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Biological Effect of some Functional Soybean Yoghurt Products on Osteoporosis in Experimental Rats

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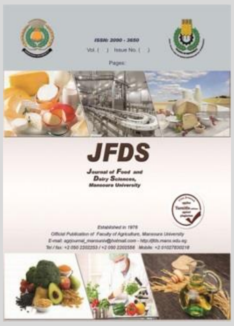

ABSTRACT

Natural health products, are popular with patients due to their ease of access and perceived margin of safety. This study aimed to prepare a functional yoghurt and study its effect on osteoporosis rats injected with dexamethasone. Thirty five adult male albino rats were divided into two main groups, the first group (n = 5) as a normal control group, while the second group (n =30) were injected with dexamethasone (1 ml/100g) to induce osteoporosis once a day for 6 weeks. The second main group was divided into six subgroups (n = 5). Subgroup 1 was fed on basal diet as a positive control. Subgroups 2, 3 ,4 ,5 and 6 were fed on soymilk, soymilk yoghurt, soymilk yogurt with pomegranate fruit, soymilk yogurt with persimmon fruit and soymilk yoghurt with kiwi fruit respectively. Result showed that soymilk yoghurt fortified with fruits was rich in minerals, vitamins and lactic acids. Also the rats suffering from osteoporosis and treated with soymilk yoghurt fortified with fruits led to decrease in cholesterol, triglycerides, LDL-c, ALT, AST, total protein, total bilirubin, creatinine, urea, uric acid, MDA and serum P levels as well as urine Ca and increased HCL, HDL-c, SOD, GPx, CAT, serum Ca and Vitamin D, especially with soymilk yoghurt with kiwi.

Keywords: Functional yoghurt - Soymilk - Probiotic – Osteoporosis- pomegranate- persimmon- kiwi

INTRODUCTION

Osteoarthritis (OA) is a prevalent, degenerative joint disease that affects up to 80% of people over the age of 65. It causes severe pain, function limitations, exhaustion, higher societal expenditures, and increased healthcare use (Blumenkrantz *et al*., 2004 and Litwic *et al.,* 2013). The burden of osteoarthritis is estimated to upsurge with population aging and over weightiness, although the occurrence of osteoarthritis developments with age, there is a growing view that osteoarthritis happens to people at earlier time of live (Nguyen *et al*., 2011 and Losina *et al.*, 2013).

The disease symptoms and disorder are stiffness, pain, reduce the movement area of the joint, alteration in proprioception, muscle weakness of the quadriceps and progressive loss of joints function. Those disease symptoms lead to restrict of person capability to stand up from a chair, climb stairs and difficult in walking or walking with a limp in awkwardly way, instabilities and poor alignment also notice in people with osteoarthritis (OA) (Losina *et al*., 2013). During a person's movement or activity, a crackling sound can be heard because of the arthritis in the surface of the articular cartilage (Nguyen *et al*., 2011). The second gene pool of the human body, the intestinal microbial flora, is recognized to play a significant role in human disease as well as immunological function, nutrient uptake, and numerous host cell functions. And it plays a role in a number of pathways that have an impact on bone health (Ilesanmi-Oyelere and Kruger 2021). It has been demonstrated that probiotics and prebiotics improve the stomach, bone, and calcium absorption. With the aid of advantageous microorganisms in the gut, prebiotics are also known to be fermented into fermentative substrates like short chain fatty acids (SCFAS), primarily acetate, butyrate, and propionate. By reducing inflammation in the stomach and bones, prebiotics and probiotics have a positive impact on bone health (Klaenhammer *et al*., 2012). Bifidobacterium and Lactobacillus made up the majority of the examined microbes. The high dietary calcium level and the significant probiotic supplementation both contributed to the favorable effects of the probiotics. One of the main mechanisms is the production of short-chain fatty acids, which increases mineral solubility. Another is the production of the phytase enzyme by bacteria, which counteracts the mineral depletion caused by phytate. A third mechanism is the reduction of intestinal inflammation, which is followed by an increase in bone mass density; (4) hydrolyzing glycoside bond food in the intestines by *Lactobacillus* and *Bifidobacterium* (Khan 2014).

Soybeans are a key component of more than half of all oily flours and a quarter of all vegetable oils, which considered a significant commodity grown worldwide (Elasraag, 2018). Soybeans are an important food for their protein, fat, fiber and mineral content. In addition to many functional aspects and their effect in the prevention of osteoporosis, including the properties of estrogen and antioxidants (Mateas and Aparicio *et al*., 2008). Soybean contains 40% protein, which is an important dietary protein for humans and maintains mineral density in aged bones. In addition, soybean protein and its hydrolysates bind with calcium and enhance its absorption in the intestines of mice (Bao *et al*., 2007).

Soymilk is a food with great nutritional value that is excellent for those with lactose intolerance, allergies, or vegetarian diets because it contains proteins and unsaturated fatty acids. Additionally, soybean milk and its ferments are

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beneficial nutritional supplements since they contain powerful antioxidants Ikya *et al* (2013). Yogurt and rayeb have recently been produced using a variety of ingredients, such as soy milk, grape juice and buffalo milk, and frequently combined with fruits including natural fruit juice, pulp, and dry fruits to enhance the aesthetic value (Ghadge *et al*., 2008).

Therefore, the current study was started on the processing functional yoghurt from soybean milk supplemented with fruits and its effect on the functional and nutritional value of the soybean milk. On the other hand, clarification of the relationship between the soymilk yoghurt fortified with probiotics and some fruits and increasing bone mass in rats injected by osteoarthritis.

MATERIALS AND METHODS

Materials:

Dried soy beans (*Glycine max*) :

was purchased from the local market, El Manzala city, EL-Dakahlia Governorate, Egypt.

Cow milk and Fresh fruits :

as pomegranate (*Punica grantum*), persimmon (*Diospyros kaki***)** and kiwi (*Actinidia deliciosa*) were collected from local market., El Manzala city, EL-Dakahlia Governorate, Egypt.

Starter cultures Probiotic bacteria:

pure probiotic bacteria strains contain (*Bifidobacterium* sp., *Streptococcus thermophiles* and *Lactobacillus acidophilus)* were supplied by Microbiology Laboratory of the National Research Center, Giza, Egypt.

Dexamethasone:

(DEX)-MUP 8mg/amp (2ml) I.M./L.V (8mg Dexamethasone phosphate) and biochemical kits analysis were obtained from El-Gomhoria company for chemical and drugs, Mansoura City, Dakahlia Governorate, Egypt.

Animals: About 35 healthy adult male albino rats (*Sprague dawely*) weighing (170 to 180 g per each) were obtained from Agricultural Research Center, Giza, Egypt. All the biological experimental procedures were applied according to Internationally Ethical Guidelines for the care and use of laboratory animals. And permission for the experiment was obtained from the Research Ethics Committee at the Faculty of Specific Education, Mansoura University.

