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Research Article

EFFECT OF SOME DIETARY LIPIDS ADMINISTRATION ON THE LEVELS OF SOME SERUM MINERALS IN WISTAR ALBINO RATS

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ABSTRACT
The type of lipid in the diet is essential for the proper functioning of the body system. This study was conducted to investigate the effects of administration of soybean oil, olive oil and margarine on the serum levels of calcium, iron and zinc. Group 1 received standard feed and tap water, while groups 2, 3, and 4 rats received 2 ml/kg body weight of soybean oil, olive oil and margarine respectively, orally for 21 days. Rat fed on diet containing soya bean oil had a significant ($p<0.05$) increase in serum calcium (mg/dl) levels while rats fed on olive oil and margarine had a significant ($p<0.05$) decrease compared to the control group. Diet with margarine caused significant ($p<0.05$) increases in serum zinc (µg/dl) levels whereas the group fed olive oil had significant ($p<0.05$) decreases in serum zinc compared to the control group. There was no significant ($P>0.05$) difference in the serum zinc levels for the group fed soya bean oil as compared with the control group. The results showed significant ($p<0.05$) increases in the serum iron levels with margarine producing the highest increase (485.25±26.19mmol/l) relative to the control group (281.0±6.12mmol/l). The margarine fed group had significant ($p<0.05$) increase on serum zinc levels (191.85±4.33µg/dl) whereas the group fed olive oil had significant ($p<0.05$) decrease in serum zinc (144.77±5.23µg/dl) relative to the control group (179.90±4.56µg/dl). It can be concluded that the administration of soy bean oil increased the serum calcium levels which could be beneficial in preventing osteoporosis. The incorporation of these lipids in normal diet will serve as a good source of some vital minerals.

Keywords: *Minerals, Calcium, Iron, Zinc, Dietary Lipid*

INTRODUCTION
Dietary fats and oils are known to provide concentrated source of energy for human metabolic processes (Rezq *et al*., 2010). Dietary lipids are known as macronutrients and are not only fundamental energy-providing nutrient for human metabolic processes, but also greatly impact specific cell functions. In addition, they are the main source of fat-soluble vitamins (Sanchez-Muniz and Bastida, 2006). Dietary lipids are composed of different types of fatty acids. Animal studies indicate that high-fat diets can adversely affect bone health (Hoffman *et al*., 1999). Report (Parhami, 2003) shows that saturated fatty acids could weaken bone health while some studies show that long-chain polyunsaturated fatty acids influence bone mass in different animal models (Watkins *et al*., 2003). The effect of dietary lipids on the bone has been hypothesized to include alterations in calcium absorption, prostaglandin synthesis, osteoblast formation and lipid oxidation (Rezq *et al*., 2010; Hag *et al*., 2003). The absorption of dietary minerals is influenced by nutritional needs of the organism, by the amount present in the diet and factors influencing the bioavailiability and utilization of the minerals. Whereas nutritional requirements tend to modulate homeostatic mechanisms of absorption, bioavailability of minerals is principally influenced by exogenous factors (Lukaski, 2007). However because dietary fat represent a significant fraction of daily energy intake and because the *in vivo* physiological interactions between fatty acids and minerals have been reported, there is increasing interest in examining the effects of dietary lipids on the bioavailiability of minerals (Lukaski, 2007). The purpose of this study is to evaluate the effects of different dietary lipids administration on some essential minerals including calcium, zinc, and iron.

MATERIALS AND METHODS

Chemicals and reagents: All chemicals and reagents that were used in this work were of analytical grade. Serum calcium was determined using Randox laboratory kit reagents. Serum zinc was estimated using zinc fluid monoreagent produced by Centronic GmbH; serum iron was determined by iron/TIBC reagent set produced by TECO Diagnostics. The absorbance's of all the tests were determined using spectrophotometer.

Oils and fat: Soya bean oil (Royal soya bean oil; Argentina), Olive oil (Goya extra virgin oil) and margarine (Blue band) were purchased from the local market in Umuahia, Abia state. These were the three sources of dietary lipids (polyunsaturated fatty acid, monounsaturated fatty acid and saturated fatty acids respectively) used in the study.

