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تأثير الترمس الحلو والمر على نسبة سكر الدم للفئران المصابة بإرتفاع سكر الدم

Effect of sweet and bitter lupin on blood sugar of hyperglycemic rats

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٢٠١٩

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المستخلص

في الوقت الحاضر، تم الاتجاه تدريجيًا نحو تقليل استخدام العقاقير الصناعية لخفض نسبة الجلوكوز في الدم لدى مرضى السكر بسبب الآثار الجانبية الناتجة . ولهذا السبب استخدام النباتات الطبية في العلاج قد تضاعف. لذلك، تم إجراء هذه الدراسة لمعرفة تأثير بذور الترمس بنسبة (٥، ١٠، ١٥) ٪ على الفئران المصابة بالسكر. تم استخدام أربعين فأر ذكر أبيض وتقسيم الفئران إلى مجموعتين رئيسيتين (ن = ٥ الفئران). فئران المجموعة الأولى تغذت على النظام الغذائي الأساسي فقط كمجموعة ضابطة سالبة. المجموعة الثانية تم حقنها بالألوكسان وتقسيمها إلى سبع مجموعات فرعية. المجموعة (١) تم تغذيتها على نظام غذائي يحتوي على خبز غير مدعم. تم تغذية المجموعة (٢)، (٣)، (٤) على نظام غذائي يحتوي على الخبز المدعم بنسب (٥، ١٠، ١٥)٪ من الترمس المر، على التوالي. تم تغذية المجموعة (٥)، (٦)، (٧) على نظام غذائي يحتوي على الخبز المدعم بنسب (٥ ، ١٠ ، ١٥)٪ من الترمس الحلو، على التوالي. في نهاية الفترة التجريبية (٦ أسابيع)، تم التضحية بالفئران وجمع عينات الدم للحصول على مصل الدم. أشارت النتائج إلى أن تدعيم الخبز بنسب (٥ ، ١٠ ، ١٥)٪ من الترمس الحلو والمر في النظام الغذائي تسبب في خفض مستوى الجلوكوز في الدم بشكل ملحوظ مقارنة مع المجموعة الضابطة الإيجابية. وقد لوحظ أيضًا أنه تم تحسين وظائف الكبد في الفئران المعالجة مقارنةً بالمجموعة الضابطة الإيجابية. في الختام، تبين أنه يمكن استخدام الخبز المدعم بالترمس الحلو والمر كعلاج تكميلي مناسب لمرضى السكر.

الكلمات المفتاحية: الترمس الحلو – الترمس المر – الفئران – مستويات السكر في الدم – وظائف الكبد والكلى في الفئران – ارتفاع السكر في الدم – الهيستوباثولوجي.

Effect of sweet and bitter lupin on blood sugar of hyperglycemic rats

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Abstract

Nowadays, tend to use synthetic drugs to lower serum glucose in diabetic patients is gradually decreased because of their related side effects. In this regard, tend to use of medicinal plants has been doubled. Therefore, this work was conducted to investigate the effect of lupin seeds at the level of (5, 10, and 15) % on diabetic rats. Forty male albino mice were used and were split to two main groups (n=5 rat). In the headmost group rats fed on the basal diet only as a control negative group. The followed group injected with alloxan and split into seven groups. Group (1) was eaten diet containing un-fortified bread. Group (2), (3) and (4) were fed on diet containing bread fortified with 5%, 10% and 15% bitter lupin, respectively. Group (5), (6) and (7) were fed on diet containing fortified bread with 5%, 10% and 15% sweet lupin, respectively. At the end of the experimental time (6 weeks), rats were killed and blood samples were taken to obtain serum. Results indicated that supplementation with bread of (5, 10 and 15) % sweet and bitter lupin in the diet caused considerably ($P<0.05$) lower in sugar level compared to the positive group. It was also observed that liver functions of the treated rats were improved compared to the positive control group. In conclusion, sweet and bitter lupin could be used as an appropriate supplementation treatment for diabetic patients.