Basal Diet: The basal diet, shown in Table A, is constructed according to the formula given by NRC (1995).

Table A. Chemical ingredients of basal diet.

Ingredients	%Basal diet	Ingredients	%Basal diet
Casein	20	Corn oil	5
Corn starch	49.7	Mineral admixtures	10
Sugar (Sucrose)	10	Vitamin admixtures	2
Cellulose	3	DL-methionine	0.3

Methods:

Preparation of raw materials:

- **Starter cultures probiotic bacteria:** The three probiotic strains were mixed (1:2:2), then activated in 10% (W/V) sterile reconstituted skim milk and incubated at 37°C for 48 h. The process was repeated three times prior to product manufacturing (Mostafa, 2011).
- **Preparation of soymilk:** Whole soya beans were rinsed and steeped in distilled water overnight. Soya beans were comminuted in a blender for 3 minutes using distilled water after decanting the water. Soymilk was obtained by filtering the resulting slurry through double-layered cheesecloth. Following that, pasteurize the milk for 30 minutes at 68 °C according to (Udeozor, 2012).
- **Preparation of fruits**: Pulps pomegranate fruits were washed, drained, then manually cut up and the outer leathery skin were removed. Persimmon fruits were washed, roots were removed and cut. Kiwi fruits were peeled and cut. All prepared fruits were blended in a blender without water until homogeneous, filtered then packed in polyethylene bags. The samples were stored in deep freezer at (-18°c) until used.

Fermentation of soymilk by probiotics bacteria:

Soymilk was pasteurized to 85°C for 15 min then rapidly cooled to 40^0c and inoculated with a mixture of 10% probiotic bacteria mix (*Streptococcus Thermophilus, Lactobacillus Acidophilus and Bifidobacterium Sp*.). Four parts of inoculated soymilk were divided. The first part (no additives) utilized as a control. Each part from other was separated into three equal portions and then 3% of the preserved fruit pulps (pomegranate, Persimmon and kiwi) were added, respectively. The inoculated milk yoghurt mixes were put into 120 g plastic cups and incubated at 40 ^{O}C for fully coagulation until pH value reached to 4.7 after (2-3 h). The fermented yoghurt samples were chilled and kept in a refrigerator at 5±1 ^{O}C for 14 days as mentioned by (Osman *et al*., 2020).

Yogurt analytical methods:

Chemical analysis:

- Mineral contents of the samples were determined as indicated to Chapman and Pratt (1979). The total amounts of Mg, Ca, and K were determined using atomic absorption spectrophotometry, according to A.O.A.C. (2005). Whereas, P content was determined using a spectrophotometer according to Peters *et al.,* (2003).
- Lactic acid and Vitamin B1, 2, 3 and 6 were determination by Isocratic High Performance Liquid Chromatography (HPLC). according to Mmili *et al.* (1981) and Saad *et al.,* (2015).

Design of biological experiment:

Thirty five adult male albino rats were divided into two main groups, the first group (n = 5) as a normal control group, while the second group (n =30) were injected with dexamethasone (1 ml/100g) to induce osteoporosis once a day for 6 weeks according to Laste *et al.* (2013). The second main group was divided into six subgroups (n = 5). Subgroup 1 was fed on basal diet as a positive control. The other five subgroups treated with soybean milk, yogurt and its products by oral stomach tube (3ml/ kg/rat) once daily as follow ;

- Group (3): Fed on soymilk.
- Group (4): Fed on soymilk yoghurt.
- Group (5): Fed on soymilk yogurt with 3% pomegranate.
- Group (6): Fed on soymilk yogurt with 3% persimmon.
- Group (7): Fed on soymilk yoghurt with 3% kiwi.

Nutritional parameters detected for experimental rats:

The study was allocated for six weeks. On a daily basis, to monitor health status such as body condition, external appearance, hair color, movement and discomfort in walking.

Aaccording to Chapman *et al.*, (1959), feed intake (gm.) was assessed every two days, and rate weight (gm.) was recorded weekly during the study period of 42 days. The following formulae were used to compute body weight gain:

Body weight gain

$$BWG(\%) = \frac{\text{final weight(g)} - \text{intial weight(g)}}{\text{intial weight(g)}} \text{x}100$$

Feed efficiency ratio (FER) = weight gain (g) / Feed intake (g)

Blood sample collection:

Blood samples were collected ccording to Drury and Wallington (1980), then kept in a deep freeze at – 18^0c until used for biochemical analyses.

Biochemical analysis:

A -Lipid profile was estimated as:

- Triglycerides (TG) and total cholesterol (TC) were chemically determined using specific diagnostic kits according to the methods described by Fassati and Prencipe (1982) and Allain *et al*., (1974), respectively.
- High-density lipoprotein (HDL-C) cholesterol measured chemically using the method described by (Lopes *et al.,* 1977).
- LDL_{-C} and $VLDL_{-C}$ were calculated by using the method of Friedewald *et al.* (1972).

$$LDLc = \text{Total cholesterol} - (HDL_C + VLDL_C)$$

$$VLDLc = TG/5$$

B -Liver function:

- The activity of serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) enzymes were chemically measured to assess liver function using the method described by Burtis *et al*., (1999).
- The activity of serum total protein (TP) concentrations was evaluated chemically using the Folin-phenol reagent and bovine serum as a standard, as described by Lowry *et al.* (1951).
- The total bilirubin (TBil) in the blood was measured using the method described by Stiehl (1982).

C -Renal function was obtained as following analysis:

- Urea, uric acid and creatinine were determined according to the methods described by Malhotra (2003), Fassati *et al.* (1980), and Bartels *et al.* (1972), respectively.

D -Antioxidant activity

- Malondialdehyde (MDA) is a lipid peroxidation product, have been determined using the procedure described by Mistura and Midora (1987).
- Superoxide dismutase (SOD): according to the method described by Nandi & Chatterjee (1988), the pyrogallol auto-oxidation method is employed to determine SOD
- Catalase (CAT): the catalase activity was determined using the method of Claiborne (1985).
- Glutathione peroxidase (GPx): GSH-Px was measured according to the method of (Gross *et al.*, 1967 and Necheles *et al.*, 1968).

Ca and P minerals

Serum levels of calcium and phosphorus were determined according to Gindler and King, (1972) and ElMerzabani *et al.,* (1977), respectively.

Statistical analysis:

All data were statistically analyzed using the analysis variance (ANOVA) test and the least significant difference (L.S.D) at 0.05 and Duncan's test according to Gomez and Gomez, (1984).