Experimental design: Sixteen female Wistar albino rats weighing between 160-165g (12 -13 weeks old) were purchased from the laboratory animal center of department of Zoology, University of Nigeria Nsukka, Enugu State. The rats were kept in cages for two weeks to acclimatize and were allowed free access to food and water *ad libitum.* The protocol was approved by the experimental animal ethics committee of the College of Natural and Applied Sciences, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The rats were randomly distributed into four groups of four animals each (1-4). Group 1 (control group) received standard feed (Grand cereal Ltd, Nigeria) and tap water, group 2 received 2 ml/kg body weight of soybean oil, group 3 received 2 ml/kg body weight of olive oil, while group 4 received 2 ml/kg body weight of margarine respectively, orally for 21 days.

Sample collection: overnight prior to collection of samples, the animals were starved of food. Blood was collected from ocular median-cantus vein of the rats with the aid of capillary tubes and transferred to test tubes and allowed to clot and subsequently centrifuged at 2000rpm for 10 minutes to obtain the serum component. The separated serum was stored 2-8°C in a refrigerator. All analyses were completed within 24 hours of sample collection.

Statistical analysis: Data collected were subjected to analysis of variance (ANOVA) using the paired t-test statistics. The mean ± SD of each parameter was taken for each group. Test probability value of $p<0.05$ was considered significant. The analysis was carried out on SPSS for windows version 14.

RESULTS AND DISCUSSION

Results

The effect of some dietary lipids on serum calcium is depicted in Figure 1. The results showed that serum calcium was significantly ($p<0.05$) increased in rats fed soya bean oil (16.60±0.40mg/dl) compared to the control group (8.09±0.47mg/dl). There was a significant ($p<0.05$) decrease on the serum calcium level (5.42±0.21mg/dl) in the group administered margarine while the administration of olive oil could not elicit a significant ($p>0.05$) decrease in the serum calcium level (7.76±0.20mg/dl). The effect of the administration of dietary lipids on the serum iron levels is depicted in Figure 2. The results showed significant ($p<0.05$) increases in the serum iron levels with margarine producing the highest increase (485.25±26.19mmol/l) relative to the control group (281.0±6.12mmol/l). The results in Figure 3 showed that rats fed on margarine had significant ($p<0.05$) increase in serum zinc levels (191.85±4.33µg/dl) whereas the group fed olive oil had significant ($p<0.05$) decrease in serum zinc (144.77±5.23µg/dl) relative to the control group (179.90±4.56µg/dl). The results also indicated that serum zinc ion level of the soybean oil fed group also decreased (173.4±2.11µg/dl) non significantly ($p>0.05$) compared to the control group (179.9±4.56µg/dl).

Discussion

Because dietary fats and lipids represent a significant fraction of daily energy intake the aim of the present study was to investigate the effects of supplementation of diets with soybean oil, olive oil and margarine on serum availability of some serum minerals and electrolyte.

Calcium is a very important mineral in human metabolism. In addition to its widely known role in bone structure; calcium is used to help control muscle and nerve function, as well as, to manage acid/base balance in the blood stream. About 99% of the total body calcium stores are found in bones and teeth