Keywords:

Sweet lupin – Bitter lupin – Rats – Blood glucose levels – Liver function– hyperglycemia – Histopathology.

Introduction:

Worldwide there are about 415 million adult's diabetes mellitus. The spreading is heighten, and it is predictable that more than 640 million mature people will have diabetes by 2040 (Ogurtsova, Rocha & Huang, 2017, p.40-50). Diabetes cause many harm effect on body such as increased risk of cardiovascular diseases (Harreiter, Dovjak & Kautzky-Willer , 2014, p.91–108) raises the risk of nonalcoholic fatty liver disease (Castro, 2017), damage in eyes, kidney, nervous system (WHO, 2018) and two- to three-fold increased risk of strokes (Sarwar *et al.*, 2010) so the suggested opinion is controlling early glucose levels in blood for the protection of future complications of diabetes (Laiteerapong, Karter & Moffet ,2017, p.94–100).

Diabetes mellitus may the fastest growing in disease metabolism in the creation and as nature heterogeneous knowledge of the disease which make increase so we need for more challenging and for more therapeutic appropriate. Conventional plant remedies have been used for centuries in the treatment of diabetes (Kesari, Gupta & Watal, 2005, p. 247–250). Traditional medicine and medicinal plants which use in most developing countries, as a normative basis for the maintenance of good health, has been widely observed (Tiwari & Madhusudanarao, 2002, p.30–38). A lot of the oral drugs are cost too much and have many side-effects. A substitution of these artificial agents, plants provide a probability source of hypoglycemic drugs and are widely used in several known systems of medicine to prevent diabetes (Lo & Wasser, 2011, p.401–426). Simple and inexpensive diet strategies should aid in achieving and maintaining optimal control of diabetes and complication of diabetes (Xuemei, Hai- Lu, Jing, Juliana & Peter, 2012, p.185 – 191).

Lupin seeds (sweet and bitter lupin) from the family of legume (Yu *et al*., 2019) and one of the Fabaceae family (Citerne, Toby Pennington & Cronk, 2006, p. 12017-12020) and her native is Mediterranean area (Kurzbaum, Safori, Monir, & Simsolo, 2008, p.20-22). Quinolizidine and piperidine alkaloids in lupin seeds have confer bitterness and toxicity to the alkaloid-rich lupin varieties (Green, Welch, Panter & Lee, 2013, p.1129–1138).

Lupin seeds can be ate after soaking it in water (Ertaş & Bilgiçli, 2014, p.3348–3354), whenever alkaloids increase in type whenever the time of soaking increase. The content of protein in lupin seeds are a high which has directed attention again in lupin to use it as a source of proteins in human and animal nutrition (Sedláková, Straková, Suchý, Jana & Herzig, 2016, p.165-175) and the content is high of lysine, arginine, leucine and phenylalanine in white lupin seeds (Sujak, Kotlarz, & Strobel, 2006, p.711-719), contain useful useful fats represented in omega-six to omega-three from 2:1, and when looking for

carbohydrates in lupin it turned out theat there is soluble fiber and insoluble fiber (Prusinski, 2017, p.95–105). White lupin consider a good sources of vitamins B group, especially niacin (Colin, Harold, Koushik, & Jonathan, 2015, p.99 -103) and antioxidant such as α-tocopherol , vitamin E and Vitamin C (Juana, MarthaL, Rosa, & Concepción, 2005, p.211-220). Main microelements which found in white lupin are Mn , K, and Mg, and the prevailing microelements are Na, Fe, and Ca (Prusinski, 2017, p.95–105). Lupins contain high amounts of manganese, in L. albus (Colin *et al*., 2015, p.99 -103).

