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Comparative Study between Crude and Manufactured Soybean for Improvement Minerals Absorption and Bone Density in Rats

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Abstract

The improvements of minerals absorption and bone dentistry in rats using crude and manufacture soybean were investigated. Soybean powder contained high amount of protein, carbohydrates, fat, ash, fiber. The highest mineral contents recorded for calcium and phosphorus, while the lowest values for zinc and iron. The whole soybean contains higher amount of all tested isoflavones (diadazein, genistein, isoformantine and biochanine) when compared with manufactured. The biological studies indicated that the highest body minerals density recorded for group fed on soybean powder (56.5) and group fed on soybean tablet (3.06) with no significant difference. The highest body minerals concentration recorded for group fed on soybeans powder (28.25) and group fed on soybean tablet (1.53) with significant difference. The highest calcium after 15 days recorded for group fed on soybean powder (56.5), phosphorus recorded for group fed on soybean powder (28.25), iron for group fed on soybean tablets (3.06) and zinc recorded for group fed on soybean tablets (1.53). The mean values were 5.62 mg/dl, 3.05 mg/dl, 0.65 µg/dl and 2.26 µg/dl, respectively. The highest calcium after 45 days recorded for group fed on soybean powder (28.25), phosphorus for group fed on soybean powder (28.25), iron recorded for group fed on soybean power (28.25) and zinc recorded for group fed on soybean tablets (1.53) with significant difference. The highest calcium after ashing recorded for group fed on soybean soybeans tablets (1.53), phosphorus recorded for group fed on soybeans tablets (3.06), iron recorded for group fed on soybeans tablets (1.53) and zinc recorded for group fed on soybean powder (56.5) with significant difference. In conclusion, crude soybean was higher than manufactured for improvement of minerals absorption and bone dentistry in rats.

Key words: |Chemical composition, Isoflavones, Minerals and Bone density.

Introduction

Soybean (*Glycine max* L.) is a species of legume native to east Asia, widely grown for its edible bean which has several uses. Soybean is recognized as an oil seed containing several useful nutrients including protein, carbohydrate, vitamins, and minerals. Dry soybean contain 36% protein, 19% oil, 35% carbohydrate (17% of which dietary fiber), 5% minerals and several other components including vitamins **(Liu, 1997)**.

Epidemiological and clinical studies have showed that, due to the large consumption of soybean, there is less incidence of cardio-vascular disease, osteoporosis, and certain types of cancer in Japan and China, in comparison to western countries (**Lee *et al*., 2003)**.

Phytochemicals are complex chemicals that vary from plant to plant. They include pigments, antioxidants and other compounds **(Insel *et al*., 2014).** Many bioactive compounds are isolated from soybean and soy food products including isoflavones, peptides, flavonoids, phytic acid, soy lipids, soy phytoalexins, soyasaponins, lectins, hemagglutinin, soy toxins, and vitamins **(Davis *et al.*, 2007)**. Flavonoids are low-molecular weight polyphenolic compounds classified according to their chemical structure into flavonols, flavones, flavanones, isoflavones, catechins, anthocyanidins and chalcones **(Rice-Evans 2001)**. **USDA, (2008)** studied that the isoflavones content in some foods and found that soybeans, green, cooked, boild and drained without salt contain daidzein, genisten and glycitein 7.41, 7.6 and 4.60 mg/100g, edible portion while raw soybeans were 20.34, 22.57 and 7.57 mg/100g edible portion while in mature soybeans cooked seeds were 5.00, 6.70 and 0.80 mg/100g edible portion and in mature soybeans raw seeds 12.86, 18.77 and 2.88 respectively.

Soy foods are rich source of dietary protein. Soy based foods are rich in a class of compounds called isoflavones. Isoflavones have chemical structure that is similar to the hormone estrogen receptors commonly called phytoestrogens. The consumption of soy isoflavones appears to result in health benefits for cancer, heart disease, menopausal symptoms and osteoporosis. So, soy protein has became major components of food **(Bolla, 2015)**.

Isoflavones were suggested to prevent bone loss associated with menopause. Though extensive research using animal models has provided convincing data to indicate a significant improvement in bone mass or other end points following feeding with soybean, results from intervention studies are still controversial . Additional research is needed to determine if isoflavones are an effective alternative to hormone replacement therapy for the prevention and treatment of osteoporosis (**Lagari and Levis, 2010)**.