(Zhu and Prince, 2012). Other nutrients provide important support to help absorb and use calcium in the bones. Those nutrients include Vitamin D, potassium and magnesium (Christakos *et al*., 2011). We observed from our results (Figure 1) that the administration of margarine significantly reduced the serum calcium levels with olive oil also reducing it although non-significantly. Our result is in line with previous report that margarine and olive oil diets significantly decreased serum concentration of calcium in mice (Rezq *et al.,* 2010). The positive effects of olive oil on serum calcium may be attributed to its higher contents of monounsaturated fatty acids, which had a positive association with bone mineral density (Trichopoulou *et al*., 2002). Olive oil and its main phenolic micronutrient (oleuropein) prevent inflammation-induced bone loss in the ovariectomised rat (Puel *et al*., 2004). Our results is in contrast to another finding which reported increased serum levels of vitamin D and calcium ion in young men after replacement of butter with soft margarine in usual diet (Kozlowska-Wojciechowska *et al*., 2002). This findings show that the type of fat in the diet play an important role in bone health. The beneficial effects of margarine on bone mineral content, histology and mechanical properties may be attributed to their decreased PGE2 production and induced bone resorption (Liu *et al*., 2003). We also reported a significant increase on the serum calcium concentration induced by the administration of soybean oil. Rezq *et al.,* (2010) reported increased serum calcium concentration in mice administered soybean oil. The result from our study is consistent with the report of Zhog *et al.,* (2000) which stated that soy bean oil in the diet have a role in the prevention of osteoporosis as it reduced bone loss and increase bone density. Hala and Mogbolal (2013) reported that feeding of ovariectomized rats with diet containing 5% soy bean oil significantly restored the decreased serum calcium and phosphorus levels induced by ovariectomy to normal levels. The findings suggest that supplementation with soybean oil was more effective in inhibiting bone resorption and increasing bone formation (Hala and Mogbolal, 2013). These findings are consistent to those of (Shuid *et al*.,; Boulbaroud *et al*.,; Byun and Lee, 2010) which reported that vegetable oils contain omega-3 and omega-6 polyunsaturated fatty acids which increased serum calcium and phosphorus concentrations and reduced urinary calcium and phosphorus excretion, thus enhanced bone formation. These results may be attributed to the high content of polyunsaturated fatty acids found in soya bean oil which are beneficial in inhibiting the activity of osteoclast and enhancing the activity of osteoblasts in animals (Watkins *et al.,* 1997). Studies in laboratory rats, although inconclusive, indicate two trends. Calcium absorption and utilization are impaired when fat intake exceed 10% of the energy intake. Saturated fatty acids or triglycerols made up of saturated fatty acids lower calcium utilization (Lukaski, 2007). Feeding rats with olive oil, significantly improved serum iron levels. This result agreed with previous result that legumes in general and soya bean in particular have a high iron and ferritin content (Lobreaux and Briat, 1991). Previous studies measuring soya bean iron bioavailability appear to be conflicting. For example, Lynch *et al.,* (1984) reported a very small absorption of iron from soy meal, while Sayers *et al.,* (1973) showed a much larger percentage of iron absorption. Another study reveals that iron in soya bean is an available source of iron (Laura *et al*., 2003). The study of Laura *et al.,* (2003) closely resembles that of Sayers *et al.,* (1973) who used intrinsic isotope labeling, ferritin as the food iron form, and females as the study participants. Overall, the women in the Sayers *et al.,* (1973) study had a lower iron status than the women in Laura *et al.,* (2003) study. The result of the present study agrees with that of Sayers *et al.,* (1973) which showed that iron in soya beans is in fact a bio available source of iron for iron-deficient humans. The result of Pabon and Lonnerdal (2001) suggests that saturated fats may increase iron absorption and that part of this may be achieved by changes in the fatty acid composition of intestinal mucosa. From our result there was improved serum level of iron in the rats fed olive oil. It has also been revealed that eating healthy fats in olive oil can provide adequate iron and lower the risk of disease. Olive oil also helps to boost iron intake as they combine iron-rich foods with foods that help increase iron absorption. Also margarine improved serum levels of iron. Another study revealed that iron fortification of margarine with micronized ground ferric pyrophosphate (MGFePP) or sodium iron edetate (NaFeEDTA) improved body iron stores in women of reproductive age (Maria *et al*., 2010). The report of Perez-Granados *et al.,* (2001) showed that there was no difference on the iron-binding capacity and haemoglobin values in rats administered unused olive oil and olive oil used in frying.

