Potential effect of Sesame (*Sesamum Indicum*) seeds and oil on iron deficiency anemia in rats

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Abstract

Sesame is rich in bioactive food components has therapeutic properties on anemia in rats. The present study aimed to evaluate the effect of sesame seeds and its oil on management of anemia, lipid profile and improve antioxidant status in animal. This study was conducted on twenty albino male rats and categorized into 4 groups (5 rats per each). Group (1) kept as normal group (control -ve), while the other three groups were administered a single dose of phenyl hydrazine injection 40 mg/kg/day for two days, then rats categorized into three groups which were group 2 control positive (+ve) (untreated) and groups (3and 4) treated with 15% as a powder of sesame seeds and 5 ml of oil by stomach tube daily for eight weeks, respectively. The obtained results revealed that sesame seed and oil contain highest amount of phenolic compounds and polyunsaturated fatty acids. The biological results showed that significant ($p \leq 0.05$) increase in hemoglobin and RBCs were noticed in rats treated with sesame seeds and oil when compared with positive control> Also, significant ($p \leq 0.05$) increase in total antioxidants (TA), superoxide dismutase (SOD), were observed in rats treated with Sesame seeds and oil than positive control. The results showed that a decrease significantly ($p \leq 0.05$) in serum triglyceride, total cholesterol and LDL-c, VLDL-c levels and a significant ($p \leq 0.05$) increase in HDL-c level were spotted in rats treated with sesame seed and oil than positive control.

Keywords: Sesame seeds, total phenolic compounds, hemoglobin, antioxidants, nutritional deficiencies.

Introduction

Anemia is a public health and nutrition problem affecting developing and developed countries, affecting human health and also social and economic development **(Means, 2019**). Anemia is more prevalent in developing countries with high propagation rates due to nutritional deficiencies. It is other causes of include severe menstrual loss, parasitic contagion, chronic, infections, micronutrient deficiencies, and hemoglobinopathy **(kaur *et al*., 2015).**

Bedigion and Dorthea, (2011) found that 34 species of sesame (*Sesamum Indicum*) are found in the world mainly in tropical South Africa and Asia, Nigeria, Sudan, Congo and 8 are species in the Indian region , and must have been cultivated in Euphrates valley and in Bokhara of Afghanistan. Recently, the African origin has also been well established. **Chafique and Fleurentin, (1987) and Michalak *et al.*, (2018)** reported that it is cultivated throughout the tropical and subtropical regions in India, in South Africa, Asia, Sudan, Afghanistan, Pakistan, Bangladesh, and in many countries.

Nakano *et al.* (2002) asserted that sesame seeds and oil are consumed as a staple food. Sesame seeds is used in traditional medicine for many diseases treatment. **Hall, (2003) and Kuijsten *et al.* (2005)** demonstrated that sesame oil contains of (35:54%) oleic, (39:59%) linoleic, (10%) palmitic acids and bioactive compounds such tocopherols and lignin, which role play important role on antioxidant. Also, **Zhenwei *et al.* (2012) and Erfan Sadeghi *et al.*, (2018)** mentioned that, sesame seeds and oil are rich in the essential amino acids. It also contains of minerals Mg, Ca, P, Fe, Zn, and Co, and vitamin E & K and rich in fiber, carbohydrate and protein.

Regarding healthy aspects, **Jannat *et al.* (2013) and Obiajunwa *et al.*, (2015)** reported that, sesame seed and oil have widely used to supply energy and prevent aging and by has a high content of antioxidant known to human health because it contains are γ-tocopherol and phenols. Also, **Wen-Huey *et al.*, (2006)** suggested that, sesame intake decreases blood lipids and improve sex hormones in postmenopausal women. Furthermore, **Penavalo *et al.*, (2005)** investigated that sesame oil has multiple physiological functions which are responsible for its estrogenic activity and also decreasing blood lipids. Recently, **Mohamed and Awatif, (2018)** recommended that, sesame seed (*Sesamum indicum L.*) seed and oil used widely as healthy foods to provide nutraceuticals and nutrients that may have an anti-aging effect and increase energy. Also, **Ensminger and Esminger, (2017)** indicated that, sesame seeds contains calcium which helps to prevent colon cancer, osteoporosis. Also it contains zinc which

protect of osteoporosis. In this concern, **Coony *et al.* (2001)** observed that, sesame seed consumption enhances vitamin E activity which in turn prevents heart diseases and cancer. Also, **Elleuch *et al.* (2007)** stated that, sesame seed contains flavonoid, which used as effective antioxidant and anticancer, and also affects blood lipids and sex hormones. Therefore, the present study aims to investigate the potential effect of sesame seeds and oil on iron deficiency anemia in rats.

