The Effect of Sesame, Sesame Oil and Yogurt on Osteoporosis in Rats

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Abstract

Osteoporosis is a disease that affects many millions of people around the world. The present study aimed to treated female rats' osteoporosis using sesame, sesame oil and yogurt as sources rich in calcium. The experiment was carried out at the Post Graduated Lab of Home Economics Faculty, Helwan University. Animals were housed in well aerated cages under hygienic condition and feed on basal diet for one week for adaptation. After the adaptation period, rats were be divided into two main groups, as follows: -First group: Negative control group, rats (n=7) were fed on basal diet only during the experimental period. Second group: Rats (n=49), were received oral predisone acetate (4.5 ml/kg b.w./ day twice a week to establish osteoporotic, then the animals were divided as follow:

subgroup (1): Rats (served as positive control group) were fed on basal diet only.

subgroup (2): Rats were fed on basal diet supplemented with the 50g sesame per kg of basal diet.

subgroup (3): Rats were fed on basal diet supplemented with the 100g sesame per kg of basal diet.

subgroup (4): Rats were fed on basal diet supplemented with the 50g sesame oil per kg of basal diet.

subgroup (5): Rats were fed on basal diet supplemented with the 100g sesame oil per kg of basal diet.

subgroup (6): Rats were fed on basal diet supplemented with the 50g yogurt per kg of basal diet.

subgroup (7): Rats were fed on basal diet supplemented with the 100g yogurt per kg of basal diet.

Calcium and phosphors in serum and femur bone of rats were determined as well as liver function, BMD and BMC as well as

histopathological examination were determined. According to the obtained results, it could be recommended that Sesame, sesame oil and yogurt may promote health 9 osteoporosis and liver function) so they must be taken daily. Sesame, sesame oil and yogurt daily consumption may be recommended for osteoporosis, liver function due to its beneficial effects. Nutrition education programs should be carried out to the public with the benefits of sesame, sesame oil and yogurt.

Keywords: Sesame, Yogurt, Osteoporosis, Rats and Calcium

Introduction

Osteoporosis is a disease that affects many millions of people around the world. Osteoporosis is a health condition that weakens bones, making them fragile and more likely to break. It develops slowly over several years and is often only diagnosed when a fall or sudden impact causes a bone to break (fracture) **(Jane and Jasminka, 2013)**. Osteoporosis is the most common health condition among metabolic bone disease, which is related to a decrease in bone minerals density, and microstructural deterioration of bone tissue **Lorentzon and Cummings (2015).** Osteoporosis is a multifactorial skeletal disease, characterized by reduction in bone mass and disruption of the micro architectural structure of bone tissue, resulting in loss of mechanical strength and increased risk of fracture **(Anonymous.,2000).** Osteoporosis is a leading cause of mortality and morbidity in the elderly and a key factor in the high cost of medical care (**Kanis el al., 2005).** Calcium is vital for life muscle function; nerve activity and bone mineralization depend on an accurate balance between the extracellular and intracellular calcium **(Brown 2015).** The study of **Kamchan et al. (2022)** reported that sesame seed has a high level of calcium but has limited bioavailability because of the presence of oxalate, phytate and fiber. **Poneros-Schneier et al. (2021)** investigated the bioavailability of calcium in several foods were investigated, and reported that sesame oil had a calcium bioavailability of about 65% **(Kanis et al., 2005).** In addition, some studies claimed about the drastic benefits of

sesame for inhibition of plaque formation in clinical situations **(Smith et al., 1985).** In addition to causing permanent pain, osteoporosis causes some patients to lose height. When osteoporosis affects vertebrae, or the bones of the spine, it often leads to a stooped or hunched posture **Khadilkar, and Mandlik (2015).** The trouble is of osteoporosis is a "silent disease ,"because there are no symptoms prior to a fracture. The most common injuries in people with osteoporosis are broken wrist and broken hip **(Ferdous et al., 2015).** Osteoporosis is more likely to occur in people who have older age, gender, and endocrine disorders as estrogen deficiencies in Women. Also, reduced sunlight exposure, environmental factors, dietary conditions as calcium deficiencies (low calcium intake), and a lifelong lack of calcium plays a role in the development of osteoporosis. Low calcium intake contributes to diminished bone density, early bone loss and an increased risk of fractures, poor living habits **(Bárbara and Lígia, 2010).** Maintaining a healthy lifestyle can reduce the degree of bone loss **(Kaptoge et al., 2013).** The present study aimed to treated female rats' osteoporosis using sesame, sesame oil and yogurt as sources rich in calcium.