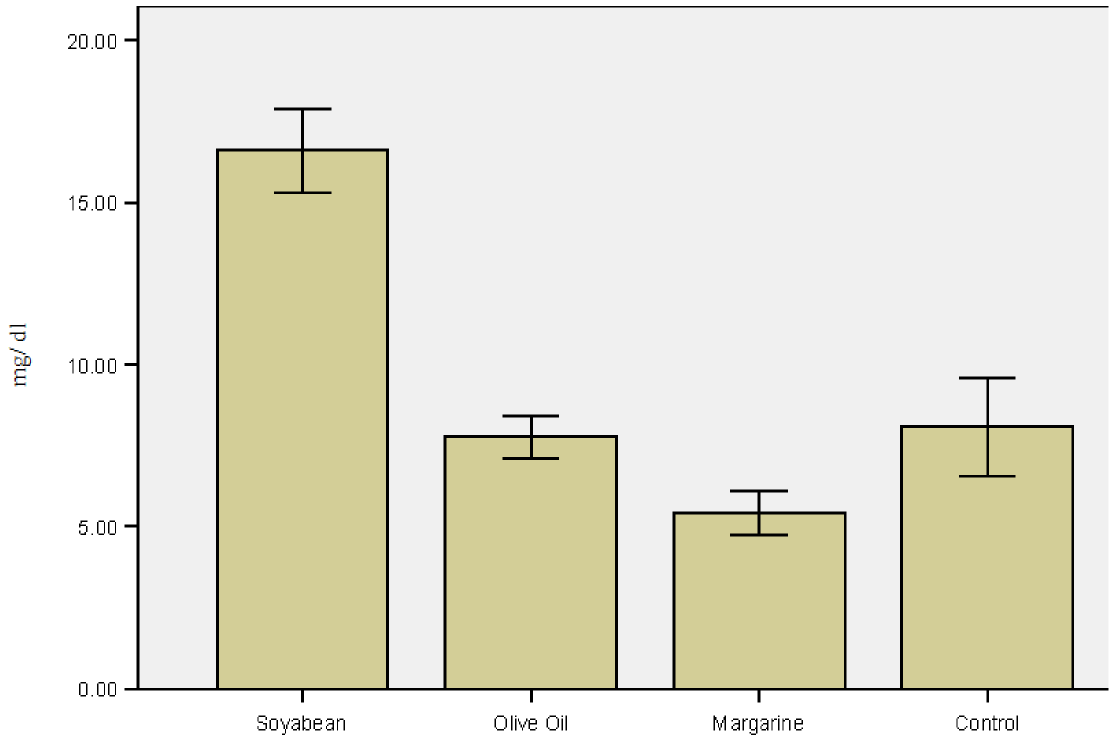

Figure 1: Effect of dietary lipids administration on serum levels of calcium(mg/dl)