Materials and Methods

Materials

Sesame seed and oil: were obtained from local markets, El - Mansoura, Egypt.

Rats**:** Male albino rats (90 ±15g) were obtained from Helwan Station, Ministry of Health and Population, Cairo, Egypt (**Reeves, *et al.*, 1993).**

Methods

Preparation of seeds powder :

Seeds was milled in a mixer to give a powder and kept in dusky stoppered glass bottles in a dark dry location till use, according to **Russo, (2001)**

Determination of phenolic compounds

Total phenolic compounds were determined by HPLC according to the method of **Goupy *et al.*, (1999**).

Determination of fatty acids

The fatty acid profile of sesame seed oil was determined according to ISO 5508 (1990) and ISO 5509 (2000) by gas chromatography (GC) as described by **Nath, (1996).**

Experimental Diets

The basal diet prepared according to the following formula as mentioned by (**AIN, 1993**) as follow: corn oil (10%), protein (10%), corn starch (69.5%), cellulose (5%) vitamin mixture (1%), mineral mixture

(4%), methionine (0.3%) and choline chloride (0.2%). Vitamins and minerals mixtures were prepared such as described by **Campbell, (1963) and Hegsted, (1941**), respectively.

Biological experimental design

Rats were fed on basal diet adaptation for five days then the rats were allocated into four equal groups. Ethical guidelines were maintained in animal handling during the study and permission was obtained from the concerned Department. Normal control group fed on the basal only (n=5), while the other three groups were administered a single dose of phenyl hydrazine injection (40 mg/kg /day) for two day, then rats categorized into three groups which were control positive (+ve) (untreated) and two groups treated with sesame seeds (5 g/kg diet/day) and oil (5 ml /kg/day) by stomaic tube daily. The study assigned for eight weeks. The feed intake was calculated daily and the body weight gain was recorded weekly.

Serum analysis

At the end of the experiment, the rats were sacrificed to obtain blood samples. Heparenized blood was analyzed for estimation of hemoglobin (HB), red blood cells (RBCs), white blood cells (WBCs) and platelets count (PLT) asses by **Drabkin (1949) and Mc Inory, (1954),** respectively. Total cholesterol, HDL-cholesterol and triglyceride content were determined by enzymatic colorimetric method according to **Allian *et al.*, (1974), Richmond (1973) and Fossati and Principle (1982**), respectively. LDL-cholesterol and VLDL-cholesterol were calculated by **Friedewald *et al.*, (1972**). Total antioxidants and superoxide dismutase enzymes (SOD) were determined by **Beuchamp and Fridovich, (1971) and Green *et al.*, (1981),** respectively.

Statistical Analysis

Results of the biochemical estimations of the rats are reported as mean ± SE (Standard Error). The total variation was analyzed by performing one-way analysis of variance. ”LSD (Least Significant Difference) test” was used for determining significance (**Sümbüloglu *et al.* 1998**).

Results and Discussion

The contents of phenolic compounds (ppm) in sesame seed

Data in Table (1) showed the amounts of phenolic compounds with an average from 0.73 to 2425.16 ppm. The sesame seeds content was highest in e-vanillic followed by salycilic, catechein and 3-OH-tyrosol their content were 2425.16, 63.91, 34.52 and 23.37 ppm, respectively. While the lowest amounts of phenolic compound in sesame seeds were reversetol, iso-ferulic, gallic, 4-amino-benzoic and content were 0.73, 1.17, 1.43 and 2.12 ppm, respectively.

These results agreed with the results of **Lee *et al.*., (2002)** who observed that epicatechin, procyanidins, guercint and *p*-catechins are flavonoids in sesame seed. Also, **Kanu *et al.*, (2007)** recommended that, sesame seeds contain of the bioactive compounds that play a role in the reduction of the risk for the development of chronic diseases. Furthermore, **Russo, (2007)** suggested that, contain of salycilic acid are rich in other phenolic acids and the contribution of these compounds to the protective effect incidence of colorectal cancer.

