CABBAGE PLANT (*BRASSICA OLERACEA L.*) AS NUTRACEUTICAL TO COPE WITH HEPATITIS AND DIABETES MELLITUS IN SPRAGUE DAWLEY ALBINO RATS

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Abstract

This study was conducted to investigate the effect of the parts of cabbage *(Brassica oleracea L.var capitata)* on impaired liver function of injected rats with carbon tetrachloride (Ccl4) and diabetes mellitus of injected rats with alloxan. Fifty six mature albino rats weight 150-170 g B.Wt each were used, and divided into 14 equal group, two were kept as a control (-ve) groups while the 6 groups injected s/c by carbon tetrachloride (ccl4) in paraffin oil 50% V/V (2ml/Kg. B.Wt) twice a week for two weeks to induce hepatopathy, and the other 6 group injected by alloxan (150mg/kg) body weight to induce diabetes. The parts of cabbage (leaves, stalks, roots, seeds and mix of them) were added at a percent of 7.5% from the basel diet. serum liver function (ALT, AST,AST/ALT, and ALP), total cholesterol, triglycerides, lipoprotein fraction (HDL, LDL, VLDL), AI, glucose, were determined, Antioxidant liver enzymes (SOD, GPX and CAT) were evaluated. Data of hepatopathic and diabetic rats revealed that the parts of cabbage showed significant changes in the biochemical parameters. The cabbage parts diets, however corrected the alterations of the control (+ve) groups. In conclusion, the parts of cabbage (leaves, stalks, roots, seeds and mix) could be considered powerful nutraceutical therapeutic means for the treatment of hepatitis and diabetes in rats.

***KEY WORDS*:** Liver function, diabetes, hepatitis, cabbage (leaves, stalks, roots, seeds and mix).

نبات الكرنب (*Brassica oleraceal*) كعلاج طبيعي لمقاومه مرض الكبد والسكري في الفئران البيضاء سلاله سبراجو داولى

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المستخلص العربي

تم إجراء الدر اسه الحالية لمعرفه تأثير أجزاء نبات الكرنب على الخلل الفسيولوجي في كبد الفئران المحقونة برابع كلوريد الكربون والفئران المصابة بالسكري المحقونة بالالوكسان, وتم استخدام ٥٦ فأر ألبينو بالغ تتراوح أوزانهم ١٥٠–١٧٠ جم وتقسيمها إل ١٤ مجموعه متساوية وتم وضع مجموعتين منهم كمجموعه ضابطه سالبه (سليمة) وقسمت المجموعات الأخرى إلى ٦ مجموعات حقنت برابع كلوريد الكربون المخلوط مع زيت البرافين ٥٠% بالحجم بنسبه ٢ مل /كجم من وزن الجسم مرتين أسبوعيا لمدة أسبوعين و ٦ مجموعات أخرى حقنت بالالوكسان بواقع ١٥٠ ملجم/كجم من وزن الجسم للإحداث الإصابة بالسكر، واستخدمت أجزاء نبات الكرنب (الأوراق – الساق – الجذور – البذور وخليط منهم جميعا) وذلك بإضافتها بنسبه ٧.٥% من الوجبة الاساسيه على هيئه مسحوق جاف. وتم قياس أنزيمات الكبد (ALT, AST, AST/ALT, ALP) - الكوليسترول الكلى - الجلسريدات الثلاثية– الليبوبروتينات (HDL - LDL - VLDL - AI) - الجلوكوز - أنزيمات الكبد المضادة للأكسدة. هذه التحاليل أجريت على الفئران المصابة بالكبد والسكر. وأوضحت النتائج أن استخدام أجزاء نبات الكرمب عكس التغيرات فى الفئران. وقد أمكن استنتاج أن أجزاء نبات الكرنب يمكن اعتبرها علاج قوى طبيعى لالتهاب الكبد ومرض السكر.

الكلمات المفتاحية: وظائف الكبد – مرض السكري – التهاب الكبد الوبائي – الكرنب (الأوراق – الساق – الجذور –البذور –الخليط).

