

## بذور السمسم ومساهمتها في تحسين مستوى هشاشة العظام

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**Abstract:** This study was carried out to evaluate the role of sesame seeds in helping to reduce the symptoms of osteoporosis and improving the level of calcium in the blood of women suffering from osteoporosis. A total of 30 female subjects participated in the study, which was divided into three groups of 10 people each. Group1 negative control, Group2 positive control (osteoporotic group) and Group3 women suffering osteoporosis and were given medical therapy + (200 mg/kg) per day of sesame seeds. This was for a period of three months. The results revealed that the mean values in the serum calcium of osteoporotic group (control +) decreased significantly at  $P<0.05$ , as compared to (control -) group. Serum ionized and total calcium increased in a group of women suffering from osteoporosis who were given (200 mg/kg) per day of sesame seeds for a period of three months significantly at  $P<0.01$ , as compared to control (+) group. The study found that the group treated with 200 mg/kg of sesame seeds showed an improvement in serum calcium levels.

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So, this study recommended taking sesame seeds and foods rich in calcium that help accelerate bone growth, decrease bone fracture incidence, and improve the level of calcium in the blood.

**Key words:** Osteoporosis, Calcium, Sesame seeds, Chemical composition.

### **Introduction**

Osteoporosis is a silent skeletal disorder characterized by compromised bone strength that predisposes individuals to an increased risk of fracture (**Ali et al., 2013**). It is a multifactorial disease, and many clinical risk factors for the disease have been identified. Of these risk factors are low peak bone mass, hormonal factors, the use of certain drugs (e.g., glucocorticoids), cigarette smoking, low physical activity, low intake of calcium and vitamin D, race, small body size, and a personal or family history of fracture (**Cummins et al., 2011**).

Sesame is an erect annual herb that grows 60–150 cm tall. Sesame is widely grown and popular because of its highly aromatic odor and mellow flavor (**Mili et al., 2021**). Sesame oil has advantages over other vegetable oils owing to its high nutritional and therapeutic value. Sesame seeds, which are used in traditional Indian and Chinese medicine, contain 57% highly stable oil (**Reshma et al., 2010**). Sesame seeds are a rich source of many essential minerals such as calcium, iron, manganese, phosphorus, magnesium, selenium and copper and these minerals play a vital role in bone mineralization and health. Sesame seeds have been used as a source of healthy foods (**Ramadan, 2014**).

The present study, aimed to evaluate the role of sesame seeds in improving the level of calcium of women suffering from osteoporosis.

## **Material and methods:**

### **Patients**

The study was conducted at Assiut University Hospital. A sample of 20 osteoporotic females between the ages of 50 and 75 years were enrolled in the study. Ten sex and age matched non osteoporotic females were chosen as negative control group.

### **Ethical consideration:**

All subjects included in this study provided written informed consent, and the protocol of this study was approved by the ethics committee of the Faculty of medicine at Assiut University.

### **Inclusion criteria:**

Women who suffer from osteoporosis and women who have a lower than normal blood calcium level.

### **Exclusion criteria:**

Women with normal or high levels of calcium; age < 50 years; advanced kidney disease; diabetic women; women suffering from Hypo-vitaminosis D; bariatric surgery ; taking antacid medications and proton pump inhibitors.

### **Materials:**

**Sample:** Three Kg of sesame seeds (**Sesamum indicum**) (*Shandawil* 3) for the season 2022, were purchased from Haraz Company, for Agricultural Seeds, Perfumery and Medicinal Plants, Egypt.

### **Methods:**

#### **Determination of the chemical composition of sesame seeds**

The proximate major chemical constituents are moisture, ash, total protein, crude fiber, and fat in sesame seeds were determined according to the method outlined by **A.O.A.C. (2010)**. Total carbohydrate was calculated by subtracting.

Total carbohydrate = 100 - (moisture% + ash% + fat% + protein% + fiber content%) on dry weight basis (A.O.A.C., 2015, A.O.A.C. , 2019 and El-Beltagi *et al.*, 2022). The Caloric value was calculated according to the method of (Seleet, 2010).

