, the diets only containing soybean oil, olive oil, sunflower oil, butter or animal fat induced significant increases, compared to the control group. Feeding mice diets containing soybean oil or margarine produced significant decrease in magnesium concentration in femur bone, while those feed diet containing butter showed significant increases in magnesium, compared to the control group. Mice fed on diets containing the other test oils or fats showed non-significant changes in the concentration of magnesium in femur bone.

Daily calcium intake, fecal calcium and urinary calcium: Results in Table 6 revealed that there was no significant difference in calcium intake for groups fed on diets containing tested oils or fats as compared to the group fed on diet without oils or fats. Mice fed on diet supplemented with corn oil has significantly higher calcium intake more than mice fed on olive oil, animal fat or margarine diets. Concerning fecal and urinary calcium execration, there were significant decreases in their levels in mice fed on diets containing oils or fats as compared to that without both of them.

Apparent calcium absorption, apparent calcium absorption ratio and apparent calcium balance: Effect of feeding mice for six weeks on diets supplemented with some dietary oils or fats on apparent calcium absorption, apparent calcium absorption ratio and apparent calcium balance is recorded in Table 7. The apparent absorption, apparent absorption ratio and apparent balance of calcium were significantly increased by feeding diets containing soybean oil, corn oil, palm oil, olive oil, sunflower oil, butter or animal fat.

Table 4: Effect of some dietary oils and fats on femur bone length, volume and density in mice

	Parameters as Mean±SE		
Groups	Length (mm)	Volume (cm^3)	Bone density (g/cm^3)
Group (1) diet without oils or fats	20.40±0.51^{ab}	0.74±0.01^{a}	0.84±0.004^{b}
Group (2) diet with soybean oil	18.00±0.47^{c}	0.40±0.004^{c}	1.54±0.17^{b}
Group (3) diet with corn oil	21.40±0.40^{a}	0.44±0.01^{c}	1.53±0.13^{b}
Group (4) diet with palm oil	19.00±0.76^{bc}	0.60±0.003^{b}	1.04±0.02^{b}
Group (5) diet with olive oil	20.80±0.74^{ab}	0.22±0.004^{d}	3.23±0.72^{a}
Group (6) diet with sunflower oil	19.80±0.66^{bc}	0.40±0.003^{c}	1.60±0.18^{b}
Group (7) diet with butter	19.00±0.45^{bc}	0.16±0.003^{d}	4.02±0.60^{a}
Group (8) diet with animal fat	21.00±0.32^{a}	0.24±0.01^{d}	3.35±0.60^{a}
Group (9) diet with margarine	20.60±0.75^{ab}	0.80±0.01^{a}	0.77±0.02^{b}

Means±SE in each column with different superscript letters differ significantly at $p<0.05$

Table 5: Effect of some dietary oils and fats on concentrations of calcium, phosphorus and magnesium in femur bone of mice

	Concentrations of (Mean±SE)		
Groups	Calcium (mg/g)	Phosphorus (mg/g)	Magnesium (mg/g)
Group (1) diet without oils or fats	232.13±4.16^{e}	99.54±1.71^{d}	29.03±2.99^{bc}
Group (2) diet with soybean oil	254.99±3.48^{c}	114.69±1.15^{bc}	15.54±1.72^{d}
Group (3) diet with corn oil	239.28±1.60^{de}	102.60±0.66^{d}	25.36±0.93^{c}
Group (4) diet with palm oil	248.63±4.52^{cd}	102.44±1.33^{d}	25.06±0.96^{c}
Group (5) diet with olive oil	267.37±3.84^{b}	117.20±1.62^{b}	26.35±2.46^{bc}
Group (6) diet with sunflower oil	253.54±3.81^{c}	111.49±1.58^{c}	25.10±1.52^{c}
Group (7) diet with butter	280.72±2.98^{a}	122.78±1.24^{a}	33.28±1.27^{a}
Group (8) diet with animal fat	266.56±4.23^{b}	116.51±1.95^{b}	31.29±1.18^{ab}
Group (9) diet with margarine	235.13±1.39^{e}	98.63±0.79^{d}	16.32±1.72^{d}

Means±SE in each column with different superscript letters differ significantly at $p<0.05$