Many studies showed that lupin cause many useful health benefits, especially in the area of high blood sugar prevention (Magni *et al*., 2004, p.646–650), hypertension control, and cholesterol reduction (Sirtori, Arnoldi &Johnson, 2004, p.423–38; Bettzieche *et al*., 2008, p.3114–3121) and when consumption of lupin kernel fiber beneficially alter CVD risk factors cause of the high content of its water-soluble fiber and its high bile acid–binding ability (Belski, 2012, p.147–215). Because the lupin seeds contain antioxidants, (Zielinska et *al*., 2008, p.1711–1720 and Martinez-Villalunga *et al*., 2009, p.84–88) it helped to reduce cancer.

Materials:

- **Plants: Sweet and bitter lupin were bought from the domestic market, Port Said, Egypt.**
- **Mice: Male albino weight (170±5g) which are from Sprague Dawley strain purchased from Helwan Farm, Ministry of Health, Cairo, Egypt.**
- **Chemicals: Casein, vitamin mixtures, mineral mixtures, cellulose, choline tartrate and diethyl ether was got from Modern Factory, Cairo, Egypt.**
- **Kits: were bought from Gama Trade Factory, Egypt.**

Methods:

Preparation of dried sweet and bitter lupin:

Bitter and sweet lupin were got from the domestic market at Port Said town. The seeds were cleaned by hand to remove the foreign materials and then stored in polyethylene bags at room temperature (25° C) until further use.

Soaking:

Bitter and sweet lupins was soaked in water for the later at a lupin. Water ratio of 1:10 (w/v). The soaking time were applied this variation of soaking time between bitter and sweet lupin is related to the level of bitter alkaloids. Thus, sweet lupin seeds, which contain a low level of alkaloids don't need a lot of time of soaking). After soaking the water was dried off and the seeds were dried at 50° C for 12 hr. in a hot air oven (Embaby, 2010, p.1055-1062).

Preparation of toast bread:

Normal toast bread consists of 500 g of flour blend, 9 g of compressed baker's yeast, 5 g of NaCl, 13 g of cane sugar and approximately 280 ml of water (El-Demery, 2011).

Supplementation of bread with sweet and bitter lupin:

The bread was supplemented with (5, 10 and 15% Sweet and bitter lupin) by replacing the amounts of Sweet and bitter lupin with the same amounts from wheat flour.

Induction of hyperglycemia:

150 mg/kg body weight Alloxan, is antiseptic normal saline solution, and was used to induce diabetes according to the method described by (Desai & Bhide, 1985, p.783-789).

Experimental Design:

Male albino rats (40), Sprague Dawley strain, which weighted (170 ± 5 gm) were housed in well-aerated wire cages. All animals saved under normal healthy condition and were eaten basal diet for one week to adopt with condition. The basal diet was consisted of 14% protein (casein), 4% oil, 0.25% choline, 1% vitamin mixture, 3.5% mineral mixture, 10% sucrose, 5% cellulose, 0.5% DL-methionine and the remainder was starch. The diet was formulated according to (Reeves, Nielsen, & Fahey, 1993, p.1939-1951). After the week rats were divided into 2 main groups as follows:

The first group: 5 rats were eaten basal diet only as a control negative group .The second group: (diabetic rats, n=35) were injected with the alloxan (150 mg/kg b.w.) to induce diabetic rats; these groups were fed on basal diet for 4 days. After this period serum glucose were determined in the first and second main group, to insure from the induction with diabetes. The second main groups were divided into 7 subgroups, as follow :

-Subgroup (1) five rats were fed on diet containing 300 g un-fortified bread, as a control positive group.

-Subgroup (2), (3) and (4) 5 rats of each were fed on diet containing 300 g fortified bread with 5%, 10% and 15% bitter lupin, respectively.

-Subgroup (5), (6) and (7) 5 rats of each were fed on diet containing 300 g fortified bread with 5, 10 and 15% sweet lupin, respectively.

When the experiment period end (28 days), blood samples were collected after 12 hours fasting using the portal vein and rats were immolated under ether anesthetized. Blood samples transferred into clean dry centrifuge tubes and left to clot at room temperature, then centrifuged for 10 minutes at 3000 rpm to separate the serum according to (Drury and Wallington, 1980). Serum was

carefully aspirate transferred into clean covet tubes and stored frozen at – 20 ˚C until analysis.