Genistein is a phytoestrogen (estrogen-like chemical compound present in plants) that binds to estrogen receptors and has both weak estrogenic and weak anti-estrogenic effects. There are three major classes of phytoestrogens that have estrogen-like actions in the human body. They are lignans, isoflavones, and coumestans. Genistein is an isoflavone. Exposure to genistein occurs principally through foods made with soybeans and soy protein **(BCERC, 2007)**.

Genistein decreased levels of bone re-sorption markers and increased levels of markers of new bone formation producing a net gain in bone mass after one year and two years **(Daniells, 2007).**

Genistin ,a glycoside that contains genistein as its aglycone skeleton, is hydrolyzed by enzymes in saliva and the intestinal mucosa, as well as enterobacterial β- glucosidase to produce genistein. Several reports have shown that genistein serves a wide variety of functions including anti –oxidative, anti - carcinogenic and anti –allergic activities **(Wang *et al*., 2006)**.

The loss of bone minerals continues throughout the rest of a person's life-which is one of the reasons there is a lot of excitement about research into daidzein's ability to help stimulate bone formation and mineralization, in the same way that hormones do. Animal experiments, as well as bone tissue and bone cell culture investigations, have demonstrated daidzein's effect on bone metabolism. Also, daidzein has been shown to enhance bone formation, and help prevent and treat osteoporosis in elderly women **(NIH, 2015)**.

Some studies have shown a link between improved bone health and soya intake, especially in women. People who regularly eat soya appear to have higher bone density and lower rates of fracture than those with low intakes. Research is in this area is ongoing and dietary interventions are not considered a replacement for anti-osteoporotic medication **(Hassan, 2013).**

This work was conducted to study the effect of crude and manufacture soybeans for improvements of minerals absorption and bone dentistry in rats.

Materials And Methods

Materials

Soybeans were obtained from Ministry of Agriculture and land reclamation, Cairo, Egypt.

Manufactured soybeans as (tablets) were obtained from Amazon, USA.

Casein , cellulose ,corn starch , minerals and vitamins required for preparing diets were obtained from Biodigestic Company, Cairo, Egypt.

Chemicals and reagents of HPLC

Daidzein, genistein, flavone, bisphenol A, butylated hydroxytoluene (BHT) and acetic acid were supplied by Sigma-Aldrich (Germany). Acetonitrile, ethanol, methanol, acetone, and n-hexane (HPLC grade) are Riedel-de Haän products.

Chemical kits

Chemical kits were obtained from Biodigestic Company, Cairo, Egypt.

Rats

A total of 36 normal male albino rats of Sprague Dawley Strain were obtained from the Laboratory of Animal Colony , Ministry of Health and Population , Helwan Farm, Cairo, Egypt.

Methods

Preparation of soybeans

Soy bean were cleaned by removing impurities , seeds grinded finally (2-3 roll) in home grinder (Multiquick System BRAUN Company made in Germany) then kept in polyethylene bags till use.

Manufactured soy beans (tablets) were grinded finally (2-3 roll) in home grinder.

Determination of isoflavones

Stock standard solutions of daidzein, genistein, and bisphenol A were prepared by dissolving standards in Dimethyl sulfate (DMSO). Approximately 15 mg each of daidzein, genistein, bisphenol A, and flavone were accurately weighed and dissolved in 1.5 ml DMSO.

HPLC system

HPLC assembled from Shimadzu modular components, consisting of a model LC-10AD pump, a model SPD-M10AVP diode array detector, and an interface module was used for this analysis. The samples (20 μl) were injected into a SUPELCOSIL LC-18-DB column (250 x 4.6mm, i.d. 5

μm). Elution was carried out at a flow rate of 1 ml/min. The following mobile phase and gradient programme were used: mobile phase A: 10 % acetic acid, mobile phase B: 100 % acetonitrile. Gradient: linear gradient: from 35 to 100 % B over 10 min, isocratic at 100 % B over 10 min, and isocratic at 35 % B for 20 min. Speed ABN cartridges were obtained from Applied Separation, Allentown (USA). The calibration curves were obtained for each standard by expressing the peak area obtained from HPLC analyses with 20 μl injection as a function of standard concentration according to the method described by **Vranova, (2005)**.

Analytical methods

Moisture, Protein (N x 6.25 Keldahl method), fat (hexane solvent, Soxhielt apparatus), fiber and ash were determined according to the method recommended by **A. O. A. C. (2010)**. Carbohydrate calculated by differences as follows:

Carbohydrates (%) = 100 - (% moisture + % protein + % fat + % ash + % fiber).