Table 6: Effect of some dietary oils and fats on daily calcium intake and calcium excretion in feces and urine in mice

	Parameters as Mean±SE		
Groups	Calcium intake (mg/day)	Fecal calcium (mg/day)	Urinary calcium (mg/day)
Group (1) diet without oils or fats	31.50±0.79^{abc}	12.64±0.72^{a}	0.58±0.001^{a}
Group (2) diet with soybean oil	31.50±1.87^{abc}	6.90±0.53^{c}	0.44±0.01^{b}
Group (3) diet with corn oil	35.20±1.15^{a}	7.52±0.01^{c}	0.39±0.02^{cd}
Group (4) diet with palm oil	33.00±0.94^{abc}	7.26±0.39^{c}	0.37±0.001^{d}
Group (5) diet with olive oil	30.90±1.64^{bc}	4.02±0.50^{d}	0.25±0.002^{f}
Group (6) diet with sunflower oil	35.00±1.13^{ab}	6.59±0.40^{c}	0.29±0.002^{e}
Group (7) diet with butter	35.00±1.37^{ab}	3.30±0.29^{d}	0.19±0.001^{g}
Group (8) diet with animal fat	30.50±1.59^{c}	3.56±0.37^{d}	0.37±0.001^{d}
Group (9) diet with margarine	29.00±0.61^{c}	10.05±0.48^{b}	0.42±0.01^{bc}

Means±SE in each column with different superscript letters differ significantly at p<0.05

Table 7: Effect of some dietary oils and fats on apparent calcium absorption, apparent calcium absorption ratio and apparent calcium balance in mice

	Parameters as Mean±SE		
Groups	Apparent calcium absorption (mg/day)	Apparent calcium absorption ratio (%)	Apparent calcium balance (mg/day)
Group (1) diet without oils or fats	18.86±1.88^{c}	59.98±2.36^{d}	18.27±0.29^{d}
Group (2) diet with soybean oil	24.62±1.40^{b}	77.84±0.98^{b}	24.17±1.87^{c}
Group (3) diet with corn oil	28.48±1.07^{ab}	78.96±1.40^{b}	28.10±1.40^{ab}
Group (4) diet with palm oil	25.74±1.50^{b}	77.90±1.36^{b}	25.45±1.06^{bc}
Group (5) diet with olive oil	26.88±0.77^{b}	87.00±0.63^{a}	26.64±1.51^{bc}
Group (6) diet with sunflower oil	28.41±1.20^{ab}	81.24±0.66^{b}	28.03±0.77^{ab}
Group (7) diet with butter	31.70±1.29^{a}	90.60±0.73^{a}	31.51±1.20^{a}
Group (8) diet with animal fat	26.94±0.53^{b}	88.43±1.36^{a}	26.58±1.28^{bc}
Group (9) diet with margarine	18.95±1.88^{c}	65.35±2.36^{c}	18.52±0.54^{d}

Means±SE in each column with different superscript letters differ significantly at p<0.05

There were no significant changes in calcium apparent absorption and balance in the group fed on margarine diet as compared to the control group.