Table (1): Polyphenolic compounds and flavonoid (ppm) in sesame seed

Phenolic compounds	sesame seed	Phenolic compounds	sesame seed
Gallic	1.43	Vanillic	3.06
Pyrogallol	6.27	P-conmaric	3.97
4-Amino-benzoic	2.12	Ferulic	3.18
3-OH-Tyrosol	23.37	Iso-ferulic	1.17
Protocatchuic	6.46	Reversetol	0.73
Chlorogenic	2.56	Ellagic	21.11
Epi-Catachin	--	E-vanillic	2425.16
Catechein	34.52	coumaric -Alpha	5.80
Catechol	14.83	Benzoic	6.33
Caffeine	9.67	3,4,5-methoxy-cinnamic	5.35
P-Oh-benzoic	7.97	Coumarin	12.11
Caffeic	4.41	Salycilic	63.91

Gas chromatography of sesame oil

For fatty acid composition, pumpkin seed oil was analyzed by gas chromatography with capillary column in (Table 2). The recorded that ethanolic extract were oleic acid l (13.01%), linoleic acid (33.14%), 9E-ocadecenoic acid (4.41%), palmitic acid (3.07%), 2-furanpentanoic acids (0.41%), arachidic acid (0.28%), behenic acid (0.65%), stearic acid (9.03%), docosanoic acid (0.54%) and gadoleic acid (0.31%) respectively. This data confirms the good nutritional quality with functional properties of sesame oil as our body is unable to synthesize fatty acids.

These results are in accordance with those obtained by **Cook and Samman, (1996)** who illustrated that, fatty acids are antioxidants, free radical scavengers and inhibit lipid peroxidation. Also, **Mazandarani *et al.*, (2012)** justified that phenolic compounds are considered as a major group of antioxidant molecules that contribute to the antioxidant activities of seeds and herbs of their ability to scavenge free radicals. **Shyu and Hwang, (2002)** reported that, the antioxidant activity of sesame seed and its healthful properties are attributed to the presence of lignans such as sesamolin and 2-Episalatin. **Agarwal et al. (2005)** said that the imbalance of oxidants generates of excessive amounts of reactive oxygen species prejudice in body on various ways. **Sabuncu et al. (2001)** illustrated that, reproductive cells and tissues will stay stable only when antioxidant and oxidant status is in balance with oxidative stress.

Table (2): Fatty acid composition of sesame seed oil

Component	Relative area (%)
Oleic acid	13.01
Linoleic acid	33.14
9E-Ocadecenoic acid	4.41
Palmitic acids	3.07
2-furanpentanoic acids	0.41
Arachidic acid	0.28
Behenic acid	0.65
Stearic acid	9.03
Docosanoic acid	0.54
Gadoleic acid	0.31

Effects of sesame seed and oil on BWG, FI and FER of experimental rats

Data in Table (3) showed that an significant increase in the body weight gain (BWG), food intake (FI) and food efficiency ratio (FER) of all rat groups treated with red beet than positive control. The results showed that an increase significantly in BWG was noticed of rats group treated with sesame seed which reached 63.43.0 (g) and rats group treated with sesame oil which reached 66.65(g) than positive control which reached 41.88(g). Also the results revealed that an increase significantly in FI was recorded of rats group treated with sesame seeds which reached 15.99 (g/day) and rats group treated with sesame oil which reached 16.21 (g/day) when compared with positive control which reached 11.73(g/day). On the same table, the results showed that significant increase in FER was observed of rats groups treated with sesame seeds and oil which reached 0.065 and 0.074respectively than positive control which reached 0.059. **Díaz-Castro *et al*. 2008** reported that the body weights of the anemic rats were significantly lower.

Table (3): Effect of sesame seed and oil on BWG, FI and FER of experimental rats

Parameters	Negative control	Positive control	Sesame seed	Sesame oil
B W G (g)	95.72±8.42^{a}	41.88±5.1 ^{d}	63.43.0±6.13^{c}	66.65±5.57 ^{c}
F I (g/day)	16.85±1.84^{a}	11.73±1.17 ^{c}	15.99±1.45^{b}	16.21±1.22 ^{a}
FER	0.0894±0.001^{a}	0.059±0.003^{d}	0.065±0.005^{c}	0.074±0.004 ^{b}

Means in the same row with different superscript letters are significantly different at P≤ 0.05.

Effects of sesame seed and oil on hemoglobin, RBCs, WBCs and PLT of experimental rats

As evident from Table (4) a significant (P< 0.05) increase in hemoglobin, red blood cells (RBCs) and significant decrease in white blood cells (WBCs) and platelets count (PLT) of all rat groups treated with sesame seeds and oil than positive control. The results showed that significant increase in hemoglobin was noticed of rats groups treated with

sesame seeds and oil which reached (10.9 and 11.7) respectively than positive control which reached (7.77).