Total Calories = 9 (fat) + 4 (protein) + 4 (total carbohydrates)

#### **Determination of the mineral content of sesame seeds**

Magnesium (Mg), calcium (Ca) and potassium (P) were determined using the ICP (ICAP6200) according to (Issac and Johnson, 2002). Sodium (Na) content was estimated using flame photometry (Jenway PFP7) according to the procedure reported by (A.O.A.C., 2010).

#### **Experimental design:**

A total of 30 subjects participated in the study, which was divided into three groups of 10 subjects for each group . G1 was the negative control group (women without osteoporosis), the positive control group G2 (women suffering from osteoporosis) on their regular medical treatment only and G3 women having osteoporosis and were given regular medical treatment and (200 mg) sesame seeds daily for three months.

#### **Diagnosis of Osteoporosis**

The Heel of the foot (calcaneus) was used for the diagnosis of osteoporosis using quantitative ultrasound (QUS) measurements because it contains a high percentage of trabecular bone. The T-score is predominant in the diagnosis of osteoporosis and is used for adults, men and women over 50 years of age. From the T-score it is possible to know the percentage of bone mineral density, and according To the World Health Organization, the T-score can be classified as:

**Normal:** T-score of -1 or above, **Osteopenia:** T-score lower than -1 and greater than -2.5, **Osteoporosis:** T-score of -2.5 or lower, **Severe osteoporosis:** T-score of -2.5 or lower, and presence of at least one fragility fracture (Chitra and Sharon, 2021).

#### Serum calcium Analysis:

Serum calcium level (total and ionized) was determined before and at the end of the experiment according to pagana *et al.*, (2018).

**Demographic characteristics and a number of risk factors for osteoporosis assessment** (age, BMI, active or passive smoking, rheumatoid, family History of osteoporosis, frailty due to premature menopause under 45 years of age).

#### Statistical Analysis

All obtained data were subjected to statistical analysis of variance and treatment means were compared for significant differences using the Least Significant Deference's "LSD" at  $p= 0.05$  and  $p= 0.01$  according to the MSTAT-C Statistical software (Russell, 2013). A computer programme was used to perform all the analysis of variance in accordance with the procedure outlined by Duncan (2015).

#### Results and Discussion

##### Gross chemical composition and caloric value of sesame seeds

Table (1) revealed that sesame seeds had a percentage of moisture, ash, crude fat, crude fiber, protein and carbohydrates which were (2.62, 3.19, 51.5, 10.487, 24.06 and 8.143); respectively. The caloric value of sesame seeds was (592.312 k. cal./100g).

**Table (1): Gross chemical composition and caloric value of sesame seeds (%on a dry weight basis)\***

Sample%	Moisture	Ash	Crud fat	Crude fiber	Protein	Carbohydrates * *	Caloric
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							Value s*
Sesame seeds	2.62 ±1.0 00	3.19 ±1.000	51.5 ±1.000	10.487 ±1.000	24.06 ±1.000	8.143 ±1.000	592. 312 ±1.0 00

Mean of three replicates

\*\* Carbohydrates were

calculated by difference

\*Caloric value k. cal./100g

Our results are similar to those obtained by **Nzikou *et al.*, (2009)** who found that, sesame seeds contained 5.7% moisture, 20% crude protein, 3.7% ash, 3.2% crude fiber, 54% fat and 13.4% carbohydrate. Also, **Borchani *et al.*, (2010)** showed that, the chemical composition of sesame seed is an important source of oil (44 – 58%), protein (18–25%), carbohydrate (13.5%) and ash (5%).

**Christian *et al.*, (2019)** showed that the chemical composition of Sesame *Indicium L.* seed was moisture (6.21±2.41%), ash (8.46±0.24%), crude fiber (6.12±4.10%), crude protein (14.73±6.39%) and carbohydrate (64.00±86.14%).

#### Minerals content of sesame seeds

Table (2) shows the statistical analysis of Minerals content (mg/100g) of sesame seeds (on a dry weight basis), Sesame seeds recorded content of P, Ca, Mg and Na which recorded (10682.19, 1949.52, 5864.47, 1907.46 mg/kg); respectively. **Alyemeni *et al.*, (2011)** revealed that the mineral composition of Sesame *indicium* seeds contained high amounts (mg/100g) of Ca (1200), P (580), K (374), Mg (185), Na (72), Fe (10.6) and low amount of Zn (3.8).