Introduction:

The liver is the largest gland in the body. It constitutes about 3% of the body weight in the adults and 5% in the infant (**Chary and Sharma, 2004).**

The liver is the conductor and orchestrator of a wide variety of significant metabolic processes including carbohydrate, fat& protein metabolism, vitamin storage & activation, and detoxification & excretion of both endogenous and exogenous waste products (**Weinsier *et al.*, 1993).**

Liver is also involved in metabolism, activation and transport of many vitamins & minerals to certain extent **(Chatterjea and Shinde, 2002).** Hepatically synthesized proteins transport vitamin A, iron, zinc, and copper. Carotene is converted to vitamin Am, b to 5 methyl tetrahydrofolic acid and vitamin D to its active form by the liver (**Williams, 1995**).

Liver disease may be classed, i.e Liver cirrhosis (cell destruction and increase in fibrous tissue), acute or chronic hepatitis (inflammatory disease) and hepatitis (noninflammatory condition) as mentioned by **Evans (1996**).

When the liver is diseased each of its functions is limitted, but the extent differs with the various forms of disease. Normally there is a considerable reserve in the liver's capacity for most functions (**Garrow *et al.*, 1993**). The liver has an enormous functional reserve as it can perform satisfactorily with only 20% of functioning liver cells and has a marvelous potential to regenerate after injury (**Weinsier *et al.*, 1993**).

Adler *et al.*, (2007) defined diabetes mellitus as a disease resulting from a lack of insulin action. Insulin is a hormone produced in the pancreas. without it, sugar in the food we eat cannot be converted into glucose in the blood and spills out into urine. Diabetes mellitus represents a group of heterogeneous metabolic disorders that develop when insulin secretion is insufficient to maintain normal plasma glucose levels **(American Association of Clinical Endocrinologists, 2012).**

Ranjna, (2003) defined diabetes mellitus; when fasting glucose level>140mg/dl on at least two occasions. And random glucose level> 200mg/dl is suggestive of diabetes mellitus.

Tommy (2004) reported that diabetes can have a significant impact on quality of life by increasing risk for a variety of complications. These include blindness, kidney disease, high blood pressure, heart disease and stroke, nervous system disease, dental disease, amputations, pregnancy complications such as poorly controlled diabetes before conception and during the first trimester of pregnancy can cause major birth defects in 5% to 10% of pregnancies and spontaneous abortions in 15% to 20% of pregnancies, and poorly controlled diabetes during the second and third trimesters of pregnancy can result in very large babies, posing a risk to the mother and the child during delivery.

Phytotherapy is the treatment and prevention of disease using plants, plant parts, and preparations made from them. The plants traditionally used in phytotherapy are called medicinal plants, or herbs (**Weiss and Fintelmann, 2000**).

Holland *et al.*, (1991) reported that cabbage is an excellent source of minerals such as calcium, iron, magnesium, sodium, potassium and phosphorus, most of which are in an available from. Before being thought of as a food, cabbage was valued for medicinal purposes in treating headaches, gout, diarrhea and peptic ulcers **(Cheney, 1950)**.

Much research has focused on beneficial phytochemicals in cabbage, particularly its indole-3-carbinole (I3C), sulforaphane and indoles. These compounds help activate and stabilize the body's antioxidant and detoxification mechanisms that dismantle and eliminate cancer-producing substances **(Brooks *et al.*, 2001**). The protective action of cruciferous vegetables has been attributed to the presence of antioxidant phytochemicals, especially antioxidant vitamins including ascorbic acid, α-tocopherol and β-carotene **(Prior and Cao, 2000**).

Basic research on cabbage photochemical is ongoing to discern if certain cabbage compounds may affect health or have anti-disease effects. Such compounds include sulforaphane and other glucosinolates which may stimulate the production of detoxifying enzymes during metabolism, Studies suggest that cruciferous vegetables, including cabbage, may have protective effects against colon cancer (**Tse and Eslick 2014).**

Boyd *et al.*, (1982) reported that dietary cabbage depresses liver cancer in rats after aflatoxin *B* administration. **Kiharu** *et al.,* **(2008)** reported that isorhamnetin *3-0-* glucoside, which was contained together with isorhamnetin 3,7-di-*O*- glucoside in atsumi-kabu leaves, suppressed increases in the plasma ALT and AST activities of mice with liver injury induced by the injection of carbon tetrachloride.