Energy value was estimated by the sum of multiplying protein and carbohydrates by 4.0 and fat by 9.0 according to **FAO (1982)**.

Determination of minerals content

The proximate analyses were carried out according to A.O.A.C. methods. The mineral contents of the soybeans were determined by atomic absorption spectrophotometer for calcium, iron and zinc by flame photometry and phosphorus using a colorimeter **(AOAC, 2007)**.

Biological experimental

Experimental design

Male Albino rats (n =36) of Sprague Dawley Strain weighing (100 ±10 g) were housed in well aerated individual wire cages under hygienic laboratory in (Faculty of Home Economics) conditions and fed on a diet which had deficiency minerals(Ca, P, Fe, Zn) for two weeks. All rats were fed on basal diet (casein diet) prepared according to **(AIN, 1993)** for 7 consecutive days. All groups were fed on a diet which had a free minerals of (Ca, Fe, P, Zn) except group one (-ve) control group was fed on basal diet for two weeks. After this adaptation period, rats are divided into 6 groups, each group which consists of six rats as follows: First group: was left as a negative control (-ve) and fed on basal diet only. Second group: left as a positive control (+ve) and fed on a deficiency minerals diet (half amount of the minerals Ca, P, Fe and Zn). Third group: fed on a basal diet substitution with soy beans powder at amount (56.5 g /100g diet). Fourth group: fed on a basal diet substitution with soy beans powder at amount (28.25 g /100g diet). Fifth group: fed on a basal diet with soy beans tablets powder at amount (3.06 g/100gdiet). Sixth group: fed on a basal diet with soy beans tablets powder at amount (1.53 g/100g diet).

Blood sampling

After fasting for 12 hours, blood samples in initial times were obtained from retro orbital vein, while it obtained from hepatic portal vein at the end of each experiments. Two kinds of blood samples were taken. The first parts of blood samples were collected into a dry clean centrifuge glass tubes and left to clot in water bath (37°C) for 30 minutes, then centrifuged for 10 minutes at 3000 rpm to separate the serum, which were carefully aspirated and transferred into clean cuvette tube and stored frozen till analysis.

Determination of calcium, phosphorus, iron and zinc in serum bone

Determination calcium

Calcium was determined according to **(Gindler and King, 1972).**

Determination Phosphorus

Serum phosphorus was determined according to **(El-Merzabani, 1977)**.

Determination iron

Serum iron was determined according to **(Dreux, 1977).**

Determination zinc

Serum iron was determined according to **(Dreux, 1977).**

Determination of bone minerals density (BMD)

Measurements of bone mineral concentration (BMC), bone width (BW) and bone mineral density (BMD = BMC/BW) were made at the middle and epiphysis of femur by dual energy X-ray absorptiometry PIXImus (GE Lunar Co, Madison, WI) at beginning of experiment and 20 weeks after operation according to the method described by **Liang *et al.*, (2012)**.

Statistical analysis

The data were analyzed using a completely randomized factorial design **(SPSS, 1998)** when a significant main effect was detected; the means were separated with the Student-Newman-Keuls Test. Differences between treatments of ($P \leq 0.05$) were considered significant using Costat Program. Biological results were analyzed by One Way ANOVA.

Results And Discussion

Data presented in Table (1) show the chemical composition of powder soy bean. It is clear to notice that soy bean powder contained high amount of protein, carbohydrates, fat, ash, fiber. The mean values were 35.28, 26.62, 22.71, 5.59 and 9.80 %, respectively. On the other hand, the moisture content recorded the lowest value being, 5.34%. These results are in agreement with **Liu (1997)**, who reported that dry soybeans contain 36% protein, 19% oil, 35% carbohydrate (17% of which dietary fiber). Also, **Synder and Kwon, (1987)** found that the amount of protein in soybeans, 38-44%, is larger than the protein content of other legumes, 20-30%, and much larger than that of cereals, 8-15%. This large amount of protein in soybeans along with the high biological value (BV) increases their value as feedstuff and is one reason for the economic advantage that soybeans have over other oil seeds.