The biological effect of the determination of body weight gain percent of seeds were body weight gain (BWG%) and feed efficiency ratio (FER) were calculated according to the method of (Champan, Castillo & Campbell, 1959, p.679-686) .

Biochemical analysis of serum:

Glucose was specified in-the serum according to the way descried by (Titez, 1976, p.1213–1214). Alkaline phosphatase (ALP) was specified in the serum according to the method described by (Farley, Chesnut, & Baylink, 1981, p.2002-2007).Aspartate aminotransferase (AST) was determined to the method of (Henry, 1974) and Alanine aminotransferase (ALT) were calorimetrically specified according to the way of (Reitman & Frankel, 1957, p.28: 56). Alkaline Phosphatase was specified according to the method described by (Belfield & Golderg, 1971, p.842-846).

Statistical analysis

Results were expressed as mean ± SD. Data were estimated statistically with computerized SPSS package program (SPSS 9.00 software for Windows) using one-way analysis of variance (ANOVA). Significant difference between means was evaluated at p< 0.05 according to (Snedecor & Cochran, 1986, p.90).

Results and discussions:

- **Gross chemical composition of sweet and bitter lupin:**

Data in Table (1) revealed that, the contents of moisture, protein and ash in the bitter lupin were higher than sweet lupin. While lipid, crud fiber and carbohydrates increased in sweet lupin than that of bitter lupin.

These results were in the line with Kohajdova, Karovičova, & Schmidt (2011, p.203–211) who found that, the average values of (total fiber, total protein, fat and ash) in white and yellow lupin were 30.6, 14.64, 3.65 and 39.42 g/100g D M and (36.8, 8.54, 4.95 and 34.33 g/100g DM), respectively. In this respect, Martinez-Villaluenga, Frias, & Vidal-Valverde, (2006, p.291–299); Martinez-Villaluenga, *et al.* (2009, p.84–88); Zielinska *et al.*, (2008, p.1711–1720) reported that, lupin is a good nutrients source, not only proteins but also dietary fiber, lipids, vitamins and minerals.

Table (1): Gross chemical composition of sweet and bitter lupin:

Types of lupin / Nutrients (g/100g)	Sweet lupin	Bitter lupin
Moisture	7.70	7.92
Protein	31.17	36.00
Lipid	12.98	10.52
Ash	3.41	4.45
Crud fiber	20.43	19.32
Carbohydrate (by difference)	44.74	41.11

- **The effect of adding sweet and bitter lupin on chemical composition and nutritive values of bread:**

Data in Table (2) showed that total carbohydrates in all fortified bread with (5, 10 and 15%) sweet and bitter lupin decrease than that of the control (un-fortified bread). On the other hand, total protein, fat, fiber and ash increased gradually with increasing the levels of sweet and bitter lupin.

Our results agree with, Prusinski, (2017, p.95–105) concluded that fortified bread (wheat flour) with lupin allows for increase the nutritive of bread such as protein and dietary fiber is concerned. Wheat mixed with lupin flour may help on achieve amino acid balance. In addition, Bähr *et al*., (2015) reported that the amino acids achieve the role of protein's nutrition in lupin flour when bread fortified with lupin flour.

Al Omari *et al*., (2015, p.57 – 63) who concluded that nutritive values of Arabic flat bread (AFB) could be improved by using germinated lupin flour (GLF), and to define the effect of these substitutions on resulted germinated lupin flour (GLF), since the chemical components were increased in bread without affecting their organoleptic properties.

Villarino, Jayasenaa, Cooreya, Chakrabarti-Bell, & Johnson (2015, p. 835-857) evaluated the effects of sweet lupin on bioactive composition, nutrition, phytochemical and protein quality of repeated wheat flour bread and he found that fiber, protein, carotenoid content and dietary phenolic, antioxidant capacity and protein digestibility corrected amino acid score (PDCAAS) were higher, whereas available carbohydrate level was lower.