The effect of anthocyanins on symptoms of experimental diabetic rats was examined by **Jankowski *et al.*, (2000),** and he found that daily administration of anthocyanins decreased sugar concentration in urine and blood serum. Administration of cabbage extract improved the increasing in blood glucose levels in diabetic rats. This effect may be due to its contained anthocyanins which have antidiabetic properties **(Hazem *et al.*, 2008).**

These results suggested the antidiabetic and antioxidant potential of *Brassica oleracea var. italica* in streptozotocin induced diabetic rats

(Vijay and Vimukta, 2014). **Asadujjaman *et al.*, (2011)** indicated that various fractions (Petroleum ether, ethyl acetate and chloroform) of the ethanolic extract of *Brassica oleracea* have favorable effect in hypolipidemic and hepatoprotective activities.

Materials and Methods:

The tested plant in this investigation is cabbage (*Brassica oleracea var)* family Crucifera. The parts of cabbage mainly were used; leaves, roots, seeds, stalk and their mix.

***Rats*:** Mature male albino rats of Sprague – Dawley (56 rats) strain weighing 150-170 g. B.Wt. at age of 14-16 weeks were obtained from Laboratory of Animal Colony, Helwan, Egypt. Rats were fed the basal diet for 7 days before the beginning of the experiment for adaptation.

***Preparation of plant parts*:**

Fresh samples were cleaned by hand from the damaged leaves, then washed with tap water followed by distilled water, and into small sliced. Slides were dried by solar drying (Drying Vazl) to save the phenol compounds activity. Drying continued till constant weight for moisture determined as described by the method of ***(A. O. A. C, 2000)***. The dried samples were ground using electric stainless still mill (Braun, 537, Germany) to give homogenous powder, which was kept in polyethylene bags at frozing temperature until using.

Chemical analysis of tested plant parts:

Samples were subjected to chemical analysis in order to determine: Moisture, protein, fat, fiber, ash and some minerals (sodium, potassium and iron) according to AOAC (2000).

Preparation of hepatic rat (Ccl4):

Carbon tetrachloride (Ccl4) was obtained from El-Gomhoryia Company for Chemical Industries, Cairo, Egypt as 10% liquid solution. It was dispensed in white plastic bottles each containing one liter as a toxic chemical material for liver poisoning according to **Passmore and Eastwood (1986).** In the same time, it is mixed with paraffin oil which obtained from the pharmacy for dilution during the induction.

Preparation of diabetic rats (alloxon):

Diabetes was induced in normal healthy male albino rats via intraperitoneal injection of alloxon 150 mg/kg body weight according to the method described by **Desai and Bhide (1985).** Six hours after the injection of alloxan, fasting blood samples were obtained by retro – orbital method to estimate fasting serum glucose. Rats having fasting serum glucose more than 185 (mg/dl) were considered diabetics **(NDDG, 1994)**.

<u>Grouping and feeding of rats</u>:

All biological experiments were done at the Research Institute of Ophthalmology, Medical Analysis Department, Giza, Egypt. Rats (n=56) housed individually in wire cages in a room temperature maintained at 25 ± 2°C, and kept under normal healthy conditions. were injected s/c by Ccl4 to induce liver damage according to **Jayasekhar *et al*., (1997).**

All rats were fed on standard diet for one week before starting the experiment for acclimatization. After one week period, the rats were divided into **14** groups (**4 rats each**), all groups were fed for **28** days as follows:

- **Group (1):** Normal rats fed on basal diet only as a control negative (-ve) (healthy rats).
- **Group (2):** Hepatitis rats fed on basal diet only as a control positive. (+ve).
- **Group (3):** Hepatitis rats fed on basal diet containing 7.5% cabbage leaves.
- **Group (4):** Hepatitis rats fed on basal diet containing 7.5% cabbage stalks.
- **Group (5):** Hepatitis rats fed on basal diet containing 7.5% cabbage roots.
- **Group (6):** Hepatitis rats fed on basal diet containing 7.5% cabbage seeds.
- **Group (7):** Hepatitis rats fed on basal diet containing 7.5% mix of all parts former.
- **Group (8):** Normal rats fed on basal diet only as a control negative (-ve) (healthy rats)
- **Group (9):** Diabetic rats fed on basal diet only as a control positive (+ve).
- **Group (10):** Diabetic rats fed on basal diet containing 7.5% cabbage leaves.
- **Group (11):** Diabetic rats fed on basal diet containing 7.5% cabbage stalks.
- **Group (12):** Diabetic rats fed on basal diet containing 7.5% cabbage roots.
- **Group (13):** Diabetic rats fed on basal diet containing 7.5% cabbage seeds.
- **Group (14):** Diabetic rats fed on basal diet containing 7.5% mix of parts former.