Materials and Methods

Experimental Design:

Animals were housed in well aerated cages under hygienic condition and feed on basal diet for one week for adaptation. After the adaptation period, rats were be divided into two main groups, as follows: -

First group: Negative control group, rats (n=7) were fed on basal diet only during the experimental period. **Second group:** Rats (n=49), were received oral predisone acetate (4.5 ml/kg b.w./ day twice a week to establish osteoporotic models according to **(Liao et al., 2003**). then the animals were divided as follow:

Subgroup (1): Rats (served as positive control group) were fed on basal diet only.

Subgroup (2): Rats were fed on basal diet supplemented with the 50g sesame per kg of basal diet.

Subgroup (3): Rats were fed on basal diet supplemented with the 100g sesame per kg of basal diet.

Subgroup (4); Rats were fed on basal diet supplemented with

Subgroup (5): the 50g sesame oil per kg of basal diet.
Rats were fed on basal diet supplemented with the 100g sesame oil per kg of basal diet.

Subgroup (6): Rats were fed on basal diet supplemented with the 50g yogurt per kg of basal diet.

Subgroup (7): Rats were fed on basal diet supplemented with the 100g yogurt per kg of basal diet.

Biological Evaluation:

Feed intake was recorded daily and animals were weighed at the beginning and twice a week throughout the experimental period. Body weight gain and feed efficiency ratio were calculated at the end of the experiment according to the method of **Chapman *et al*., (1959)**.

Biochemical Analysis: Collected serum were used for determination of: calcium, phosphorus, parathyroid hormone (PTH), vitamin D, superoxide dismutase (SOD) and glutathione peroxidase (GPX)

Liver functions:

Aspartate aminotransferase (AST), Alanine aminotransferase (ALT) and Alkaline phosphates (ALP)

Bone mineral density and bone mineral concentration:

Femur bones (Right and lift) were separated after scarification. These femur bones were pt in foil paper and kept in deep freezer. BMD (Bone Mineral Density), BMC (Bone Mineral Concentration) measured by Dual Energy X- ray absorptiometry (DEXA).

Determination of calcium and phosphorus in bone;

Calcium and phosphors in femur bone of rats were determined according to the method described by **Muynckk and Vanhaecke (2009).**

Statistical Analysis:

All data obtained results were analyzed using Statistical Package for the Social Sciences (SPSS) for Windows, version 20 (SPSS Inc., Chicago, IL, USA). Collected data were presented as mean± standard deviation (SD). Analysis of Variance (ANOVA) test was used for determining the significances among different groups according to **(Armitage and Berry, 1987)**.

Results and Discussions

Data in table (1) indicated that, the mean value of food intake (FI) in control negative 13.76 g/day for each rat, whole the mean value of control positive group was 14.06 g/ day. The effect of sesame, sesame oil and yogurt on feed efficiency ratio (FER0 of osteoporotic rats are presented in the table (1) the mean value ± SD of FER for control (-) was 3.69±0.18, while it was 3.43±0.65 for osteoporotic group (control+). Body weight gain% (BWG) of the healthy group, osteoporotic group and osteoporotic groups which treated with sesame, sesame oil and yogurt shown in table (1) the mean value ± SD of BWG% of negative control group was 22.96 while it was (22.46) for osteoporotic group. Fed on diet containing yogurt 100 g led to non-significant increase in BWG% as compared to control positive group.

Table (1): Effect of sesame, sesame oil and yogurt on feed intake, FER and BWG (%) of female rats suffering from osteoporosis.