**Table (2): Minerals content (mg/100g) of sesame seeds (on a dry weight basis)**

Sample	P mg/100g	Ca mg/100g	Mg mg/100g	Na mg/100g
Sesame seeds	10681.19 ±1.000	1948.52 ±1.000	5863.47 ±1.000	1907.46±1.000

P=Phosphorus, Ca= calcium, Mg= Magnesium and Na= Sodium

**Christian *et al.*, (2019)** showed that the mineral composition of *Sesamum Indicum* L. seed was sodium (0.80±0.09%), potassium (1.12±0.32%), calcium (0.44±0.10%), magnesium (0.29±0.45%), zinc (0.82±0.21%) and iron (1.02±0.11%). The distribution showed that sodium and zinc had the highest percentage (18%) while magnesium had the lowest (6%).

**Table (3): Demographic characteristics and a number of risk factors for osteoporosis assessment**

Description	Category	Frequency	Percentage%
<b>Age</b>	50–55 year	8	26.6
	56–60 year	10	33.3
	Above 60 year	12	40
<b>BMD Screening Categorization</b>	Normal	10	33.3
	Osteopenia	8	26.6
	Osteoporosis	12	40
<b>BMI</b>	Underweight	18	60
	Obese	4	13.3
	Over weight	2	6.6
	Normal	6	20

<b>Passive Smoking</b>	Yes	26	86.6
	No	4	13.3
<b>Rheumatoid</b>	Yes	25	83.3
	No	5	16.6
<b>Previous fracture</b>	Yes	23	76.6
	No	7	23.3
<b>Family History of Osteoporosis</b>	Yes	22	73.3
	No	8	26.6
<b>Frailty due to premature menopause (under 45 years of age)</b>	Yes	21	70
	No	9	30

Table (3) shows a number of risk factors for osteoporosis and their relationship to increasing the incidence of osteoporosis. Our results showed that there is a relationship between ageing and osteoporosis. We found that women over 60 were more susceptible to osteoporosis.

**In agreement with our results, Al-Mukhtar *et al.*, (2013)** found that the elderly age group of more than 60 years old has a great incidence of osteoporosis and this result closely matches with other research. The probable explanation is that the balance of cellular activity is altered with the ageing process, with a reduced osteoblast



response to continued bone resorption, so the resorption cavities are incompletely filled by new bone formation during the remodelling cycle .

In this work, 18 females were underweight and it was reported in many studies that low body mass index (BMI) is considered a risk factor for osteoporosis while overweight is considered a protective factor to reduce the possibility of osteoporosis. Similarly, **Al-Mukhtar et al., (2013)** found a negative association between low BMI and the BMD. The association between body weight and BMD could be explained in various ways (**Baccaro et al., 2013**).

**kuru et al., (2014)** in their work reported that 48.5% of the patients were diagnosed with osteoporosis and 51.5% of them were diagnosed with low bone density. A total of 34 patients had a fracture history with minor trauma and some of the patients had more than one fracture (12 ankles and feet, 10 forearms, 9 vertebral, 4 hands, 3 hips, 2 ribs, 1 tibial). When the patients with and without fracture histories were compared, the mean Qualeffo-41 score in patients with fracture was  $43.85 \pm 2.57$  and in the non-fracture group was  $36.27 \pm 2.01$ . They conclude that Forearm, ankle and foot fractures can be commonly seen in osteoporosis patients with fracture history.

Moreover, **Morin et al., (2014)** confirmed that non-traumatic fractures in women are associated with osteoporosis at the femoral neck and that the site of a previous fracture impacts future osteoporotic fracture risk, independent of BMD.

**Warensjo et al., (2011)** found an association between low habitual dietary calcium intake and an increased risk of fractures and osteoporosis. In 2016, the National Osteoporosis Foundation and American Society for Preventive Cardiology concluded, based on the available evidence, that calcium intakes from food and supplements

within the tolerable upper limit are considered safe from a cardiovascular standpoint, in healthy adults (**Kopecky et al., 2016**).