RESULTS AND DISCUSSION

Mineral content of fruity soymilk yoghurt:

Mineral content including calcium (ca), potassium (K), phosphorus (p) and magnesium (mg) mg/100g for soymilk yoghurt and fortified with fruits are shown in Table (1). Soymilk yoghurt recorded significant increase in calcium and phosphorus levels but recorded significant decrease in magnesium while showed non significant in potassium compared with cow milk yoghurt. It is obvious that the highest ca content recorded for soymilk yoghurt followed by kiwi soymilk yoghurt while the lowest ca level was for persimmon soymilk yoghurt. Regarding phosphorus, data show that soymilk yoghurt recorded the highest phosphorus level followed by kiwi soymilk yoghurt then persimmon soymilk yoghurt and cow milk yogurt. While the pomegranate soymilk yoghurt recorded the lowest phosphorus amount. As for Mg data, significant differences ($p < 0.05$) were observed between samples. It is obvious that the addition of fruits to soymilk yoghurt caused an increment in mg amount as recorded the highest content in pomegranate soymilk yoghurt, while lowest mg contents recorded in soymilk yoghurt without addition. Finally, from the previous results we could observe that calcium and phosphorus contents decreased while magnesium increased significantly ($p < 0.05$) by the addition of fruits compared to soymilk yoghurt. Stephen *et al.* (2017) resulted that calcium and phosphorus were high in commercial yoghurt sample, probably because of the fortification of yoghurt with minerals. Potassium content was high in cow and soymilk yoghurt, followed by cow and soymilk yoghurt, Soymilk yoghurt, and soymilk yoghurt having the lowest value. Whereas, potassium was found to be higher in cow and soymilk yoghurt compared to sample commercial yoghurt with the calcium content.

Table 1. Some minerals content of fruity soymilk yoghurt.

Samples	Ca	K	P	Mg
	mg/100g			
Cow milk yoghurt	$138.57^c \pm1.090$	$164.53^d \pm1.898$	$94.98^d\pm1.030$	$21.69^c\pm0.859$
soymilk yoghurt	$195.31^a \pm1.948$	$163.36^d \pm1.082$	$174.51^a\pm0.739$	$18.29^d\pm0.657$
Pomegranate soymilk Yoghurt	$138.40^c \pm1.741$	$563.49^a \pm2.664$	$51.26^e\pm1.550$	$41.53^a\pm0.972$
Persimmon soymilk Yoghurt	$116.49^d \pm0.888$	$236.32^c \pm2.075$	$128.31^c\pm0.765$	$21.83^c\pm0.218$
Kiwi soymilk Yoghurt	$148.33^b \pm1.454$	$451.31^b \pm1.387$	$137.44^b\pm1.722$	$34.19^b\pm0.559$
LSD at 0.01	3.82	4.92	3.18	1.82
LSD at 0.001	5.53	7.13	4.60	2.63
LSD at 0.05	2.68	3.46	2.24	1.28

The values in each column with different superscript are significantly different at ($p < 0.05$).

Yoghurt was rich in minerals and may be due to the content of the minerals in the fortified fruits. Copper, magnesium, manganese, zinc, and iron are among the minerals found in persimmon (Karaman *et al*. 2014). In addition, calcium, iron, potassium, magnesium, manganese, copper, phosphorus, zinc, and selenium are some of the minerals found in kiwi fruit (Chawla *et al.*, 2019; 2020). Moreover, the pomegranate contained the most determined minerals at adequate concentrations, with Ca, K, P, and Na being the most prevalent minerals at 338.5, 146.4, 117.9, and 66.4 mg/100g dry matter, respectively (Rowayshed *et al.* 2013).

Vitamins and Lactic acid% in fruity soymilk yoghurt:

Table (2) Table (5) reflected the content of some vitamins in different studied yoghurt. Data in the Table showed that cow milk yoghurt recorded the highest value of Vit A (retinol) scores, while soymilk yoghurt recorded the lowest one. Addition of fruits to soymilk yoghurt significantly increased the value of Vit. A compared with soymilk yoghurt. While kiwi soymilk yoghurt recorded the highest Vit. A content, followed by pomegranate soymilk yoghurt then persimmon soymilk yoghurt. For Vit.B components which included Vit. B1 (thiamine), Vit. B2 (riboflavin), Vit. B3 (niacin) and Vit. B6 (pyridoxine), data showed no significant differences observed ($p<0.05$) between persimmon soymilk yoghurt and kiwi soymilk yoghurt in level Vit B1. While the lowest value recorded in cow milk yoghurt then soymilk yoghurt and pomegranate. Vit. B2 recorded the highest content for cow milk yoghurt, while the lowest value indicated with pomegranate and Kiwi soymilk yoghurt with no significant differences between them. In the same Table Vit. B3 was increased significantly ($p<0.05$) by the addition of fruits, persimmon soymilk yoghurt recorded the highest value followed by pomegranate and kiwi soymilk yoghurt, while the lowest Vit. B3 value recorded in soymilk yoghurt. Results of Vit. B6 recorded the highest value with kiwi soymilk yoghurt followed by persimmon then pomegranate soymilk yoghurt, while the lowest value recorded in cow milk yoghurt and soymilk yoghurt with no significant differences ($p<0.05$) between them. In the case of lactic acid%, it was found that cow milk yoghurt recorded the highest score, while the lowest value score was for soymilk yoghurt at $p<0.05$ and no significant differences ($p<0.05$) were noticed between persimmon soymilk yoghurt and kiwi soymilk yoghurt were observed.

Yogurt is a good source of zinc, calcium, phosphorus, folate, niacin, magnesium, and protein, as well as Vitamins B2, B1, and B12. It provides a high biological value protein, while milk and dairy products, especially yoghurt, include bioavailable vitamins and minerals. Yogurt and other dairy products improve the quality of a meal overall and raise the likelihood that it will fulfil nutritional guidelines (Baburao *et al.*, 2019). Vitamin content changes during fermentation, wherein Deguchi *et al.* (1985) discovered that thiamin, nicotinic acid, and folic acid levels differed significantly between species or strains. The drop in thiamin level could be due to the organism's own use of niacin, which is required for growth. Hou *et al.* (2000) discovered that when soymilk was fermented with either B. infantis CCRC 14633 or B. longum b6, the concentration of riboflavin and thiamin increased, but the niacin level decreased. Several studies have found that fermenting milk boosts nutritional value by raising vitamin levels. When soymilk was fermented with the *basidiomycete Ganoderma* lucidum WZ02, the concentrations of niacin, riboflavin, and thiamin all increased, according to Hailong and Liang (2009). Most B complex vitamins, save thiamin, were shown to be elevated in the manufacture of fermented soya bean products such natto and tempeh. Additionally, vitamins A, B, C, E, and K are all present in kiwis, as well as significant amounts of dietary fibre, folate, potassium, and other minerals (Richardson *et al*., 2018). Regarding the rise in lactic acid in yoghurt, cow milk may be to blame. Yogurt is a dairy product made by milk being fermented by lactic acid bacteria. Yogurt's distinctive gel-like texture is a result of lactic acid being produced during the fermentation of milk sugar (lactose) (Ome *et al.* 2018). While, the lactic acid contents obtained in this study also compared favorably with the range (0.17 – 1.16%) reported by Olubamiwa and Kolapo (2010) for soy-yoghurt produced using soy-coconut milk premix.