Parameters Animal groups	Mean of FI (g/day/rat)	FER Mean ± SD	BWG (%) Mean ± SD
Negative control (-)	**13.76**	**3.96 ± 0.18^{a}**	**22.69± 10.52^{a}**
Positive control (+)	**14.06**	**3.43 ± 0.65^{a}**	**22.46 ± 1.05^{a}**
Sesame 50g	**14.94**	**2.54 ± 0.32^{ab}**	**16.67 ± 1.87^{ab}**
Sesame 100g	**14.88**	**2.72 ± 0.82^{b}**	**13.47 ± 3.72^{b}**
Sesame Oil 50g	**14.16**	**1.77 ± 0.21^{b}**	**14.67 ± 1.87^{b}**
Sesame Oil 100g	**12.84**	**2.86 ± 0.05^{ab}**	**15.77 ± 8.63^{ab}**
Yogurt 50g	**14.16**	**2.86 ± 0.05^{ab}**	**16.56. ± 1.06^{ab}**
Yogurt 100g	**14.52**	**2.56 ± 0.32^{ab}**	**15.98 ± 1.87^{ab}**

*Non-significant differences between the values had the same letter.

* LSD: Least Significant Difference at level ($p<0.05$)

Data in table (2) indicated that, the mean value of bone mineral density (BMD) in control negative 0.130 g/cm2 for each rat, whole the mean value of control positive group was 0.070 g/cm2. The effect of sesame, sesame oil and yogurt on bone mineral concentration (BMC) of osteoporotic rats are presented in the table (2) the mean value ± SD of BMC for control (-) was 0.16g, while it was 0.08g for osteoporotic group (control+). Fed on diet containing yogurt 100 g led to significant increase in BMC as compared to control positive group. Osteoporosis caused by glucocorticoids suppresses bone formation by impairing osteoblast activity and number, which causes bone loss **(DiMunno and Delle, 2005).** There are numerous reports of BMD and BMC declines in osteoporosis illness **(Wu et al., 2021 and Matsumoto et al., 2022).**

Table (2): Effect of sesame, sesame oil and yogurt on bone mineral density and bone mineral concentration of female rats suffering from osteoporosis.

Parameters Animal groups	BMD g/cm2	BMC g
Negative control (-)	0.130 ± 0.005^{a}	0.16 ± 0.009^{a}
Positive control (+)	0.070± 0.011^{f}	0.08 ± 0.005^{f}
Sesame 50g	0.102 ± 0.006^{cd}	0.12 ± 0.005^{bc}
Sesame 100g	0.091 ± 0.002^{e}	0.10 ± 0.008^{de}
Sesame Oil 50g	0.097 ± 0.002^{de}	0.11 ± 0.004^{cd}
Sesame Oil 100g	0.116 ± 00067^{b}	0.13 ± 0.006^{b}
Yogurt 50g	0.094 ± 0.004^{de}	0.10 ± 0.003^{e}
Yogurt 100g	0.116 ± 0.005^{bc}	0.12 ± 0.008^{bc}

Data in table (3) indicated that, the mean value of calcium in control negative 8.80mg/dl for each rat, whole the mean value of control positive group was 9.70 mg/dl. The effect of sesame, sesame oil and yogurt on serum calcium and phosphorus of osteoporotic rats are presented in the table (3) the mean value ± SD of phosphorus for control (-) was 8.05mg/dl, while it was 7.5 mg/dl for osteoporotic group (control+). Fed on diet containing sesame oil 100 g led to significant decrease in phosphorus as compared to control positive group.

These findings concur with those of **Farina et al. (2011),** who found that salmon consumption by women has a protective impact. Increased calcium intake prevents bone loss, probably as a result of calcium's ability to inhibit PTH release. Bone loss is prevented by increasing calcium and vitamin D intake. According to **Negm (2018),** supplementing with sesame oil powder dramatically lowered PTH.

Table (3): Effect of sesame, sesame oil and yogurt on serum calcium and phosphorus levels of female rats suffering from osteoporosis.