Data given in Table (2) show the minerals content of soybean powder. It is evident that the highest mineral contents recorded for calcium and phosphorus, the values were 169.61 and 79.73 mg/100g, respectively, while the lowest values recorded for zinc and ferric. The values were 11.25 and 17.24 mg/100g, respectively. These results are in agreement with **O'Dell, (1979)**, he mentioned that the major forms of minerals in soybeans are sulphates, phosphates and carbonates. Potassium is found in the soybeans in the highest concentration, followed by phosphorus, magnesium, sulphur, calcium, chloride and sodium in that order. Minor minerals include silicon, iron, zinc, manganese, copper, molybdenum, fluoride, chromium, selenium, cobalt, cadmium, lead, arsenic, mercury, and iodine.

The identification of isoflavones of whole and manufactured soy bean using HPLC is shown in Table (3). The obtained results indicated that the main compounds identified in isoflavones of whole and manufactured soy bean were diadazein, genistein, isoformantine and biochanine. The whole soybeans contains higher amount of all tested isoflavones when compared with manufactured. The values were (46.08, 23.56, 536.89 & 21.86 mg/100g) and (30.63, 15.88, 172.19 & 12.08 mg/100g) of diadazein, genistein, isoformantine and biochanine, respectively. These results are in agreement with **Park and Surh, (2004),** they reported that the major isoflavones in soybean are genistein, daidzein, and glycitein, representing about 50, 40, and 10% of total isoflavone profiles, respectively. Also, **Young, (1991)** mentioned that soy isoflavones, daidzein and genistein, are present at high concentrations as a glycoside in many soybeans. Soybeans contain 0.1 to 5 mg/g total isoflavones, primarily genistein, daidzein, and glycitein, the three major isoflavonoids found in soybean and soy products. These compounds are naturally present as the β-glucosides genistin, daidzin, and glycitin, representing 50 to 55%, 40 to 45%, and 5 to 10% of the total isoflavone content, respectively depending on the soy products.

Data presented in Table (4) show the effect of feeding soybeans (powder and tablets) at different levels on body minerals density and body minerals concentration. It is clear that the body minerals density (BMD) of control (-) was higher than control (+) with significant difference. The mean value was 0.13 and 0.08 (g/cm^2), respectively, while, the highest body minerals density recorded for group fed on soybeans powder (56.5) and group fed on soybeans tablet (3.06) with no significant difference. The mean values were 0.12 and 0.12 (g/cm^2), respectively. On the other hand, the lowest body minerals density recorded for group fed on soybeans powder (28.25) and group fed on soybeans tablet (1.53) with no significant difference. The mean values were 0.08 and 0.08(g/cm^2), respectively. In case of body minerals concentration (BMC), the obtained results showed that the body minerals concentration of control (+) was higher than control (-) with significant difference. The mean value was 0.31 and 0.16 (g), respectively, while, the highest body minerals concentration recorded for group fed on soybeans powder (28.25) and group fed on soybeans tablet (1.53) with significant difference. The mean values were 0.49 and 0.42 (g), respectively. On the other hand, the lowest body minerals concentration recorded for group fed on soybeans tablet (3.06) and group fed on soybeans powder (56.50) with no significant difference. The mean values were 0.08 and 0.08(g), respectively. These results are in agreement with **Gao *et al.*, (2011)**, they showed that bilateral ovariectomy developed bone changes similar to those seen in the estrogen deficient osteoporotic women, most markedly is the decrease in bone density. Oral administration of soy total extract or genistein significantly improved the femur bone density and so prevented bone loss due to estrogen deficiency. Also, **Omi *et al.*, (1994)** reported that supplementation of soybean protein concentrate (20%) increased both bone density and calcium content in tibia as compared with the group fed the casein-based diet (20%). Furthermore, **Horiuchi *et al.*, (2001)** studied the effect of soy protein intake on bone metabolism in postmenopausal Japanese woman. They suggested that a high soy protein intake is associated with a higher bone mineral density and a lower level of bone resorption.