Table 2. Vitamins and lactic acid content of fruity soymilk yoghurt:

Samples	Vitamin (A) IU	mg/100g				Lactic acid%
		Thiamin (B1)	Riboflavin (B2)	Niacin (B3)	Pyridoxine (B6)	
Cow milk yoghurt	229.00^{a}±6.00	0.019^{d}±0.003	0.261^{a}±0.003	0.212^{c}±0.003	0.056^{c}±0.004	11.13^{a}±0.110
soymilk yoghurt	52.00^{e} ±3.00	0.240^{bc}±0.030	0.093^{bc}±0.003	0.180^{d}±0.003	0.060^{c}±0.002	0.59^{d} ±0.160
Pomegranate soymilk yoghurt	131.00^{c}±4.00	0.210^{c} ±0.020	0.088^{c}±0.003	0.260^{b}±0.002	0.080^{bc}±0.020	0.86^{c} ±0.040
Persimmon soymilk yoghurt	66.00^{d} ±5.00	0.300^{a} ±0.040	0.098^{b} ±0.004	0.310^{a}±0.004	0.110^{ab}±0.020	0.98^{bc}±0.130
Kiwi soymilk Yoghurt	196.00^{b}±4.00	0.260^{ab}±0.020	0.090^{c} ±0.004	0.210^{c}±0.003	0.130^{a} ±0.030	1.08^{b} ±0.050
LSD at 0.01	11.68	0.066	0.009	0.008	0.047	0.28
LSD at 0.001	16.92	n.s	n.s	0.011	0.069	0.41
LSD at 0.05	8.22	0.045	0.006	0.006	0.034	0.20

Each value is the mean ± SD

The values in each column with different superscript are significantly different at ($p < 0.05$).

Biologicalassay:

Body weight gain of experimental rats fed on fruity soymilk yoghurt for 42 days:

The statistical data in Table (3) illustrated the initial body weight, final weight, change in weight, gain weight, feed intake and feed efficiency ratio in normal group and groups fed on the yoghurt samples.

After seven days of adaptation, the mean values of initial body weight of all rats groups ranged between 174.12 and 175.96 g. As shown in Table 3, the statistical results on initial weight of rats revealed that no significant differences ($p<0.05$) were noticed in osteoporosis rats groups. While, at the end of experiments the body weight ranged from 179.54 to 246.84 g with significant differences between all groups. According to, Malkawi *et al*., (2018) reveled that after the injection of DEX in rats suffered from osteoporosis and about ∼20% reduction in weight gain.

Table 3. Body weight gain of experimental rats fed on fruity soymilk yoghurt for 42 days:

Parameters Groups	Initial weight g	Final weight g	Change in weight g	Body weight gain %	Feed intake	Feed efficiency ratio
G1: Normal (-)	$174.65^{a}\pm2.89$	$198.95^{e}\pm3.30$	$24.30^{e}\pm6.19$	$13.96^{e}\pm3.78$	$16.58^{e}\pm0.27$	$0.020^{d}\pm0.005$
G2:Positive (+)	$174.51^{a}\pm3.97$	$179.54^{f}\pm4.4.3$	$5.03^{f}\pm0.46$	$2.88^{f}\pm0.20$	$14.96^{f}\pm0.37$	$0.005^{e}\pm0.001$
G3:soymilk milk	$174.12^{a}\pm2.42$	$203.65^{e}\pm2.99$	$29.53^{e}\pm0.57$	$16.96^{e}\pm0.09$	$16.97^{e}\pm0.25$	$0.024^{d}\pm0.001$
G4:Soymilk yoghurt	$175.69^{a}\pm4.48$	$219.54^{d}\pm4.00$	$43.85^{d}\pm0.48$	$24.97^{d}\pm0.91$	$18.30^{d}\pm0.33$	$0.033^{c}\pm0.002$
G5:pomegranate soymilk yoghurt	$175.65^{a}\pm4.41$	$246.84^{b}\pm4.19$	$71.19^{b}\pm8.60$	$40.63^{b}\pm5.92$	$20.57^{b}\pm0.35$	$0.047^{a}\pm0.006$
G6:persimmon soymilk yoghurt	$175.96^{a}\pm2.58$	$231.11^{c}\pm2.87$	$55.15^{c}\pm5.45$	$31.38^{c}\pm3.56$	$19.26^{c}\pm0.24$	$0.039^{b}\pm0.004$
G7:kiwi soymilk yoghurt	$174.89^{a}\pm3.52$	$256.12^{a}\pm3.39$	$81.23^{a}\pm0.13$	$46.46^{a}\pm1.01$	$21.34^{a}\pm0.28$	$0.052^{a}\pm0.002$
LSD at 0.01	n.s	8.84	10.97	7.33	0.74	0.008
LSD at 0.001	n.s	12.31	15.26	10.21	1.02	0.012
LSD at 0.05	n.s	6.37	7.90	5.29	0.53	0.006

Each value is the mean ± SD
The values in each column with different superscript are significantly different at ($p < 0.05$).

Data presented in Table (3) showed that the positive control group recorded significant decrease in final weight, change in weight, gain weight %, feed intake and feed efficiency ratio comparable with normal control group, while soymilk yoghurt showed significant increase in final weight, change in weight, gain weight %, feed intake and feed efficiency ratio comparable with positive control group and soymilk group. On the other hand addition fruits to soymilk yoghurt significantly increased all of them. The highest, weight gain, feed intake and feed efficiency ratio were scored with rats fed on kiwi soymilk yoghurt, followed with group fed on pomegranate soymilk yoghurt then persimmon soymilk yoghurt comparing with normal control group.