Parameters / Animal groups	Ca (mg/dl) Mean ± SD	P (mg/dl) Mean ± SD
Negative control (-)	**8.80 ± 1.80^{a}**	**8.054 ± 2.50^{a}**
Positive control (+)	**9.70 ± 1.64^{a}**	**7.523 ± 1.36^{ab}**
Sesame 50g	**9.66 ± 1.58^{a}**	**7.425 ± 1.00^{abc}**
Sesame 100g	**8.90 ± 1.70^{a}**	**7.20 ±1.42^{ab}**
Sesame Oil 50g	**9.60 ± 1.62^{a}**	**5.80 ±1.33^{cd}**
Sesame Oil 100g	**9.40 ± 1.81^{a}**	**3.63 ± 0.78^{e}**
Yogurt 50g	**10.26 ± 1.58^{a}**	**4.93 ± 1.50^{de}**
Yogurt 100g	**9.60 ± 0.76^{a}**	**6.20 ±1.42^{bcd}**

Data in table (4) indicated that, the mean value of parathyroid hormone (PTH) in control negative 15.13 pg/ml for each rat, whole the mean value of control positive group was 49.50 pg/ml. The effect of sesame, sesame oil and yogurt on serum calcium and phosphorus of osteoporotic rats are presented in the table (4) the mean value ± SD of Vitamin D for control (-) was 1.36 ug/ml, while it was 101.54 ug/ml for osteoporotic group (control+). Fed on diet containing sesame oil 100 g led to significant increase in vitamin D as compared to control positive group.

The main regulators of bone remodeling are calcium, vitamin D, and parathyroid hormone **(Lu et al., 2013).** Typically, serum calcium and phosphorus are used as biochemical indicators of bone growth and formation. The reduction in serum levels of calcium and phosphorus in rats with osteoporosis that was triggered as described in this study was the previous report **(Coxam, 2005).** Additionally, it was determined that the lower serum calcium levels in rats with osteoporosis were caused by inadequate estrogen levels **(Choi and Seo, 2013).**

Table (4): Effect of sesame, sesame oil and yogurt on parathyroid hormone and vitamin D of female rats suffering from osteoporosis.

Parameters Animal groups	PTH (pg/ml) Mean ± SD	Vit. D (ng/ml) Mean ± SD
Negative control (-)	15.13 ±5.00^{f}	136.40 ± 8.90^{a}
Positive control (+)	49.50 ± 0.50^{a}	101.54 ± 7.61^{b}
Sesame 50g	21.40 ± 0.50^{d}	123.86 ± 19.03^{a}
Sesame 100g	27.90 ± 1.00^{dbc}	127.03 ± 8.06^{a}
Sesame Oil 50g	28.80 ± 2.00^{bc}	101.80 ± 21.41^{b}
Sesame Oil 100g	28.76 ± 4.72^{b}	118.65 ± 0.25^{a}
Yogurt 50g	22.60 ± 0.50^{d}	119.56 ± 19.03^{a}
Yogurt 100g	25.80 ± 1.00^{dbc}	130.03 ± 14.06^{a}

Data in table (5) indicated that, the mean value of calcium femur bone in control negative 5.28 mg/dl for each rat, whole the mean value of control positive group was 4.56 mg/dl. The effect of sesame, sesame oil and yogurt on femur bone calcium and phosphorus of osteoporotic rats are presented in the table (5) the mean value ± SD of phosphorus for control (-) was 2.25 mg/dl, while it was 2.26 mg/dl for osteoporotic group (control+). Fed on diet containing sesame oil 100 g led to non-significant decrease in phosphorus as compared to control positive group.

Table (5): Effect of sesame, sesame oil and yogurt on femur bone calcium and phosphorus levels of female rats suffering from osteoporosis.

Parameters / Animal groups	Ca in Femur Bone (mg/dl) Mean ± SD	P in Femur Bone (mg/dl) Mean ± SD
Negative control (-)	**5.28 ± 0.11 ^{b}**	**2.58 ± 0.01^{a}**
Positive control (+)	**4.56 ± 0.10^{abc}**	**2.26 ± 0.02^{a}**
Sesame 50g	**4.13 ± 0.35^{abc}**	**2.53 ± 0.35^{a}**
Sesame 100g	**5.80 ± 0.34^{ab}**	**2.20 ± 0.34^{a}**
Sesame Oil 50g	**4.85 ± 0.25^{c}**	**2.15 ± 0.05^{a}**
Sesame Oil 100g	**4.36 ± 0.40^{bc}**	**2.36 ± 0.40^{a}**
Yogurt 50g	**4.23 ± 0.35^{bc}**	**2.33 ± 0.35^{a}**
Yogurt 100g	**4.90 ± 0.34^{c}**	**2.10 ± 0.34^{a}**