Table (4): Effect of sesame seed and oil on hemoglobin, RBCs, WBCs and PLT of experimental rats

Parameters	Negative control	Positive control	Sesame seeds	Sesame oil
Hemoglobin	12.12 ± 1.2^{a}	7.77 ± 0.22^{d}	10.9 ± 0.3^{c}	11.7 ± 2.4^{b}
RBCs	6.4 ± 0.21^{b}	2.58 ± 0.2^{e}	4.7 ± 1.1^{d}	4.9 ± 0.9^{d}
WBCs	4.4 ± 1.4^{c}	7.6 ± 1.3^{a}	5.8 ± 0.2^{b}	4.85 ± 0.3^{c}
PLT	293 ± 16.8^{f}	391 ± 7.4^{a}	317 ± 8.3^{e}	336.25 ± 18.4^{d}

Means in the same row with different superscript letters are significantly different at $P\leq 0.05$.

Also the results showed that significant increase in RBCs was noticed of rats groups treated with sesame seeds and oil which reached (4.7 and 4.9) respectively when compared with positive control which reached 2.58 On the other hand, the results recorded that a significant decrease in WBCs and PLT was noticed of rats groups treated with sesame seeds which reached (5.8 and 317) respectively, and rats groups treated with sesame oil which reached (4.85 and 336.25) respectively, than positive control which reached (7.6 and 391) respectively. These results advised that, it is important to give sesame seeds and oil to patients suffering from anemia. These results are accordance with that of (**Benkovic *et al.*, 2009**) who showed that Sesame seeds mainly stimulates the factors related to RBCs rather than WBCs.

Effects of sesame seed and oil on some antioxidant parameters of experimental rats

Data in Table (5) revealed significant increase in total antioxidants (TA), superoxide dismutase (SOD) was observed in rats group treated with sesame seeds and oil than positive control. The results explained that an increase significantly in TA was observed of rats group treated with sesame seeds which reached 3.5mmol/L and rats group treated with sesame oil which reached 3.9mmol/L when compared with positive control which reached 1.3mmol/L. Also the results showed that an significant increase in SOD was recorded of rats group treated with red beet 2ml which reached

(54.14 ± 7.16 U/Ml) and rats group treated with Sesame seeds which reached (60.8U/Ml) when compared with positive control which reached (20.0U/Ml).

These results agreed with the results of **Kanu *et al.* (2007)** recommended that, sesame seeds contained bioactive compounds that play a role in the reduction of the risk for the development of chronic diseases. **Russo, (2007)** suggested that, contain of salycilic acid are the contribution of these compounds to the protective effect incidence of cancer.

Table (5): Effects of sesame seed and oil on some antioxidant parameters of experimental rats

Parameters	Negative control	Positive control	Sesame seed	Sesame oil
Total antioxidants mmol/L	4.55 ± 0.22 a	1.3 ± 0.15 c	3.5 ± 0.15 b	3.94 ± 0.06 b
Superoxide dismutase (U/Ml)	65.13 ± 5.22 a	20.0 ± 3.47d	55.14 ± 7.16 c	60.87 ± 6.35 b

Means in the same row with different superscript letters are significantly different at P≤ 0.05.

Effects of sesame seeds and oil on lipid parameters of experimental rats.

The results in Table (6) showed that a decrease significantly in serum triglyceride, total cholesterol and LDL-c, VLDL-c levels and a significant increase in HDL-c level were observed in rats treated with Sesame seeds and oil than positive control. Data presented showed a significant decrease in total cholesterol of rats treated with Sesame seeds reached (115.67mg/dl) and rats treated with Sesame oil reached (98.80mg/dl) when compared with positive control which reached (130.5 mg/dl). Also the results showed a significant decrease in triglyceride of rats treated with Sesame seeds and oil which reached (90.5 and 75.3mg/dl) respectively when compared with positive control which reached (100.13mg/dl). On the other hand, the results showed an increase significantly in HDL-c of rats treated with Sesame seeds and oil which reached (33.15 and 33.53 mg/dl) when compared with positive control which reached (28.23mg/dl).

The results showed decrease significantly in LDL-c was observed of rats treated with sesame seeds which reached (60.58mg/dl) and rats treated

with Sesame oil which reached (48.37 mg/dl) when compared with positive control (78.87 mg/dl). These results agreed with **Barbosa *et al*.. (1998**) who explained that, feeding rats on sesame seed resulted decrease in lipid level, and increase of tocopherol levels in blood and liver. **Arts *et al*., (2001)** found that, there was a strong inverse association between the intake of catechin and coronary heart disease. **Moghaddam *et al.* (2016)** reported that, the proanthocyanidin content of sesame was able to reduce TG levels.