According to Chou *et al.* (2008), numerous mechanisms, including antioxidant activity, anti-inflammatory properties, and direct scavenging of free radicals, are responsible for the positive effects of kiwi fruit, all of which reduce oxidative stress and lipid peroxidation. Shim *et al.* (2007) observed that because soybean isoflavones enhance metabolism, weight gain as well as weight loss are suppressed as a result. The same result indicated by Sartang *et al.* (2015) reported that body weight significantly increased with rats fed on fermented soymilk. Samanta *et al.* (2014) resulted an increase in final body weight for rats induced with probiotic. The actual cause for increase of body weight is unknown. The potential effects of probiotic microorganisms on gut microflora development (Patel and Lin, 2010) and have been altered to boost feed conversion and decrease pathogens (Kelleher *et al.,* 2002). The improvement in body weight seen in pressure-treated animals may be due to better host animals' metabolism and gastrointestinal efficiency developed by enhancing nutrition absorption (Gritsenko *et al.,* 2000).

Lipid profile of experimental rats fed on fruity soymilk yoghurt for 42 days:

The effect of feeding soybean milk, soymilk yoghurt and fruity soymilk yoghurt on lipid profile including total cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL_{-C}) and low-density lipoprotein (LDL_{-C}) were given in Table (4). Results indicated that osteoporosis rats (positive control) recorded the highest levels of cholesterol, triglycerides and LDL-C. while recorded the lowest level of HDL-C compared with normal control group. After feeding on soybean milk and yoghurt samples, a significant decrease was observed in the mentioned parameters comparing to the positive control (p,0.05), Kiwi soymilk yoghurt had the lowest cholesterol, triglycerides and LDL_{-C} levels followed by persimmon soymilk yoghurt. Meanwhile, the highest cholesterol, triglycerides and LDL_{-C} levels recorded in positive group suffered from osteoporosis followed by group fed on soybean milk. Soymilk yoghurt fortified with fruits reduced cholesterol, triglycerides and LDL_{-C} levels. Results revealed that the kiwi soymilk yoghurt with was the best in reducing cholesterol, triglycerides and LDL_{-C} levels of rats suffered from osteoporosis (75.33, 66.00 and 12.13 mg/dl), followed by the pomegranate soymilk yoghurt (82.67, 71.00 and 21.13 mg/dl) comparing with the positive control which scored the highest cholesterol, triglycerides and LDL_{-C} levels (142.67, 121.00 and 30.33 mg/dl). Feeding rats on soybean milk or soymilk yoghurt with or without fruits increased HDL_{-C} level comparing with those in case of positive control suffered from osteoporosis.

The results are in agreement with that obtained by Leontowicz *et al.,* (2013), reported that a kiwi fruit-rich diet reduced TG, TC, and LDL.C, as well as the value of the atherogenic index. Also, Rodriguez *et al.,* (2015) found that with a reasonable diet and consistent exercise, consumers who ate at least one kiwi per week had lower triglyceride levels, greater plasma HDL-C values, lower plasma fibrinogen concentrations, and an improved plasma lipid profile. Also, the results by Shehata and Soltan (2013) indicated that in hypercholetrolomic rats, the level of LDL.C reduced dramatically in the groups fed kiwifruit and avocado, suggesting that kiwifruit and avocado consumption may have some cardiovascular preventive qualities and a good influence on the atherosclerotic CVD risk.

According to Abbasi *et al.* (2018), In contrast to traditional soy milk, probiotic soy milk supplementation significantly decreased blood LDL-C, T-Chol, and non-HDL-C. Patients who ingested 300 g of probiotic yoghurt every day for six weeks likewise reported similar outcomes (Ejtahed *et al.* 2011). Numerous ways exist for lactic bacteria to affect blood cholesterol levels. Short chain fatty acids, particularly propionate, are metabolites of lactic bacteria that can inhibit cholesterol enzymatic synthesis. They can also facilitate cholesterol removal through faeces by binding to cholesterol and bile salts to prevent cholesterol reabsorption. Finally, lactic bacteria can assimilate cholesterol (Sadeghipour *et al.* 2014). In a similar line, pomegranate peel consumption in a high-fat diet decreased plasma biochemical indicators, regardless of whether it was paired with probiotics, according to research by Benguiar *et al.* (2020). These findings are consistent with those made by Hossin (2009), who found that pomegranate peel dramatically decreased the levels of triglycerides, total cholesterol, and LDL cholesterol in rats on a high-fat diet.

Table 4. Lipid profile of experimental rats fed on fruity soymilk yoghurt for 42 days:

Parameters Groups	TC mg/dl	TG mg/dl	HDL mg/dl	LDL mg/dl
G1: Normal (-)	66.00 [e] ±7.00	51.33 [d] ±9.61	49.00 [a] ±4.00	6.73 [e] ±2.95
G2: Positive (+)	142.67 [a]±14.57	121.00[a]± 13.00	30.33 [d] ±2.52	88.13 [a]±9.47
G3: soymilk milk	123.00 [b]±12.00	102.67 [b]±12.66	39.33 [c] ±3.55	63.13 [b] ±12.52
G4: Soymilk yoghurt	107.33 [bc]±8.62	98.00 [b] ±4.58	42.00 [bc]±3.00	45.73 [c] ±10.68
G5:pomegranate soymilk yoghurt	82.67 [de] ±4.73	71.00 [c]±7.00	47.33 [ab] ±3.51	21.13 [de] ±2.81
G6:persimmon soymilk yoghurt	94.00 [cd] ±9.54	89.00 [b] ±6.25	46.00 [ab] ±3.00	30.20 [d]±10.94
G7:kiwi soymilk yoghurt	75.33 [e] ±7.02	66.00 [cd]±7.55	50.00 [a] ±2.00	12.13 [e]±6.20
LSD at 0.01	23.28	22.27	7.52	21.25
LSD at 0.001	32.38	30.97	10.45	29.55
LSD at 0.05	16.77	16.05	5.42	15.31

TC: total cholesterol, TG: triglycerides, HDL: high-density lipoprotein and LDL: low-density lipoprotein.
Each value is the mean ± SD
The values in each column with different superscript are significantly different at (p < 0.05).

Liver function of experimental rats fed on fruity soymilk yoghurt for 42 days:

Changes of liver biomarkers values as aspartate aminotransferase (AST), alanine aminotransferase (ALT) enzymes, total protein (TP) concentrations and total bilirubin (TBil) are presented in Table (5). Liver dysfunctions were happened after injected with dexamethasone which reflected as an increase in the activity of AST and ALT in serum, indicating liver injury.

The results showed that the positive control group's AST and Alt activities were significantly higher ($p<0.05$) than those of the normal control group and the rats fed soymilk, yoghurt, and fruity soymilk yoghurt. The lowest ALT (37.33 U/L) was found in rats fed on kiwi soymilk yoghurt which was near from normal control (33.00 U/L) followed by rats fed on pomegranate soymilk yoghurt (46.00 U/L). On the other hand, the highest value of ALT was found with positive control (89.33 U/L).

As for the result of AST levels, the lowest value scored with normal control (103.00 U/L), followed by group of rats fed on kiwi soymilk yoghurt (115.00 U/L). While, the highest level of AST was found in positive control group (328.67 U/L).