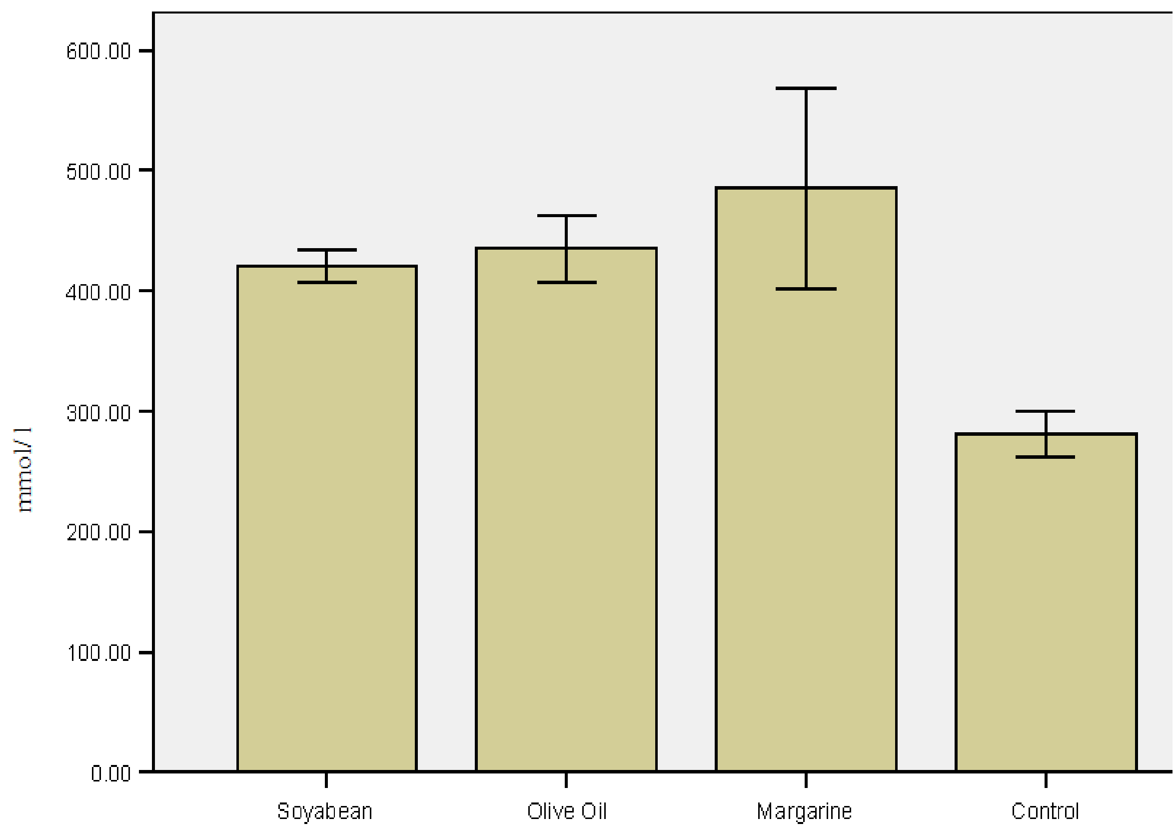

Figure 2: Effect of dietary lipids administration on serum levels of iron(mmol/l)

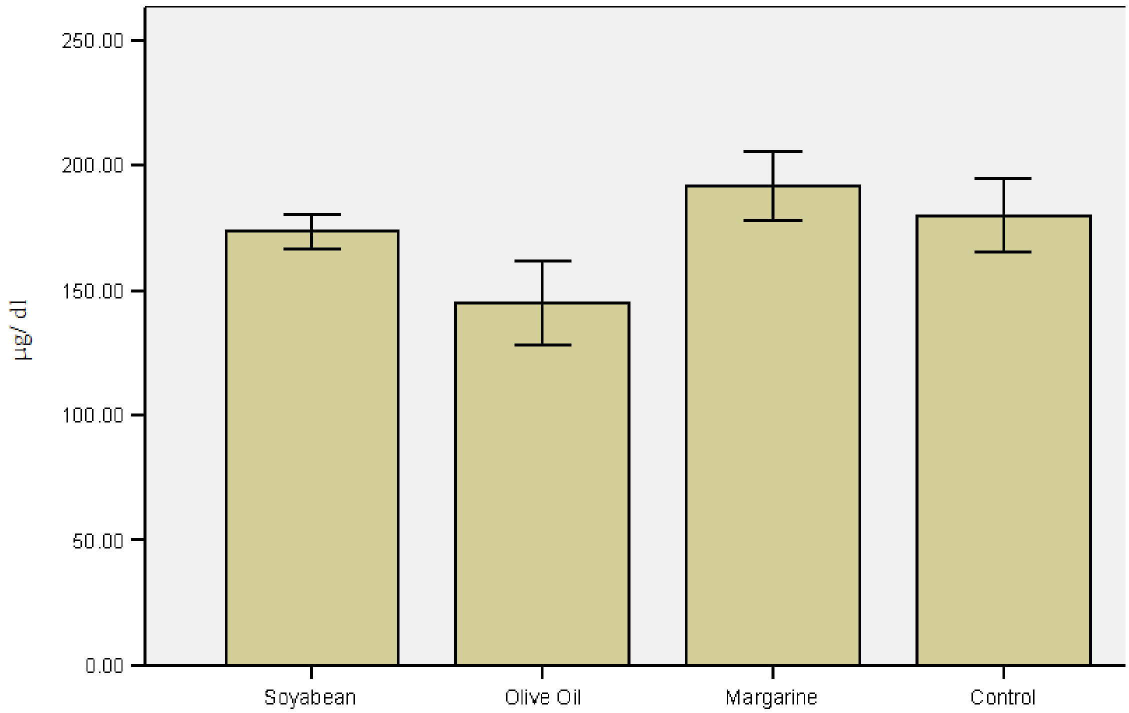

Figure 3: Effect of dietary lipids administration on serum levels of zinc (µg/dl)