Table (6): Effects of sesame seeds and oil on lipid parameters of experimental rats

Parameters	Negative control	Positive control	Sesame seed	Sesame oil
TC (mg/dl)	82.27±4.16^{d}	130.57±4.71^{a}	115.67±7.26 ^{b}	98.80±2.44 ^{c}
TG (mg/dl)	68.13±2.97^{d}	100.13±2.97^{d}	90.5±3.14 ^{b}	75.3±5.22b^{c}
HDL-c (mg/dl)	39.50±2.29^{a}	28.23±1.37^{c}	33.15±1.76^{b}	33.53±3.02^{b}
LDL-c (mg/dl)	29.14±5.99^{e}	78.87±3.55^{a}	60.58±5.76^{b}	48.37±1.34^{c}
VLDL-c (mg/dl)	13.63±0.59^{d}	20.06±2.13^{a}	18.1±0.63^{b}	15.08±1.04b^{c}

Means in the same row with different superscript letters are significantly different at P≤ 0.05.

Conclusion

This study has revealed that sesame seed and oil is an important source of many healthy components such as polyunsaturated fatty acids, phenolic phytochemicals in sesame seed and oil makes it an excellent source of bioactive components which may provide potential protection against anemia. Further researches with purified constituents are recommended to better understanding of the complete mechanism of sesame seed and oil in hemoglobin, RBCs, WBCs , and PLT levels in blood and oxidative enzymes. Sesame seeds and oil improve anemia and affects cardiovascular system.

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التأثير المحتمل لبذور وزيت السمسم على فقر الدم الناتج عن نقص الحديد في الفئران

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المستخلص

يحتوى السمسم على نسبة عالية من المركبات الغذائية النشطة بيولوجيا والتى يمكن ان يكون خصائص علاجية على فقر الدم لدى الفئران. لذا تهدف الدراسة الحالية إلى تقييم التأثير المحتمل لبذور وزيت السمسم لعلاج الانيميا الناتج عن نقص الحديد ومستوى الدهون الكلية وتحسين مضادات لأكسدة في الفئران . وقد أجريت الدراسة على ذكور الفئران البيضاء (عدد 20 فأر) تم تقسيمها إلى أربعة مجموعات (عدد 5 فئران لكل مجموعة)، وأبقيت المجموعة الأولى كمجموعة ضابطة سالبة في حين تم حقن المجموعات الثلاث الأخرى بجرعة واحدة من فينيل هيدرازين (40 ميلليجرام لكل كيلوجرام من وزن الجسم/ يوم) لمدة يومين لاحداث الانيميا ، وابقيت المجموعة الثانية كمجموعة ضابطة موجبة (غير معالجة) ، بينما المجموعتين الثالثة والرابعة تم معالجتها بنسبة 15٪ من مسحوق بذور السمسم ، 5 مل زيت السمسم بواسطة أنبوب المعدة يوميًا لمدة ثمانية أسابيع على التوالى. أظهرت النتائج ان بذور وزيت السمسم احتوائهمايحتويانعلى نسبة عالية من المركبات الفينولية الفعالة والأحماض الدهنية الغير المشبعة. كما أظهرت النتائج البيولوجية أن هناك ارتفاع ملحوظ في نسبة الهيموجلوبين وكرات الدم الحمراء في الفئران التي عولجت ببذور وزيت السمسم عند مقارنتها بالمجموعة الضابطة الموجبة (الغير معالجة) . كما حدث ارتفاع ملحوظ في مستوى مضادات الأكسدة الكلية و انزيم سوبر أكسيد ديسموتاز في الفئران التي عولجت ببذور وزيت السمسم. كذلك أظهرت النتائج أن انخفاضًا ملحوظًا في مستوى الكوليسترول الكلي و الدهون الثلاثية و الليبوبروتينات منخفضة الكثافة وارتفاع ملحوظ في الليبوبروتينات مرتفعة الكثافة في الفئران التي عولجت ببذور وزيت السمسم عند مقارنتها بالمجموعة الضابطة الموجبة .

الكلمات المفتاحية: بذور السمسم، الفينولات الكلية، الهيموجلوبين، مضادات الأكسدة، النقص الغذائى.