Regarding smoking, 25 (83.3%) of the studied females were passive smokers. Our results showed that smoking affects low BMD and thus increases the risk of osteoporosis. Cigarette smoking and osteoporosis are highly prevalent among adults worldwide. Cigarette smoking is associated with lower BMD in a dose-related and duration related fashion. Tobacco use was reported as a risk factor for osteoporotic fractures independent of body mass and of BMD (**Yoon et al., 2012**).

Smoking significantly decreases bone mineral density, which causes osteoporosis, and the histologic examination of the bone suggest a direct effect of smoking on bone structure (**Ajiro et al., 2010**).

Our results revealed that osteoporosis has been associated with a family history positive for the condition, where we found that 22 women had a family history of osteoporosis. Meanwhile, Women with a family history of osteoporosis were more likely than those without it to report preventive behavior, such as taking supplements of calcium, vitamin D, or both; physical activity; and estrogen use (**Robitaille et al., 2008**).

**Kareem et al., (2021)** found that most of their included studies showed RA is a vital risk factor for developing osteoporosis, and many factors can play a role in increasing this association including treatment of RA patients with a

high dose of glucocorticoids over a long duration, chronic joint inflammation, malabsorption of calcium, the age of the patients: (post-menopausal women and older men above 50 years), genetics, and the estrogen hormone. These factors carry significantly elevated risks for developing osteoporosis and fractures in RA patients.

**Effect of sesame seeds on serum calcium of women suffering from Osteoporosis:**

Data presented in Table (4) shows that the mean values of serum calcium in the osteoporotic group (+ control) decreased significantly  $P<0.05$ , as compared to the negative control group (- control).

Table(4) shows also that serum ionized calcium increased in a group of women suffering osteoporosis who were given medical therapy + (200 mg/kg) per day of sesame seeds for a period of three months significantly  $P<0.01$ , as compared to the positive control group. Total calcium increased in group of women suffering Osteoporosis and were given 200 mg/kg sesame seeds significantly  $P<0.01$  as compared to positive control group.

Serum calcium of the negative control group increased more than that of women suffering from osteoporosis (The positive control group). Treating a group of women suffering from osteoporosis with sesame seeds increased the mean value of serum calcium, by more than that of the positive control group.

**Table (4):Effect of sesame seeds on serum calcium in women suffering from Osteoporosis**

Groups		Ionized calcium	Total calcium
G1	before	4.98 ± 0.123	9.63 ± 0.133
	After	5.01 ± 0.166	9.72 ± 0.172
P. Value between Before and after		P ≤ 0.05	P ≤ 0.05
G2	before	3.83 ± 0.335	7.85 ± 0.204
	After	3.71 ± 0.231	7.79 ± 0.164
P. Value between Before and after		P ≤ 0.05	P ≤ 0.05
P. Value between groups 1&2		P ≤ 0.01	P ≤ 0.01
G3	before	3.73 ± 0.367	7.86 ± 0.158
	After	4.88 ± 0.329	8.61 ± 0.156
P. Value between Before and after		P ≤ 0.01	P ≤ 0.01
P. Value between groups 1&3		P ≤ 0.01	P ≤ 0.01
P. Value between groups 1&2&3		P ≤ 0.01	P ≤ 0.01

Values are expressed as mean ± Standard Deviation SD.

**Wilson, (2016)** revealed that sesame seeds improved the nutritional status, kidney functions (uric acid, urea nitrogen and creatinine), levels of calcium and phosphorus and bone mineral density (BMD). **Arooj *et al.*, (2023)** reported that sesame seeds perform many therapeutic functions against several health issues especially those related to bones because they possess a rich content of calcium, vitamins, proteins, oil, and carbohydrates.

Using the PubMed, Science Direct, and Google Scholar databases, we performed a comprehensive search of the literature from 2013 to date on reports related to sesame seeds and their bioactive ingredients. Sesamin, sesamol, sesamol, and sesamol are the major bioactive lignans found in sesame seeds. Our comprehensive review of the literature revealed the protective role of sesame seeds on bone health in postmenopausal osteoporosis. It was observed that sesame seeds have a positive impact on postmenopausal women experiencing bone-related problems, *i.e.* osteoporosis and arthritis. Therefore, this work focused on exploring the effect of sesame seeds on bone mineralization in postmenopausal women. Furthermore, to aid in balancing the hormones in women in the postmenopausal phase, we highlight the effect of the daily intake of sesame seeds in women. Finally, we conclude that the supplementation of sesame seeds in a regular diet shows a positive impact on the bone health of postmenopausal osteoporosis.