Data in table (6) indicated that, the mean value of AST in control negative 44.28 mg/dl for each rat, whole the mean value of control positive group was 51.56 mg/dl. The effect of sesame, sesame oil and yogurt on ALT of osteoporotic rats are presented in the table (6) the mean value ± SD of ALT for control (-) was 12.75±5.2, while it was 17.54±4.00 for osteoporotic group (control+). ALP of the healthy group, osteoporotic group and osteoporotic groups which treated with sesame, sesame oil and yogurt shown in table (6) the mean value ± SD of ALP of negative control group was 54.18 while it was (81.46) for osteoporotic group. Fed on diet containing sesame 100 g led to significant decrease in ALP as compared to control positive group.

The preceding effects have been consistent with **Xu et al.,(2012)** who suggested that drug-brought on liver damage is basically as a result of use of antibacterial and glucocorticoids. **Drake et**

al.,(2010) additionally found out that prenatal glucocorticoids overexposure in rats will increase hepatic lipid accumulation with steatosis. **Saka et al. (2011)** confirmed that elevation of transaminase activities, especially aspartate aminotransferases (AST), is connected to liver damage. Moreover, experimental research has proven useful results of diets wealthy of PUFAs on transaminase (asparate aminotrans-ferase and AST) activities **(Ketsa and Marchenko, 2014)**

Table (6): Effect of sesame, sesame oil and yogurt on liver enzymes AST, ALT and ALP of female rats suffering from osteoporosis.

Liver function Animal groups	AST (mg/dl) Mean ± SD	ALT (mg/dl) Mean ± SD	ALP (mg/dl) Mean ± SD
Negative control (-)	44.28 ± 12.01 ^{b}	12.75 ± 5.29^{b}	54.18 ± 14.01 ^{b}
Positive control (+)	51.56 ± 15.0^{ab}	17.54 ± 4.00^{b}	81.46 ± 17.02^{ab}
Sesame 50g	64.13 ± 31.35^{a}	30.86 ± 4.56^{a}	74.23 ± 33.35^{a}
Sesame 100g	61.80 ± 8.34^{a}	19.32 ± 3.210^{b}	71.70 ± 9.34^{a}
Sesame Oil 50g	51.85 ± 11.05^{ab}	17.64± 1.80^{b}	61.45 ± 13.06^{ab}
Sesame Oil 100g	51.36 ± 8.40^{ab}	17.67 ± 1.57^{b}	61.66 ± 19.41^{ab}
Yogurt 50g	52.23 ± 7.35^{ab}	15.85 ± 3.56^{b}	62.73 ± 18.33^{ab}
Yogurt 100g	51.90 ± 7.34^{ab}	14.42 ± 2.10^{b}	61.60 ± 18.38^{ab}

Data in table (7) indicated that, the mean value of SOD in control negative 26.50 mg/dl for each rat, whole the mean value of control positive group was 14.23 mg/dl. The effect of sesame, sesame oil and yogurt on SOD and GPX of osteoporotic rats are presented in the table (7) the mean value ± SD of GPX for control (-) was 248.60

mg/dl, while it was 123.90 mg/dl for osteoporotic group (control+). Fed on diet containing yogurt 100 g led to significant increase in GPX as compared to control positive group.

Table (7): Effect of sesame, sesame oil and yogurt on superoxide dismutase and glutathione peroxidase of female rats suffering from osteoporosis.

Parameters Animal groups	SOD Mean ± SD	GPX Mean ± SD
Negative control (-)	26.50 ± 0.06^{a}	248.60 ± 6.19^{a}
Positive control (+)	14.23 ± 0.01^{d}	123.90 ± 1.05^{d}
Sesame 50g	19.70 ± 0.93^{b}	213.25 ± 1.35^{b}
Sesame 100g	20.95 ± 0.06^{bc}	218.67 ± 5.38^{b}
Sesame Oil 50g	18.70 ± 0.02^{bc}	185.40 ± 1.00^{c}
Sesame Oil 100g	19.75 ± 0.09^{bc}	190.03 ± 3.36^{c}
Yogurt 50g	22.70 ± 0.03^{b}	230.25 ± 1.35^{a}
Yogurt 100g	23.95 ± 0.06^{bc}	238.67 ± 5.38^{a}

Recommendations: Sesame, sesame oil and yogurt may promote health (osteoporosis and liver function) so they must be taken daily. Sesame, sesame oil and yogurt daily consumption may be recommended for osteoporosis, liver function due to its beneficial effects.