With regard to the effect of soya bean oil on serum zinc levels, this study agrees with previous studies on zinc absorption (Greger *et al.*, 1978) which showed that soy isolate did not have any significant effects on the bioavailability of dietary zinc. This observation was supported by Vanstratum and Rudrum (1979). Also previous studies on zinc bioavailability in soy bean meal also revealed that zinc-antagonizing components, primarily phytate, in soy products reduce the utilization of inorganic zinc added to soy-containing diets (Edward and Barker, 2000). Based on this study, serum zinc levels were increased in margarine fed rats while olive oil induced a significant decrease in serum zinc. Zinc, an essential trace element, has been shown to have a potent stimulatory effect on bone formation (Yamaguchi *et al*., 1987; 1994). Zinc can stimulate protein synthesis in osteoblastic cells and bone tissue culture systems *in vitro* by means of activating aminoacyl-tRNA synthetase (Yamaguchi *et al*., 1987; 1994). Zinc has also been shown to inhibit osteoclastic bone resorption (Yamaguchi *et al.*, 1998). The findings from these animal studies indicate that consumption of a diet consisting of polyunsaturated fatty acids can depress zinc and calcium ions status (Lukaski, 2007).
It can be concluded that the administration of soy bean oil increased the serum calcium levels which could be beneficial in preventing osteoporosis. The incorporation of these lipids in normal diet will serve as a good source of some vital minerals.

REFERENCES

Boulbaroud S, Mesfioui A, Arfaoui A, Quichou A and El-Hessni A (2008). Preventive effects of flaxseed and sesame oils on bone loss in ovariectomized rats. *Pakistan Journal of Biological Sciences* **11**(13) 1696-1701.
Byun JS and Lee SS (2010). Effect of soybeans and sword beans on bone metabolism in a rat model of osteoporosis. *Annals of Nutrition and Metabolism* **56**(2) 106-112.
Christakos S, Dhawan P and Porta A (2011). Vitamin D and Intestinal calcium absorption. *Molecular Cell Endocrinology* **347** 936-942.
Edward HM and Baker DH (2000). Zinc bioavailability in soy bean meal. *Journal of Animal Science* **78** 1071-1021.

Greger JL, Abnernathy RP and Benneth OA (1978). Zinc and nitrogen balance in adolescent females fed varying levels of zinc and soy protein. *American Journal of Clinical Nutrition* **31** 112-116.

Haag M, Magada ON, Claassen N, Bohmer LH and Kruger MC (2003). Omega-3 fatty acids modulate ATPases involved in duodenal calcium absorption. *Prostagldin Leukotrienes Essential Fatty Acids* **68** 423- 429.

Hala MAW and Magbolah SHA (2013). Effect of Feeding on Diets Supplemented by Some Vegetable Oils on Blood Lipids and Bone Mineral Content in Osteoporotic Rats. *Life Science Journal* **10**(1) 1458-1465.

Hoffman R, Lawrence L, Kronfeld D, Cooper W, Sklan D and Dascanio J (1999). Dietary carbohydrates and fat influence radiographic bone mineral content in growing foals. *Journal of Animal Science* **77** 3330-3338.

Kozlowska-Wojciechowska, Mararewicz-Wujoc M and Nowicka G (2002). Increased levels of vitamin D and calcium in young men after replacement of butter with soft margarine in usual diet. *Polskie Archiwum Medycyny Wewnętrznej* **108**(4) 953-958.

Laura EM, Ross W, Elizabeth CT and John LB (2003). Women with how iron stores absorb iron from soya beans. *American Journal of Clinical Nutrition* **77**(1) 180-184.

Liu D, Veit HP, Wilson JH and Denbow DM (2003). Long-term supplementation of various dietary lipids alters bone mineral content, mechanical properties and histological characteristics of Japanese qual. *Poultry Science* **82** 831-839.

Lobreaux S and Briat JF (1991). Ferritin accumulation and degradation in different organs of pea (*pisum sativum*) during development. *Biochemical Journal of Nutrition* **274** 601-606.

Lukaski HC (2007). Dietary fatty acids and minerals. In: *Fatty Acids in Food and Their Health Implications,* edited by Chow CK (Marcel Dakker, Inc.) New York 541-554.

Lynch SR, Beard JL, Dassenko SA and Cook JD (1984). Iron absorption from legumes in humans. *American Journal of Clinical Nutrition* **40** 42-47.