Guemes-Vera *et al*., (2012, p.676– 682) showed that there are minerals and functional compounds in lupin flour, like carotenoids as dietary fiber or antioxidant, with health-promoting ability. Al Omari and Abdul-Hussain, (2013, p.49-54) reported that lupin flour (LF) is significantly includes high fiber content than wheat flour (WF). This finding could be attributed to lupin seeds didn't

expose to hull removing before milling. More protein and fiber content were resulted when WF substituted with LF.

Table (2): Effect of adding sweet and bitter lupin on chemical composition and nutritive values of bread:

Samples of bread / Components	Un fortified bread	Fortified bread with sweet lupin			Fortified bread with bitter lupin		
		5%	10%	15%	5%	10%	15%
Moisture %	7.50	8.215	8.405	8.722	8.712	8.900	9.207
Total Protein%	12.88	13.702	14.402	15.027	13.822	14.517	15.358
Crude Fat%	1.06	1.600	2.08	2.495	1.322	1.787	2.022
Crude Fiber%	0.95	1.413	1.580	1.701	1.400	1.500	1.671
Ash%	0.87	1.108	1.283	1.488	1.337	1.419	1.509
Carbohydrates%	76.74	73.962	72.425	70.567	73.407	71.877	70.233
Total Energy Kcal/100g	368	365	366	364	360	361	360

-Values were expressed as Means ± SD .

- **Effect of adding bread fortified with three levels from sweet and bitter lupin on body weight gain% and feed intake of diabetic mice:**

Table (3) summarize the effect of bread fortified with the three levels (5, 10 and 15%) from sweet and bitter lupin on feed intake (g/day/ each rat) and body weight gain % of diabetic rats .The most effective groups compared with others positive groups (bread fortified with 10% bitter lupin, bread fortified with 15% bitter lupin and bread fortified with 15% sweet lupin) decreased, as compared to the negative control group .

All treated groups with fortified bread with same levels from sweet and bitter lupin showed significant decrease in BWG%, when it compared with the control positive group, except diabetic group which treated with fortified bread with5% sweet lupin. In this respect, Habtewold, Tsega, & Wale (2015) reported that 14.9% of patients ascertained unexplained weight loss of total study patients which ate lupin concerning clinical presentation of diabetes mellitus where lupin seeds cause oligosaccharides, absorbed is poor in the small intestine. Oligosaccharides are not digested by enzymes in monogastric animals due to the absence of α-1,6 galactosidase capable of releasing galactose from polysaccharide molecules. Oligosaccharides undergo bacterial fermentation in the cecum. This production of gases that cause discomfort in animals process is accompanied , which is why those compounds have been classified as ANFs.

Studies suggested that, oligosaccharides may have a beneficial on the large intestine ecosystem in pigs and rats. Raffinose family oligosaccharides may lead to digestive problems in humans and animals.

Hadaegh et *al*., (2008) showed that from the basic risk agents for diabetes mellitus and IGT were unjustified weight loss. Hodgson et *al*., (2010, p.86–94) indicated that substitution partially of refined wheat-derived carbohydrate in bread with fiber and protein which came from lupin kernel flour (LKF) could reduce appetite and energy intake acutely. The sort of fiber, type of fiber in the diet may be important and protein. This raise in protein intake was concurrent with a significant raise in dietary fiber intake. Studies of higher-fiber adlibitum diets appeared that weight loss have used isolated soluble fibers. About 10% is present as soluble fiber (~1.25 g per day) and a further 20% as oligosaccharides.

Table (3): Effect of fortified bread with three levels from sweet and bitter lupin on feed intake and body weight gain % of diabetic rats.