Data given in Table (5) show the effect of feeding soybeans (powder and tablets) at different levels on serum calcium, phosphorous, iron and zinc after 15 days with deficiency minerals diet. The obtained results indicated that the serum calcium, phosphorous, iron and zinc after 15 days of control

(-) were higher than control (+) groups. The mean values were (12.95 mg/dl, 9.72 mg/dl, 0.91µg/dl and 3.92 µg/dl) and (5.10 mg/dl, 2.92 mg/dl, 0.44 µg/dl and 1.66 µg/dl), respectively. On the other hand, the highest calcium recorded for group fed on soybean powder (56.5), phosphorus recorded for group fed on soybean powder (28.25), iron recorded for group fed on soybean tablets (3.06) and zinc recorded for group fed on soybean tablets (1.53). The mean values were 5.62 mg/dl, 3.05 mg/dl, 0.65 µg/dl and 2.26µg/dl, respectively. The lowest calcium, phosphorous, iron and zinc recorded for soybean tablets (1.53), soybean powder (28.25), soybean powder (56.5) and soybean tablets (3.06). The mean values were 5.47 mg/dl, 2.12 mg/dl, 0.44 µg/dl and 1.68 µg/dl, respectively. These results are in agreement with **Rezq *et al.,* (2010),** they reported that rat fed on diet containing soya bean oil had a significant ($p<0.05$) increase in serum calcium (mg/dl). 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 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. Also, **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.

Data given in Table (6) show the effect of feeding soybeans (powder and tablets) at different levels on serum (calcium, phosphorous, iron and zinc) levels after 45 days. It is clear that the serum calcium, phosphorous, iron and zinc after 45 days of control (-) were higher than control (+) groups. The mean values were 13.22 mg/dl, 10.10 mg/dl, 0.90 µg/dl and 3.82 µg/dl with no significant difference except with zinc and 6.85 mg/dl, 6.85 mg/dl, 0.65 µg/dl and 2.71 µg/dl, respectively with no significant difference except phosphorus. On the other hand, the highest calcium recorded for group fed on soybean powder (28.25), phosphorus recorded for group fed on soybean powder (28.25), iron recorded for group fed on soybean power (28.25) and zinc recorded for group fed on soybean tablets (1.53) with significant difference. The mean values were 7.60 mg/dl, 7.95 mg/dl, 0.84 µg/dl and 3.90 µg/dl, respectively. The lowest calcium, phosphorous, iron and zinc recorded for soybean powder (56.5), soybean tablets (1.53), soybean powder (56.5) and soybean powder (28.25) with significant difference. The mean values were 5.47 mg/dl, 2.12mg/dl, 0.44µg/dl and 1.68µg/dl, respectively. These results are in agreement with

Laura *et al.*, (2003), they found that legumes in general and soya bean in particular have a high iron and ferritin content. Previous studies measuring soya bean iron bioavailability appear to be conflicting, a very small absorption of iron from soy meal.

The effect of feeding soybeans (powder and tablets) at different levels on bone (calcium, phosphorous, iron and zinc) levels after ashing is shown in Table (7). The obtained data showed that the bone calcium, phosphorous, iron and zinc after ashing of control (-) were higher than control (+) groups. The mean values were (11.80 mg/dl, 5.62 mg/dl, 200.70 µg/dl and 157.50 µg/dl) with significant difference and (10.60 mg/dl, 4.37 mg/dl, 61.80µg/dl and 108.40µg/dl) with significant difference, respectively. On the other hand, the highest calcium recorded for group fed on soybean soybeans tablets (1.53), phosphorus recorded for group fed on soybeans tablets (3.06), ferric recorded for group fed on soybeans tablets (1.53) and zinc recorded for group fed on soybean powder (56.5) with significant difference. The mean values were 11.10 mg/dl, 7.30 mg/dl, 225.4 µg/dl and 200.50 µg/dl, respectively. While, the lowest calcium, phosphorous, iron and zinc after ashing with significant difference recorded for soybean powder (28.25), soybean powder (56.5), soybean powder (56.5) and soybean powder (28.25) with significant difference. The mean values were 9.40 mg/dl, 4.39 mg/dl, 14.90 µg/dl and 58.20 µg/dl, respectively. These results are in agreement with **Sayers *et al.*, (1973),** they showed a much larger percentage of iron absorption, iron in soya bean is an available source of iron. Also, **Rezq *et al.*, (2010)** found that rat fed on diet containing soya bean oil had a significant ($p<0.05$) increase in serum calcium (mg/dl) levels. The administration of soy bean oil increased the serum calcium levels which could be beneficial in preventing osteoporosis. In conclusion, soybeans powder was higher than manufactured for improvement of minerals absorption and bone dentistry in rats.