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تأثير السمسم وزيت السمسم والزبادي على هشاشة العظام في الفئران

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قسم التغذية وعلوم الأطعمة – كلية الاقتصاد المنزلى – جامعة حلوان – مصر

الملخص العربي

هشاشة العظام مرض يصيب الملايين من البشر حول العالم. تهدف الدراسة إلى علاج هشاشة العظام لدى إناث الفئران باستخدام السمسم وزيت السمسم والزبادي كمصادر غنية بالكالسيوم. أجريت التجربة البيولوجية في معمل الدراسات العليا بكلية الاقتصاد المنزلي، جامعة حلوان. تم وضع إناث الفئران في أقفاص جيدة التهوية في ظل ظروف صحية جيدة وتغذيتها على الغذاء الأساسي لمدة أسبوع للتكيف. بعد فترة التكيف، تم تقسيم الفئران إلى مجموعتين رئيسيتين، على النحو التالي: المجموعة الأولى: مجموعة الضابطة السالبة، تم تغذية الفئران (ن = ٧) على الغذاء الأساسي فقط خلال فترة التجربة. المجموعة الثانية: تم إعطاء الفئران (ن=٤٩) أسيتات بريدنيزون عن طريق الفم (٤,٥ مل/كجم وزن الجسم/ يوم مرتين في الأسبوع للإصابة بهشاشة العظام، ثم تم تقسيم الفئران كالتالي: المجموعة الفرعية (١): تم تغذية الفئران (التي تم تقديمها كمجموعة ضابطة موجبة) على نظام غذائي أساسي فقط .المجموعة الفرعية (٢): تم تغذية الفئران على نظام غذائي أساسي مضاف إليه ٥٠ جرام سمسم لكل كيلو جرام من النظام الغذائي الأساسي . المجموعة الفرعية (٣): تم تغذية الفئران على نظام غذائي أساسي مضاف إليه ١٠٠ جرام سمسم لكل كيلو جرام من النظام الغذائي الأساسي. المجموعة الفرعية (٤): تم تغذية الفئران على نظام غذائي أساسي مضاف إليه ٥٠ جرام زيت سمسم لكل كيلو جرام من النظام الغذائي الأساسي. المجموعة الفرعية (٥): تم تغذية الفئران على نظام غذائي أساسي مضاف إليه ١٠٠ جرام زيت سمسم لكل كيلو جرام من النظام الغذائي الأساسي. المجموعة الفرعية (٦): تم تغذية الفئران على نظام غذائي أساسي مضاف إليه ٥٠ جرام زبادي لكل كيلو جرام من الغذاء الأساسي. المجموعة الفرعية (٧): تم تغذية الفئران على غذاء أساسي مضاف إليه ١٠٠ جرام زبادي لكل كيلو جرام من الغذاء الأساسي. تم تقدير الكالسيوم والفوسفور في السيرم وعظم الفخذ للفئران وكذلك وظائف الكبد وكثافة الكالسيوم في العظام وتركيز الكالسيوم في العظام وكذلك الفحص الهيستوباثولجى لعظام الفخذ لإناث الفئران. وفقًا للنتائج التي تم الحصول عليها، توصى الدراسة بأن السمسم وزيت السمسم والزبادي قد يعززان الصحة (هشاشة العظام ووظائف الكبد) لذلك يجب تناولها يوميًا. يمكن التوصية بالاستهلاك اليومي للسمسم وزيت السمسم والزبادي للوقاية من هشاشة العظام وتحسين وظائف الكبد بسبب تأثيراتها المفيدة. يجب تنفيذ برامج التثقيف الغذائي للجمهور بفوائد السمسم وزيت السمسم والزبادي.

الكلمات المفتاحية: السمسم، الزبادي، هشاشة العظام، الفئران، الكالسيوم .