DISCUSSION

This study aimed to investigate the effect of different types of dietary oils and fats on lipid profile, calcium absorption and bone mineralization in male mice. Our results with regard to addition of soybean oil to the diet, agreed with previous studies founded that soybean oil reduced serum cholesterol and lipoproteins in different aged rats fed on hypercholesterolemic diets (Choi *et al*., 1993) and it improves serum lipid profile (Ramadan *et al*., 2008). These results may be possibly explains on the basis that soybean oil is rich in UNSFAs, especially PUSFAs. Polyunsaturated fats stimulate the catabolic rate of LDL-cholesterol, thus resulting in the reduction of serum LDL-cholesterol (Choi *et al*., 1993). Concerning addition of corn oil to the diet, our finding are similar to some extent with previous reports showing that rats fed a corn oil-rich diet had higher values of serum TG (Asadi *et al*., 2008) and significantly decreased in serum HDL-c (Shad *et al*., 2002). Feeding rats on diet containing palm oil significantly improved lipid profile as it reduced serum TG, TC and lipoproteins (Choi *et al*., 1993; Oluba *et al*., 2008) and decreased serum HDL-c concentrations compared with coconut oil (Scholtz *et al*., 2004), these results agreed with our findings. The pronounced effect of palm oil may be attributes to its antioxidant properties. Palm oil is rich in antioxidant vitamins tocotrienols and unsaturated analogue of tocopherols. Tocotrienols had a hypocholesterolemic effect probably through the inhibition of cholesterol synthesis (Choi *et al*., 1993; Karaji-Bani *et al*., 2006). Improvements in lipid profile in mice fed on the diet containing olive oil may be explains on the basis that olive oil is a rich source of MUSFA that improves lipid profile. The primary MUSFAs in the diet are oleic (C18:1, n-9) and palmitoleic (C16:1, n-9) acids. Olive oil is excellent source of oleic acid. Previous studies demonstrated that olive oils containing a large fraction of MUSFAs and a substantial amount of PUSFAs promote a better triacylglycerol clearance from the blood (Beynen *et al*., 1987). In additionally, a diet with olive oil is a good source of monounsaturated fatty reduced serum TG, LDL-c concentrations with respect to diets rich in SFAs (Hayes *et al*., 1994). Healthy heart effects from olive oil are attributed to its higher contents of monounsaturated fats and its higher ingredients of antioxidants (including: chlorophyll, carotenoids and the polyphenolic compounds: tyrosol, hydrotyrosol and oleuropein), all of these compounds have free radical scavenging ability and protect vitamin E found in olive oil (Morello *et al*., 2007; Puela *et al*., 2004). Diet rich in olive oil, has much more favorable effects on blood lipid profile and plasma lipoproteins compared with coconut

oil (Mroueh *et al*., 2009). With regard to the effect of sunflower oil, our findings agreed with Kris-Etheton and Yu (1997) who reported that HDL-c production was greater in young rats fed on safflower than in those fed on palm oil. These results may be related to the type of fatty acids in sunflower oil, which is rich in PUSFAs. Polyunsaturated fatty acids are effective in lowering serum cholesterol.

Concerning, the effect of butter, animal fat, or margarine on serum lipid profile, our findings agreed with previous reported showing that, butter and margarine produced a significant rise in serum TC in normocholesterolemic women (Wardlaw and Snook, 1990) and increased serum TC, LDL-c and decreased HDL-c (Lichtenstein *et al*., 1993). These results may be explained on basis that the high SFAs and low PUSFAs contents in butter, which is an important contributing factor to raising serum cholesterol level. More recently, the *Trans* fatty acids resulting from the partial hydrogenation of vegetable oils (margarine) produced undesirable serum lipoprotein profiles (Mensink and Katan, 1990). Therefore, the hypercholesterolemic effects of margarine are to decreased proportion of PUSFAs, increased proportion of SFAs and in part to the independent effect of *trans* fatty acids. Feeding mice on diets containing butter and animal fat diet had lower serum level of TG, TC and LDL-c as compared to those feeding margarine diets. These results explained on based antiatherogenic effect of Conjugated Linoleic Acid (CLA) content of butter and animal fat. Milk and animal fat from ruminant animals are natural sources of CLA (Chin *et al*., 1992). CLA have beneficial effects on the atherosclerotic process by reducing plasma total and LDL cholesterol, the LDL/HDL cholesterol ratio (atherogenic index) and triglyceride levels in rabbits fed on atherogenic diet (Lee *et al*., 1994). Other study reported that the CLA-fed hamsters exhibited lower levels of plasma total cholesterol and triglycerides (Yurawecz *et al*., 1999).

Our results with regard to the effect of different dietary oils or fats on bone mineralization revealed that soybean oil increased serum calcium concentration, while decreased phosphorus level. It also increased calcium and phosphorus concentration in femur bone and increased bone density. Increased calcium concentration in the serum caused by adding soybean oil to the diet could be possibly explained by the reduced fecal and urinary calcium excretion that reported in the presented study. These findings were partially similar to previous study founded that soybean oil in the diet have a role in the prevention of osteoporosis as it reduce bone loss and increase bone density (Jie *et al*., 2000). These results may be attributed to soybean oil contents PUSFAs, which are beneficial in inhibits the activity of osteoclasts and enhance the activity of osteoblasts in animals (Watkins *et al*., 1997).