Depending on the results of this study, we recommend to add calcium to meals for osteoporotic females. Milk and milk products are the classical sources of calcium supply and their absorption is excellent. Small fish that can be eaten in whole, sesame seeds, and

legumes are alternative calcium sources that can add more calcium to the meals (**Titchenal and Dobbs, (2007)**).

On the other hand, one study concluded that the Ca from sesame seeds and spinach does not cause an acute response in Ca metabolism. (**Wilson, 2016**) Also, cheese could be a better dietary source of calcium than milk when the metabolic effects of the foods are considered. Sesame is also a source of helpful biologically active components found in plant foods, such as phytochemicals and it is a functional food. Bioactive compounds and nutraceuticals in sesame could be used in the prevention, control, and even management of illnesses (**Sacco et al, 2007**).

The anti-osteoporotic effect of sesame seeds could be due to the high content of essential minerals especially calcium and phosphorous which play a vital role in bone mineralization. Sesame seeds also contain high amounts of natural antioxidant lignans which prevent bone loss in ovariectomized rats. In addition, a high-calcium plus vitamin D3 diet was reported to play a vital role in bone mineralization and, thus, preventing osteoporosis (**Chen et al., 2013**).

**Boulbaroud et al., (2008)** concluded that sesame oil can prevent bone loss in ovariectomized rats. Moreover, Sesamin a major lignan compound in sesame oil was reported to produce an osteoprotective effect (**Wanachenwin et al., 2012**).

#### **CONCLUSION:**

In conclusion, it appears that consumption of sesame seeds increases calcium, thus reducing the incidence of osteoporosis. Therefore, the study recommends enriching bakeries and food stuff with sesame seeds and eating meals rich in calcium, such as dairy products (milk

and yoghurt), which may be beneficial for the treatment of postmenopausal osteoporosis in women.

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### بذور السمسم ومساهمتها في تحسين مستوى هشاشة العظام

**الملخص:** أجريت هذه الدراسة لتقييم دور بذور السمسم في المساعدة على تقليل أعراض هشاشة العظام وتحسين مستوى الكالسيوم في الدم لدى النساء المصابات بهشاشة العظام. شارك في الدراسة ٣٠ امرأة تم تقسيمهن إلى ثلاث مجموعات كل منها ١٠ أشخاص. المجموعة الأولى المجموعة الضابطة السالبة ، المجموعة الثانية المجموعة الضابطة الموجبة (مرضي هشاشة العظام)، المجموعة الثالثة مجموعة النساء المصابات بهشاشة العظام وتم إعطاؤهن علاجاً طبيياً + (٢٠٠ ملجم / كجم) يومياً من بذور السمسم. وكان هذا لمدة ثلاثة

أشهر. أظهرت النتائج أن متوسط قيم الكالسيوم في مصل الدم للمجموعة الضابطة (+) المصابة بهشاشة العظام انخفض بشكل ملحوظ ( $P < 0.05$ ، مقارنة بالمجموعة الضابطة -). ارتفع مستوى الكالسيوم الكامل والمتأين في مصل الدم لدى مجموعة النساء المصابات بهشاشة العظام وتم إعطاؤهن (٢٠٠ ملغم/كغم) يومياً من بذور السمسم لمدة ثلاثة أشهر معنوياً ( $P < 0.01$  مقارنة بالمجموعة الضابطة +). أعلى زيادة في الكالسيوم في مصل الدم سجلت للمجموعة المعاملة بـ ٢٠٠ ملجم/كجم من بذور السمسم. لذا أوصت هذه الدراسة بتناول بذور السمسم والأطعمة الغنية بالكالسيوم التي تساعد في تسريع نمو العظام وتقليل نسبة الإصابة بكسور العظام وتحسين مستوى الكالسيوم في الدم.

**الكلمات المفتاحية :** هشاشة العظام، الكالسيوم، بذور السمسم، التركيب الكيميائي