Parameters / Groups	Feed intake g/day/each rat	Body weight gain %
Group 1	17.20 ± 0.84^{a}	34.09 ± 1.57^{a}
Subgroup 1	16.60 ± 1.08^{ab}	19.44 ± 1.45^{b}
Subgroup 2	$16.60 \pm 0.55^{a\,b}$	17.24 ± 1.10^{c}
Subgroup 3	$15.80 \pm 0.57^{b\,c}$	14.24 ± 1.014^{d}
Subgroup 4	15.40 ± 0.65^{c}	12.041 ± 0.741^{e}
Subgroup 5	17.40 ± 0.65^{a}	$18.172 \pm 0.974^{b\,c}$
Subgroup 6	$16.70 \pm 0.76^{a\,b}$	14.90 ± 0.93^{d}
Subgroup 7	15.40 ± 0.65^{c}	13.60 ± 1.06^{d}

-Values were expressed as Means ± SD.
-Values at the same column with different letters are significantly different at P<0.05.

- Effect of fortified bread with three levels from sweet and bitter lupin on liver weight/body weight % of diabetic rats:

Data in Table (4) reviled that all treated groups with fortified bread with 5, 10 and 15% sweet or bitter lupin appeared that there are decrease in liver weight/body weight%, except the one which treated with bread fortified with 5% sweet lupin, as liken to the positive control group. Therefore, the top decrease in liver relative weight recorded for the groups treated with fortified bread with 15% sweet and bitter lupin. Our results agree with Besbes, Taleb-Senouci, Chabane, Daij, & Lamri-Senhadji (2013, p.205-212) results which showed that at 28 days of the experiment liver relative weight of diabetic rats compared to day 0 which treated with wheat-white lupine, BW value has a tendency to decrease.

Table (4): Effect of fortified bread with three levels from sweet and bitter lupin on some organs weight/body weight % of diabetic rats:

Parameters / Groups	Liver weight / body weight%
	Liver
Group 1	2.90 ± 0.06 [e]
Subgroup 1	3.72 ± 0.12 [a]
Subgroup 2	3.48 ± 0.07 [b]
Subgroup 3	3.20 ± 0.08 [d]
Subgroup 4	2.94 ± 0.09 [e]
Subgroup 5	3.57 ± 0.08 [b]
Subgroup 6	3.37 ± 0.04 [c]
Subgroup 7	2.94 ± 0.09 [e]

-Values were expressed as Means ± SD.

-Values at the same column with different letters are significantly different at P<0.05.

- **Effect of fortified bread with three levels from sweet and bitter lupin on serum glucose of diabetic rats:**

Data in Table (5) showed that feeding diabetic rats on diet containing (5, 10 and 15%) sweet or bitter lupin led to significant decrease in serum glucose, as it comparison with the positive control group. The highest decrease in serum glucose recorded for the group ate diet containing fortified bread with 15% bitter lupin, followed by the group, which treated with bread fortified with 15% sweet lupin, respectively.

In this respect, Kinder & Knecht, (2011, p.711-716) showed that extracts of the seed can decrease hyperglcemic in these rats to normal levels. A major protein component of the seed is conglutins, which, have food value, have therapeutical effects on blood glucose.Aniess *et al.*, (2015, p.61-69) cleared that the effects of lupin fiber reported a lowered on glucose levels in urine of diabetic rats and lowered glucose in plasma that's might due to raw and blanched lupin 5 and 10 % have hypoglycemic impact and blanched lupinhave more impact than raw as when it is comparison with diabetic control. The blood glucose levels impact of lupin fiber and lupin flour may be the active constituents such as alkaloids, flavonoids, tannins, quinovic acid and its glycocidic derivatives, saponins and triterpenoid saponins , Other phenomenon due to saponins effect have hypoglycaemic action, which may be due to the inhibition of hepatic gluconogensis ,the effect of lupinmay be due to the plus of levels of serum insulin, and also may be due to the enhancement of peripheral metabolism of glucose.

Table (5): Effect of fortified bread with three levels from sweet and bitter lupin on glucose levels of diabetic rats:

Groups \ Parameters	Glucose levels mg/dl
Group 1	74.78 ± 3.38 [h]
Subgroup 1	168.95 ± 2.79 [a]
Subgroup 2	160.49 ± 2.78 [c]
Subgroup 3	148.49 ± 1.85 [e]
Subgroup 4	134.72 ± 2.49 [g]
Subgroup 5	164.19 ± 3.33 [b]
Subgroup 6	153.89 ± 2.50 [d]
Subgroup 7	140.88± 2.20 [f]

-Values were expressed as Means ± SD.