The highest levels of ALT and AST were found in rats injected with dexamethasone to cause osteoporosis and fed on based diet. On the other hand, the groups fed on kiwi soymilk yoghurt and pomegranate recorded the lowest levels of ALT and AST compared to the positive control.

Regarding, total protein (TP) and total bilirubin (TBil) of normal, positive control and rats fed on soybean milk, yoghurt and fruity soymilk yoghurt. The mean scores of total proteins increased significantly ($p<0.05$) in all groups comparing to the positive control group which recorded (5.24 g/dl), while the normal group control had the highest level of total protein value (7.07 g/dl). While groups fed on soybean milk, soymilk yoghurt and fruity soymilk yoghurt significantly ($p<0.05$) decrease value of total protein. In the same Table, results cleared that total bilirubin recorded the highest value in positive control, whereas the lowest value was recorded with normal control group. It was found that values of total bilirubin were decreased in groups fed on samples under investigation at ($p<0.05$). The lowest value recorded with rats fed on kiwi soymilk yoghurt.

As mentioned by Hussein *et al.,* (2015) reported that kiwi fruit extract significantly ameliorated the increase in AST and ALT. This may be due to the antioxidant effect of kiwifruit may be due to the fact that it contains a higher concentration of potentially antioxidant polyphenols than other fruits (Scalzo *et al*., 2005); aside from isoflavones and flavonoids, which have anti-carcinogenic, neuroprotective, and cardioprotective activity (Dehghani *et al.*, 2006), In addition to their capacity to neutralise free radicals, phenolics also have the potential to transfer electrons to H_2O (Ebrahimzadeh *et al.*, 2009).

Additionally, Benguiar *et al* (2020) 's analysis of plasma transaminase (AST and ALT) levels between the pomegranate peel-Probiotics group and a high fat diet positive control group revealed a decrease in those levels. These findings are in line with those made by Sadeghipour *et al*. (2014), who found that wistar rats fed a lipid-rich diet had their plasma levels of AST and ALT reduced by pomegranate peel ethanolic extract.

The dexamethasone-managed group displayed a significant increase in ALP, AST, ALT, and LDH activities, which is consistent with Abou-Seif *et al* (2019) 's observation that liver function enzymes are connected. Dexamethasone, which damages cell membranes through oxidation and promotes fatty liver changes, may be to blame for liver damage..

Table 5. Liver function of experimental rats fed on fruity soymilk yoghurt for 42 days:

Parameters Groups	ALT (U/L)	AST (U/L)	T.P (g/dl)	T.BIL (mg/dl)
G1: Normal (-)	33.00 [d]±8.82	103.00 [d]±20.08	7.07 [a]±0.133	0.31 [e]±0.112
G2: Positive (+)	89.33 [a]±13.50	328.67 [a]±31.79	5.24 [e]±0297	1.01 [a]±0.196
G3: soymilk milk	70.00 [b]±7.00	267.00 [b]±32.91	6.08 [d]±0.187	0.78 [b]±0.095
G4: Soymilk yoghurt	60.67 [bc] ±12.22	239.00 [bc]±23.64	6.42 [c]±0.127	0.64 [bc]±0.075
G5:pomegranate soymilk yoghurt	46.00 [cd]±7.21	146.00 [d]±19.31	6.77 [ab]±0.153	0.45 [de]±0.085
G6:persimmon soymilk yoghurt	56.33 [bc]±14.64	200.00 [c]±23.30	6.56 [bc]±0.200	0.56 [cd]±0.076
G7:kiwi soymilk yoghurt	37.33 [d]±8.02	115.00 [d]±19.76	6.89 [ab]±0.190	0.31 [e]±0.040
LSD at 0.01	25.63	60.73	0.46	0.26
LSD at 0.001	35.64	84.47	0.65	0.36
LSD at 0.05	18.46	43.76	0.34	0.19

ALT: alanine aminotransferase. AST: aspartate aminotransferase TP: total protein and TBil: total bilirubin
Each value is the mean ± SD
The values in each column with different superscript are significantly different at (p < 0.05).

Kidney function of experimental rats fed on fruity soymilk yoghurt for 42 days:

Creatinine, urea and uric acid of experimental rats fed on soymilk yoghurt and fruity soymilk yoghurt for 42 days were represented in Table (6), Levels of creatinine, urea and uric acid of normal control rats and rats groups suffered from osteoporosis and fed on soybean milk and soymilk yoghurt were decreased comparing to the positive control. The lowest value of creatinine, urea and uric acid mg/dl was recorded for normal control (0.55, 22.33 and 1.87) mg/dl, respectively), followed by rats group fed on kiwi soymilk yoghurt with near values for the normal group which recorded (0.60, 26.00) and 2.01) mg/dl, respectively. While the highest values of creatinine, urea and uric acid recorded in positive control (1.11, 77.67 and 3.46 mg/dl), respectively.

The findings are in agreement with that of De Castro *et al*., (2014), mentioned that Kidney function testing, can assist assess if the kidneys are doing their job properly. The findings of this study clarified that osteoporosis rats had renal alterations such as increases in creatinine, urea and uric acid mg/dl. In this regard, (Stevenes *et al*., 2006) creatinine is the primary waste product of muscle creatinine metabolism. It is filtered by the glomerulus in the kidney and actively discharged by the tubules. Additionally, free creatinine may be detected in the blood serum. Result of kidney function seemed to agree with the trend in finding by El-Kholie *et al.*, (2018) who stated that compared to the control (-) group, the group that received (kiwi extract 200mg/kg) had the best results for lowering the levels of creatinine and urea nitrogen in obese rats.

Additionally, Alatriste *et al.* (2014) found that probiotic dosages of around 16 x 109 CFU given for eight weeks together with diet and protein intake resulted in drops in blood urea levels. Additionally, Dehghani *et al.* (2016) observed that giving patients with chronic kidney disease stages 3 and 4 probiotics (Familact 500, twice daily after meals for six weeks) reportedly reduced blood urea levels.