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Table (1): Chemical composition of soybean powder (g/100g)

Sample	Moisture	Protein	Fat	Ash	Fiber	Carbohydrates
Powder soy bean	5.34	35.28	22.71	5.59	9.80	26.62

Table (2): Minerals content of soybean powder (mg/100g)

Sample	Calcium	Phosphorus	Iron	Zinc
Soy bean powder	169.61	79.73	17.24	11.25

Table (3): Identification of isoflavones of crude and manufactured soybean (mg/100g)

Isoflavones	Manufactured soybean	Crude soybean
Diadazein	3.06	4.61
Genistein	1.59	2.36
Isoformantine	17.22	53.69
Biochanine	1.21	2.19

Table (4): Effect of feeding soybeans (powder and tablets) at different levels on body minerals density and body minerals concentration

Parameter / Groups(n=6)	Body minerals density BMD (g/cm^2)	Body minerals concentration BMC(g)
Control –ve	0.13 ± 0.004^{a}	0.16 ± 0.037^{d}
Control +ve	0.08 ± 0.007^{b}	0.31 ± 0.139^{bc}
Soy powder (56.5)	0.12 ± 0.008^{a}	0.23 ± 0.079^{cd}
Soy powder (28.25)	0.08 ± 0.011^{b}	0.49 ± 0.057^{a}
Soy tablet (3.06)	0.12 ± 0.004^{a}	0.22 ± 0.085^{cd}
Soy tablet (1.53)	0.08 ± 0.017^{b}	0.42 ± 0.080^{ab}

Values denote arithmetic means ± Standard deviation. Means with different letters (a, b, c, d, etc.) in the same column differ significantly at $p\leq0.05$.

Table (5): Effect of feeding soybeans (powder and tablets) at different levels on serum calcium, phosphorous, iron and zinc after 15 days with deficiency minerals diet

Parameter / Groups(n=6)	Ca (mg/dl)	P (mg/dl)	Fe (µg/dl)	Zn (µg/dl)
Control –ve	12.95±0.10[a]	9.72±0.53[a]	0.91±0.04a	3.92±1.06[a]
Control +ve	5.10±0.54[b]	2.92±0.09[b]	0.44±0.12[c]	1.66±0.36[b]
Soy (56.5)	5.62±1.10[b]	2.12±0.20[c]	0.44±0.13[c]	1.94±0.64[b]
Soy (28.25)	5.55±0.57[b]	3.05±0.55[b]	0.63±0.08[b]	1.84±0.37[b]
Soy tablet (3.06)	5.60±0.39[b]	3.00±0.20[b]	0.65±0.02[b]	1.68±0.43[b]
Soy tablet (1.53)	5.47±0.42[b]	2.95±0.17[b]	0.60±0.02[b]	2.26±0.66[b]

Values denote arithmetic means ± Standard deviation. Means with different letters (a, b, c, d, etc.) in the same column differ significantly at $p \leq 0.05$.

Table (6): Effect of feeding soybeans (powder and tablets) at different levels on serum (calcium, phosphorous, iron and zinc) levels after 45 days

Parameter / Groups(n=6)	Ca (mg/dl)	P (mg/dl)	Fe (µg/dl)	Zn µg/dl)(
Control –ve	13.22±0.35[a]	10.10±0.69[a]	0.90±0.03[a]	3.82±1.12[ab]
Control +ve	6.85±0.64[b]	6.85±1.54[bc]	0.65±0.02[b]	2.71±0.40[b]
Soy (56.5)	6.80±1.82[b]	6.02±0.74[c]	0.70±0.10[b]	3.55±0.75[ab]
Soy (28.25)	7.60±0.54[b]	7.95±1.05[b]	0.84±0.03[a]	2.84±0.51[ab]
Soy tablet (3.06)	7.55±0.38[b]	7.05±1.23[bc]	0.75±0.01[b]	3.34±0.61[ab]
Soy tablet (1.53)	7.22±0.78[b]	5.80±0.36[c]	0.72±0.09[b]	3.90±0.63[a]

Values denote arithmetic means ± Standard deviation. Means with different letters (a, b, c, d, etc.) in the same column differ significantly at $p \leq 0$.