-Values at the same column with different letters are significantly different at P<0.05.

- Effect of fortified bread with three levels from sweet and bitter lupin on liver enzymes of diabetic rats:

The data in Table (6) revealed that, injected rats which fed on diet containing 300g un-fortified bread with alloxan (Control +ve) showed significant increase p≤0.05 in AST, ALT and ALP enzymes, as compared to non-injected rats (control –ve) fed on the same diet.

The effect of fortified bread with the three levels from sweet and bitter lupin (5, 10 and 15%) on liver enzymes including aspartate aminotransferase (AST), alanine aminotransferase (ALT) and Alkaline Phosphatase (ALP) of diabetic rats presented in Table (six), respectively. Groups which treated with diet containing 300 g bread which fortified with (5, 10 and 15% sweet or bitter lupin) showed significent decrease in serum AST, ALT and ALP enzymes, in comparison with positive control group .The biggest decrease in serum AST and, ALT and ALP registered for the group which treated with bread fortified with 15% sweet lupin, followed by the group medication with fortified with 15% bitter lupin.

Our results agree with Marzouk, Soliman, & Omar, (2013, p.559-565) results which reported that when checked this activities of liver function markers (AST, ALT and ALP) were significantly elevated in diabetic rats when compared with the normal control rats. Rats administrated lupin seeds for thirty days reported significant lowering in these marker enzyme activities (ALT, AST and ALP) to almost normal levels through improving dyslipidemia.

Bouchoucha et *al*., (2016, p.615-620) indicated that AST and ALT activities decreased in the following twelve weeks L. albus administration in diabetic rats. Also Osman *et al*., (2011) evidenced that lupin seeds (bitter and sweet lupin seeds) reduced the activities of transaminases (ALT and AST).

Maritim et *al*., (2003, p. 24-38); Jung et *al*., (2006, p. 2556-2559), who cleared that the growing in activity of these enzymes (AST, ALT and ALP) is mainly due to their liver leakage into blood stream. Administrating Termis seeds powder to diabetic rats restore the activities of the aforementioned enzymes to approaching there to normal level. In addition to Abdel-Monem et *al*., (2002, p. 213-245) a possible commentary for the effect of both seeds on enzymes activity is that these seeds may inhibit the liver damage motivated by diabetes and/or the improved liver function with return of gluconeogenesis toward its normal level.

Table (6): Effect of fortified bread with three levels from sweet and bitter lupin on enzymes of liver of diabetic rats:

Parameters / Groups	AST	ALT	ALP
	U/l		
Group 1	57.45 ± 1.59 [e]	18.54 ± 1.35 [g]	78.94 ± 2.73 [f]
Subgroup 1	90.56 ± 4.57 [a]	54.46 ± 1.79 [a]	158.52 ± 4.50 [a]
Subgroup 2	82.34 ± 2.80 [b]	50.49 ± 1.05 [b]	149.08 ± 3.88 [b]
Subgroup 3	75.56 ± 3.99 [c]	42.93 ± 1.65 [c]	138.70 ± 3.75 [c]
Subgroup 4	66.61 ± 3.42 [d]	34.33 ± 1.92 [e]	121.97 ± 2.65 [d]
Subgroup 5	79.84 ± 1.97 [b]	48.58 ± 1.14 [b]	146.24 ± 1.17 [b]
Subgroup 6	72.44 ± 3.60 [c]	40.28 ± 1.69 [d]	135.29 ± 3.00 [c]
Subgroup 7	62.92 ± 2.53 [d]	32.17 ± 1.27 [f]	116.23 ± 3.86 [e]

-Values were expressed as Means ± SD.

-Values at the same column with different letters are significantly different at P<0.05.

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