Table 6. Kidney function of experimental rats fed on fruity soymilk yoghurt for 42 days:

Parameters Groups	Creatinine (mg/dl)	Urea (mg/dl)	Uric acid (mg/dl)
G1:	0.55 d	22.33 d	1.87 d
Normal (-)	±0.074	±4.51	±0.194
G2:	1.11 a	77.67 a	3.46 a
Positive (+)	±0.181	±13.20	±0.156
G3:	0.90 b	56.67 b	2.98 b
soymilk milk	±0.082	±7.10	±0.131
G4:	0.83 bc	47.67 b	2.75 b
Soymilk yoghurt	±0.095	±6.66	±0.170
G5:pomegranate	0.67 cd	32.00 cd	2.33 c
soymilk yoghurt	±0.080	±7.00	±0.176
G6:persimmon	0.71 cd	43.33 bc	2.43 c
soymilk yoghurt	±0.060	±8.74	±0.145
G7:kiwi	0.60 d	26.00 d	2.01 d
soymilk yoghurt	±0.067	±5.57	±0.208
LSD at 0.01	0.24	19.39	0.41
LSD at 0.001	0.33	26.97	0.57
LSD at 0.05	0.17	13.97	0.29

Each value is the mean ± SD
The values in each column with different superscript are significantly different at (p < 0.05).

Antioxidant activity of experimental rats fed on fruity soymilk yoghurt for 42 days:

The results in Table (7) described the results of superoxide dismutase (SOD), Glutathione peroxidase (GPx), catalase (CAT) and Malondialdehyde (MDA) antioxidant enzymes levels in serum of normal, positive control group and osteoporosis groups fed on soymilk milk, soymilk yoghurt and fruity soymilk yoghurt.

The positive control showed a significant decrease in SOD, GPx and CAT while showed a significant increase in MDA compared with normal control. A significant increase (p<0.05) was happened in the mean values of SOD, GPx and CAT for group suffered from osteoporosis and fed on soybean milk, yoghurt and fruity soymilk yoghurt. Results showed a significant increase in SOD, GPx and CAT in all rats groups fed on the samples investigated compared to the positive control. The highest values indicated with rat group fed on kiwi soymilk yoghurt. A significant(p<0.05) decrease in MDA in all groups fed on the samples investigated was observed. Normal group had the lowest level of MDA (5.70) nmol/ml comparing to the positive control which recorded the highest level (17.90) nmol/ml. Osteoporosis rats group fed on soybean milk, yoghurt and fruity soymilk yoghurt significantly (p<0.05) decreased level of MDA. Rats group fed on kiwi soybean milk yoghurt recorded the lowest values (7.07) nmol/ml comparing to the positive control, also its value was the closest to normal control.

Table 7. Antioxidant activity of experimental rats fed on fruity soymilk yoghurt for 42 days:

Parameters Groups	SOD (U/ML)	GPX (MU/ML)	CAT (U/L)	MDA (nmol/ml)
G1:	60.40 ^{a}	96.97 ^{a}	0.40 ^{a}	5.70 ^{e}
Normal (-)	±4.36	±5.15	±0.013	±0.557
G2:	25.87 ^{f}	65.07 ^{d}	0.25 ^{e}	17.90 ^{a}
Positive (+)	±4.25	±10.79	±0.043	±1.345
G3:	29.67 ^{ef}	64.23 ^{d}	0.29 ^{de}	13.98 ^{b}
soymilk milk	±2.40	±6.37	±0.033	±0.988
G4:Soymilk	35.47 ^{de}	72.13 ^{cd}	0.31 ^{cd}	12.63 ^{b}
yoghurt	±3.53	±7.40	±0.027	±1.850
G5:pomegranate	49.97 ^{bc}	81.53 ^{bc}	0.37 ^{ab}	8.93 ^{cd}
soymilk yoghurt	±3.57	±5.43	±0.011	±1.457
G6:persimmon	42.83 ^{cd}	79.70 ^{bc}	0.34 ^{bc}	10.23 ^{c}
soymilk yoghurt	±6.21	±6.78	±0.027	±1.550
G7:kiwi	53.80	90.67	0.38 ^{ab}	7.07 ^{de}
soymilk yoghurt	^{ab}±6.34	^{ab}±6.80	±0.017	±1.007
LSD at 0.01	11.14	17.73	0.06	3.19
LSD at 0.001	15.50	24.24	0.09	4.43
LSD at 0.05	8.03	12.56	0.05	2.30

SOD: superoxide dismutase, GPx: Glutathione peroxidase, CAT: catalase and MDA : Malondialdehyde.
Each value is the mean ± SD
The values in each column with different superscript are significantly different at (p < 0.05).

Consuming fruits and vegetables has been linked to a range of illness protection, according to epidemiological research and lab tests (Bazzano *et a*l., 2002). According to Collins *et al.* (2001), kiwifruit has significant in vitro antioxidant activity. Bioactive substances like polyphenols, flavonoids, carotenoids, and vitamin C have been shown to have additive and synergistic effects, which are responsible for the kiwi fruit's antioxidant qualities (Leontowicz *et al.*, 2016).

Another study in rats with carbon tetrachloride-induced liver injury found that pretreatment with pomegranate peel extract reduced lipid peroxidation while dramatically increasing CAT, SOD, and peroxidase free-radical scavenging activities (Chidambara *et al.*, 2002). CAT is the primary peroxide detoxification mechanism. In the presence of iron as a catalyst, CAT is an antioxidant enzyme that eliminates H2O2 that can create a highly reactive OH. GSH, along with GPx, participates in the GSH redox cycle, which transforms H2O2 and lipid peroxides to non-toxic compounds (Sanocka and Kurpisz, 2004). Abdel Moneim *et al.,* (2011) found a significant decrease in MDA, a by-product of lipid peroxidation, as well as increases in SOD and CAT activity in liver and kidney tissues from rats given pomegranate juice or the aqueous extract of the pomegranate peel.

Antioxidant properties of soymilk and fermented soymilk have also been demonstrated in other investigations, as revealed in our work (Wang *et al.,* 2006). Soy isoflavones, soy protein, and saponins are all linked to soymilk's antioxidative properties (Esaki *et al.,* 1998). Fermented soymilk demonstrated higher antioxidant and antimutagenic activity than soymilk, according to Sartang *et al.,* (2015).

Serum Ca, P and vitamin D of experimental rats fed on fruity soymilk yoghurt for 42 days:

Results indicated in Table (8) showed serum Ca, P and Vitamin D as well as urine Ca of of normal, positive control group and osteoporosis groups fed on soybean milk, yoghurt and fruity soymilk yoghurt. Serum Ca, P and Vitamin D of positive control deacreased, while urine Ca increased significantly ($p<0.05$) comparing to normal control. Comparing to osteoporosis control rats group, results revealed that the highest serum Ca and Vitamin D was found in rats fed on kiwi soymilk yoghurt followed by pomegrnate yoghurt, which was nearly to the normal control.on the other hand serum P recorded the lowest values (3.97 mg/dl) with the same treatment. While, urine Ca was found to be highest in positive control (83.67 mg/dl), wherease the normal control recorded the lowest urine Ca (48.67 mg/dl).