Maria A, Winifred T, Michael BZ, Jasmin TF, Martin J, Guus SD, Leon GJ and Richard FH (2010). Random serial sampling to evaluate efficacy of iron fortification: a randomized controlled trial of margarine fortification with ferric pyrophosphate or sodium iron edetate. *American Journal of Clinical Nutrition* **9**(5) 1094-1104.

Pabon ML and Lonnerdal B (2001). Effects of type of fat in the diet on iron bioavailability assessed in suckling and weaning rats. *Journal of Trace Element in Medicine and Biology* **15**(1) 18-23.

Parhami F (2003). Possible role of oxidized lipids in osteoporosis: could hyperlipidemia be a risk factor?. *Prostaglandins Leukotrienes and Essential Fatty Acids* **68** 373- 378.

Perez-Granados AM, Vaquero MP and Navarro MP (2001). Sunflower oil versus olive oil and iron metabolism in rats influence of a frying process. *Journal of the Science of Food and Agriculture* **81**(1) 115 120.

Puel C, Quintin A, Mathey J, Obled C, Mazura A, Davicco MJ, Lebecque P, Skaltsounis AL and Coxam V (2004). Olive oil is tthe main phenolic micronutrient (oleuropein) prevent inflammation-induced bone loss in the ovariectomised rat. *British Journal of Nutrition* **92** 119-127.

Rezq AA, Fatma AL and Attia AM (2010). Effectof Some Dietary Oils and Fats on Serum Lipid Profile, Calcium Absorption and Bone MIneralization in Mice. *Pakistan Journal of Nutrition* **9**(7) 643-650.

Sanchez-Muniz FJ and Bastida S (2006). Effect of frying and thermal oxidation on olive oil and food quality. In: *Olive oil and Human Health* (Oxford Shire: International Publishing) 74-108.

Sayers MH, Lynch SR, Jacobs P, Charlton RW, Bothwell TH, Walker RB and Mayet F (1973). The effect of ascorbic acid supplementation on the absorption of iron in maize, wheat and soya. *British Journal of Haematology* **24** 209-218.

Shuid AN, Chuan LH, Mohamed N, Jarin K, Fong YS and Soliman IN (2007). Recycled palm oil is better than soy oil in maintaining bone properties in a menopausal syndrome model of ovariectomized rats. *Asian Journal of Clinical Nutrition* **16** 393- 402.

Trichopoulou A, Naska A and Costacou T (2002). Dafen III group disparities in food habits across Europe. *Proceedings of Nutrition Society* **61** 553-558.
Vanstratum PG and Rudium M (1979). Effects of consumption of processed soy proteins on minerals and digestion in man. *Journal of the American Oil Chemists' Society* **56** 130-134.
Watkins BA, Shen CL, MuMurtry JP, Xu H, Bain SD and Allen KG (1997). Dietary lipids modulate bone prostaglandin E2 production, insulin-like growth factor concentrations and formation rate in chicks. *Journal of Nutrition* **127** 1084-1091.
Watkins BA, Li Y, Allen KG, Hoffman WE and Seifert MF (2000). Dietary ratio of (n-6) to (n-3) polyunsaturated fatty acids alters the fatty acid composition of bone compartments and biomarkers of bone formation in rats. *Journal of Nutrition* **130** 2274- 2284.
Yamaguchi M, Oishi H and Suketa Y (1987). Stimulatory effect of zinc on bone formation in tissue culture. *Biochemical Pharmacology* **36** 4007–4012.
Yamaguchi M, Kishi S and Hashizume M (1994). Effect of zinc-chealating dipeptides on osteoblastic MC3T3-E1 cells: Activation of aminoacyl-tRNA synthesis. *Peptides* **15** 1367–1371.
Yamaguchi M (1998). Role of zinc in bone formation and bone resorption. *Journal of Trace Element in Experimental Medicine* **11** 119–135.
Zhong JM, Shimanuki AI, Kawasaki Y and Yamaguchi M (2000). Preventive effect of dietary soybean on bone loss in ovariectomized rats: enhancement with isoflavone and zinc supplementation. *Journal For Health Science* **46** 263-268.
Zhu K and Prince RL (2012). Calcium and bone clinical biochemistry. *Bone and Calcium: The Canadian Society of Clinical Chemists* **45**(12) 861-976.