Table (7): Effect of feeding soybeans (powder and tablets) at different levels on bone (calcium, phosphorous, iron and zinc) levels after ashing

Parameter / Groups(n=6)	Ca (mg/dl)	P (mg/dl)	Fe (µg/dl)	Zn (µg/dl)
Control –ve	11.8±0.26[a]	5.62±0.88[bc]	200.7±56.9[b]	157.5±9.52[b]
Control +ve	10.6±0.20[a]	4.37±0.87[c]	61.8±15.05[c]	108.4±23.0[c]
Soy (56.5)	10.6±1.35[a]	4.39±1.10[c]	14.9±4.97[c]	200.5±16.3[a]
Soy (28.25)	9.4±2.90[a]	6.23±0.38[ab]	338±35.1[a]	58.2±14.5[d]
Soy tablet (3.06)	10.7±1.33[a]	7.30±0.17[a]	166.5±25.8[b]	140.6±21.6[b]
Soy tablet (1.53)	11.1±0.45[a]	5.72±0.33[ab]	225.4±64.1[b]	64.1±19.4[d]

Values denote arithmetic means ± Standard deviation. Means with different letters (a, b, c, d, etc.) in the same column differ significantly at $p \le 0.05$.

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دراسة مقارنة بين فول الصويا الخام والمصنع فى تحسين امتصاص المعادن وكثافة العظام فى الفئران

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الملخص العربى:

تم دراسة تحسين امتصاص المعادن وكثافة العظام في الفئران باستخدام مسحوق فول الصويا الخام والمصنع. وأظهرت النتائج أن مسحوق فول الصويا يحتوي على كمية عالية من البروتين، والكربوهيدرات، والدهون والرماد والألياف. حيث سجلت أعلى محتويات للعناصر المعدنية مع الكالسيوم والفوسفور، بينما كانت أدنى القيم المسجلة مع الزنك والحديد. لوحظ احتواء مسحوق فول الصويا على كمية أعلى من كل الايزوفلافونات مثل (الديادازين ، الجينيستين، الأيزوفورمانتين, البيوشانين) بالمقارنة مع فول الصويا المصنع .اظهرت التجارب البيولوجية أن أعلى كثافة للمعادن فى الجسم سجلت مع المجموعة التي تغذت على مسحوق فول الصويا (٥٦.٥) والمجموعة تغذت على فول الصويا فى صورة اقراص (٣.٠٦) مع عدم وجود فروق معنوية . سجلت أعلى تركيز لمعادن الجسم سجلت مع المجموعة التى تغذت على مسحوق فول الصويا (٢٨.٢٥) والمجموعة التى تغذت على فول الصويا فى صورة أقراص (١.٥٣) مع وجود فروق معنوية. سجلت أعلى مستوى للكالسيوم بعد ١٥ يوم مسجل مع مجموعة الفئران التي تغذت على مسحوق فول الصويا (٥٦.٥)، والفوسفور مع مجموعة الفئران التي تغذت على مسحوق فول الصويا (٢٨.٢٥)، الحديد مع مجموعة الفئران التي تغذت على أقراص فول الصويا (٣.٠٦)والزنك مع مجموعة الفئران التي تغذت على أقراص فول الصويا (١.٥٣).حيث كان متوسط القيم ٥.٦٢ مجم / ديسيلتر، ٣.٠٥ مجم / ديسيلتر ، ٠.٦٥, ميكروجم / ديسيلتر, ٢.٢٦ ميكروجم / ديسيلتر على التوالي .أعلى مستوى للكالسيوم بعد ٤٥ يوما سجل للمجموعة التي تغذت على مسحوق فول الصويا (٢٨.٢٥) ، والفوسفور سجل للمجموعة التي تغذت على مسحوق فول الصويا (٢٨.٢٥) ، الحديد سجل للمجموعة التى تغذت على مسحوق فول الصويا (٢٨.٢٥) والزنك سجل مع المجموعة التى تغذت على فول الصويا فى صورة أقراص(١.٥٣) مع وجود فروق معنوية . أعلى مستوى للكالسيوم بعد الترميد سجل مع المجموعة التى تغذت على فول الصويا فى صورة أقراص (١.٥٣)، والفوسفور سجل مع المجموعة التى تغذت على فول الصويا فى صورة أقراص (٣.٠٦) ، الحديد سجل مع المجموعة التى تغذت على فول الصويا فى صورة أقراص (١.٥٣) والزنك سجل مع المجموعة التى تغذت على مسحوق فول الصويا (٥٦.٥ مع وجود فروق معنوية . الخلاصة، كان مسحوق فول الصويا أعلى من المصنع فى تحسين المعادن امتصاص وكثافة العظام في الفئران.

الكلمات الدالة: التركيب الكيماوى, الايزوفلافونات, عظام الفئران, المعادن