Rats group suffered from osteoporosis and fed on soymilk milk, yoghurt and fruity soymilk yoghurt decreased the level of urine Ca comparing to osteoporosis control rats group. Group fed on kiwi soymilk yoghurt recorded the lowest value (53.67 mg/dl), which was near from the normal control (48.67 mg/dl).

Table 8. Serum Ca, P and Vitamin D as well as urine Ca of experimental rats fed on fruity soymilk yoghurt for 42 days:

Parameters Groups	mg/dl			
	Serum Ca	**Urine Ca**	**Serum P**	**Vit. D**
G1:	9.49 ^{a}	48.67 ^{c}	4.79 ^{a}	34.23 ^{a}
Normal (-)	±0.211	±5.508	±0.196	±1.172
G2:	7.99 ^{d}	83.67 ^{a}	3.61 ^{e}	24.77 ^{e}
Positive (+)	±0.259	±5.508	±0.230	±1.531
G3:	8.37 ^{c}	78.00	3.71 ^{de}	27.20
soymilk milk	±0.186	^{ab}±7.000	±0.179	^{de}±1.758
G4:	8.36 ^{c}	74.67^{ab}±	4.57	28.37
Soymilk yoghurt	±0.121	9.074	^{ab}±0.243	^{cd}±1.815
G5:pomegranate soymilk	8.66 ^{bc}	56.33	4.43 ^{b}	30.63
yoghurt	±0.110	^{c}±5.508	±0.131	^{bc}±1.680
G6:persimmon soymilk	8.54	68.67 ^{b}	4.27	28.30
yoghurt	^{bc}±0.167	±4.509	^{b}±0.189	^{cd}±2.100
G7:kiwi	8.79	53.67 ^{c}	3.97	32.87
soymilk yoghurt	^{b}±0.155	±5.859	^{cd}±0.114	^{ab}±1.137
LSD at 0.01	0.43	15.29	0.46	3.96
LSD at 0.001	0.61	21.26	0.64	5.51
LSD at 0.05	0.31	11.02	0.33	2.85

Each value is the mean ± SD
The values in each column with different superscript are significantly different at ($p < 0.05$).

Bayat *et al.* (2019) reported that consuming soy milk improved serum calcium levels while lowering serum phosphorus. Additionally, it reduced the number of osteoclasts in the tibia and vertebra while increasing the weight, volume, and density of the trabecular, the number of osteocytes, and the number of osteoblasts.

In male rats with osteoporosis, lactobacillus helveticus fermented milk enhanced bone mass density and bone mass composition, according to research by Narva *et al*. (2004) using dual-energy X-ray absorptiometry (DEXA). Regarding the impact of probiotics on vitamin D, (Jones *et al.,* 2013) reported for the first time that *Lactobacillus ruteri r*aised serum levels of vitamin D.

CONCLUSION

In summary, our data suggest that fruity soymilk yoghurt fermented by probiotic bacteria may be effective for maintaining vascular and bone health by reducing the cholesterol, triglycerides, LDL-c, ALT, AST, total protein, total bilirubin, creatinine, urea, uric acid, MDA and serum P levels as well as urine Ca and increased HDL-c, SOD, GPx, CAT, serum Ca and Vitamin D, especially in soymilk yoghurt with kiwi. The results suggested that consumption of soymilk yoghurt fortified with fruits might have some osteoarthritis disease protective properties and beneficial effects on bones.

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التأثير الحيوي لبعض منتجات زبادى فول الصويا الوظيفية على هشاشة العظام في فئران التجارب

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الملخص

تحظى المنتجات الطبيعيه بشعبيه كبيره بين المرضى ويرجع ذلك لسهولة الوصول إليها وإرتفاع الإحساس بالأمان. لذلك كان الهدف من هذه الدراسه هو انتاج زبادي وظيفي متخمر وتم تقييم الزبادى المصنع من لبن فول الصويا وبكتريا البروبيوتيك والمدعم بمركزات الفواكه مثل الرمان والكاكى والكيوى على فئران التجارب المصابة بهشاشة العظام. تم إستخدام 35 فأراً من ذكور فئران الألبينو البالغه و تقسيمها الى مجموعات رئيسيه و تشمل المجموعه الاولى الضابطه السالبه وتحتوى على 5 فئران غير مريضه تتناول الوجبة القياسيه وتم حقن ال30 فأر المتبقيه بجرعه 1 مل / 100 جم/يوم ديكساميثازون للحث على الاصابه بهشاشة العظام لمده 6 اسابيع وتقسيمها الى 6 مجموعات كالتالي المجموعه الثانيه الضابطه الموجبه: تحتوى على 5 فئران مريضه تتناول الوجبه القياسيه. باقى المجموعات تتناول الزبادى مره واحده يوميا عن طريق أنبوب المعده، المجموعه الثالثه: تحتوى على 5 فئران مريضه تتناول 3مل/كجم حليب صويا، المجموعه الرابعه: تحتوى على 5 فئران مريضه تتناول 3 مل/كجم زبادى فول صويا، المجموعه الخامسه: تحتوى على 5 فئران مريضه تتناول 3 مل/كجم زبادى فول صويا باضافة فاكهه الرمان، المجموعه السادسه: تحتوى على 5 فئران مريضه تتناول 3 مل/كجم زبادى فول صويا باضافة فاكهة الكاكي، المجموعه السابعه: تحتوى على 5 فئران مريضه تتناول 3 مل/كجم زبادى فول صويا باضافة فاكهة الكيوي. لوحظ أن إضافة الفاكهه الى زبادى حليب فول الصويا المدعم بالبروبيوتيك أصبح غنى بالعناصر و الفيتامينات وحمض اللاكتيك. وأظهرت نتائج التجربه أن الفئران التى تغذت على زبادى فول الصويا بالفواكه أدى ذلك الى نقص في قيم الكوليسترول الكلى، الدهون الثلاثيه، البروتين الدهنى منخفض الكثافه، إنزيمات الكبد ALTوAST و البروتين الكلى و البليروبين الكلى و الكرياتينين، اليوريا وحمض اليوريك و MDA ومحتوى الفوسفور فى الدم ومحتوى الكالسيوم فى البول بينما أدى الى إرتفاع فى محتوى البروتين الدهنى عالى الكثافه، SOD، GPx، CAT ، محتوى الكالسيوم فى الدم وفيتامين D ، خاصة مع زبادي فول الصويا مع الكيوي.لذا تشير النتائج و البيانات الوارده خلال الدراسه أن الزبادى المصنع من حليب فول الصويا المدعم بالفواكه و خاصة الكيوى له بعض الخصائص الوقائيه على الفئران المصابه بهشاشة العظام و تأثيرات مفيده على صحة العظام.

الكلمات الداله: زبادى وظيفي، حليب الصويا، بروبايوتيك، هشاشة العظام، رمان ، كاكي، كيوي