The effect of corn oil on serum calcium, phosphorus and magnesium levels and fecal, urinary calcium excretion, bone density and apparent calcium absorption and balance, explained on the basis that corn oil is rich in PUSFAs, which elevate femur calcium content and enhance calcium balance (Mollard and Weiler, 2006).

With regard to effect of palm oil on bone health, our results were to some extant similar to the previous study explained the effect of palm oil on bone turnover in thyrotoxic rats on the basis of its content of vitamin E which reduced bone resorption to a greater extent than bone formation (Ima-Nirwana *et al*., 1993). In addition to, vitamin E improves bone calcium content in both the left femur and the fifth lumbar vertebra. Its deficiency cause loss of bone calcium in growing female rats and this could be due to increased free radical activity or decreased calcium availability for bone deposition. Supplementing animals with palm oil containing a mixture of tocopherol and tocotrienols was effective in preventing the loss in bone calcium (Norazlina *et al*., 2002).

The positive effects of olive oil may be due to its higher contents of MUSFAs, which had a positive associated with bone mineral density (Trichopoulou *et al*., 2002). Olive oil prevents the bone loss and improves bone mineral density in rats (Puela *et al*., 2004).

The beneficial effects of sunflower oil on bone health in mice were confirmed by increased retention of calcium and phosphorus in femur bone. It caused a significant decrease in serum levels of calcium and phosphorus as well as fecal and urinary calcium excretion. In addition to, it increased bone density, femur calcium and phosphorus contents and apparent calcium absorption and balance. Therefore, calcium retained in the bone. Recent study reported that sunflower oil is rich in polyunsaturated fatty acids, which elevate femur calcium content, enhance calcium balance, increased calcium absorption efficiency and enhanced calcium bioavailability in rats (Perez-Granados *et al*., 2006), these results agreed with our results.

In contrast, our results indicated that butter, animal fat and margarine diets significantly decreased serum concentration of calcium and fecal and urinary calcium excretion. Therefore, calcium retained in the bone, as showed by the increased in bone density, apparent calcium balance and calcium and phosphorus content induced by addition of butter or animal fat to diet. However, margarine in diet did not affect significantly the bone density, femur calcium and phosphorus content. These results indicate that the type of fat in the diet play an important role on bone health. Watkins *et al*. (1996) indicated that growing animals fed saturated fat enriched diets had significantly greater bone formation rate compared to those given soybean oil. The beneficial effects of margarine (hydrogenated oil) on bone mineral content, mechanical and histological properties might be attributable to their decreased PGE2 production-

induced bone resorption (Liu *et al*., 2003). The positive effects of butter and animal fat on calcium absorption and bone calcium content may be related to its content of CLA (Yurawecz *et al*., 1999). CLA occurs naturally in many foods, though the primary sources are foods from ruminant animals such as beef, lamb and dairy products (Decker, 1999). In growing animals given butterfat, bone formation was increased and the production of ex vivo bone prostaglandin (a potent stimulator of bone resorption) decreased (Watkins *et al*., 2000). The increase in the rate of bone formation may be attributed to reduce the level of arachidonic acid and PGE2 production as well as higher levels of IGF-1 in bone (Watkins and Seifert, 2000). Reduced rate of PGE2 production from CLA might be due to a competitive inhibition of n-6 PUFA elongation that results in a lower amount of available substrate for cyclooxygenase, the enzyme necessary for PGE2 production (Watkins *et al*., 1997). CLA may directly or indirectly alter cyclooxygenase-2 (the inducible form of cyclooxygenase) activity or expression and therefore affect PGE2 production (Brownbill *et al*., 2005).

Conclusion: This study concluded that dietary intake of vegetable oils are more beneficial than animal fats (butter and beef fat) and hydrogenated oils (margarine), especially olive oil and sunflower oils, as they improve lipid profile and bone mineral contents in mice. It is known that fatty acid composition of food is more associated with variations in the plasma total cholesterol level. Therefore, dietary intake of vegetable oils, which are rich in unsaturated fatty acids, reduces the risk of atherosclerosis and coronary heart disease, while saturated fatty acids have the opposite effect. However, data revealed also that butter and animal fats are more beneficial than vegetable oils for osteoporosis as they increase calcium and phosphorus deposition in femur bone and reduce fecal and urinary calcium excretion in mice.

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