Biochemical Analysis:

- S.GOT was determined as Unit/L according to **Chawla (2003).**
- S.GPT was determined as Unit/L according to **Srivastava *et al.*, (2002).**
- Serum Alkaline phosphatase was determined (U/L) according to **Haussament (1977).**
- Total cholesterol was determined according to **Ratliff and Hall (1973).**

Enzymatic colorimetrie determination of triglycerides was carried out according to **Fossati and Prencipe (1982)**

Determination of HDL was carried out according to the method of **Fnedewaid (1972)** and **Gordon and Amer (1977).**

The determination of VLDL and LDL was carried out according to the method of **Lee and Nieman (1996)** as follows:

Atherogenic index (AI) was calculated as the VLDL + LDL cholesterol / HDL ratio according to the formula of **kikuchi –Hayakawa *et al.*, (1998).**

The principle used for glucose determination was according to **Trinder (1969).**

- ***Assay of superoxide dismutase (SOD):*** SOD was assayed according to the method of **Sun *et al.*, (1988)**.
- ***Assay of catalase (CAT):*** Catalase activity was assayed following the method of **Diego, (2011)**.
- ***Assay of glutathion peroxidase (GPX):*** Determination of GPX carried out according to the method of **Zhao (2001)**.

Statistical analyses were performed by using computer program (costate), and values compared with each other using the suitable tests.

- **Results are reported as:**
  1. Mean ± SD.
  2. P. Value. P < 0.05 = Statistically significant.

Results and discussion:

Biochemical analyses of hepatitis:

Table (1) results present the fasting serum sugar (glucose) (mg/dl) for negative control, positive control and other different groups of hepatitis rats fed on parts of cabbage (leaves, stalks, roots, seeds and mix).

From the above mentioned data significant increase of control +ve group 158.2±0.58mg/dl, was found as compared to control (– ve) group (76.1±0.26 mg/dl).

When rats fed on the parts of cabbage (leaves, stalks, roots, seeds and mix.) the maximum reduction of glucose recorded for seeds group which was (70.1+0.56 mg/dl) compared to (+ve) group; it is clear that the seeds group gave better results than other parts.

Diagbare (2005) showed that broccoli and cabbage are the richest food sources of the trace metal chromium which seems to control insulin and blood sugar. Results of table (1) are in accordance of that published by **Ali (2011).**

Table (2) results present the values of serum AST, ALT, AST/ALT and ALP (U/L) for negative control, positive control and other different groups of hepatitis rats fed on parts of cabbage (leaves, stalks, roots, seeds and mix).

Data of table (2) showed the high significant increase in AST, ALT, AST/ ALT and ALP from (40.3+0.72 U/L, 18.1+0.36 U/L, 2+0.15 and 219+0.66 U/L) respectively, in normal rats (-ve) group to (77.4+0.45 U/L, 29.1+0.45U/L, 2.8+0.15 and 394.3+0.43U/L) respectively, in hepatitis inflicted rats, this was change due to the injection by Ccl4.

In this concern, **Gaw *et al.*, (2004)** reported that raised activities of the amino transferees (AST and ALT) indicate hepato cellular damage.

Due to feeding on leaves, stalks, roots, seeds and mix. at 7.5% level significant decreases of (AST, ALT. AST/ALT and ALP) were evident when compared with (control +ve) group.

High significant decrease for AST, ALT, AST/ALT and ALP recorded for seeds groups for AST and ALT which were (52.1+0.37 and 20.2+0.49U/L) respectively. Lowest value revealed for mixture group as regards ALP which was(230+0.45U/L).

But for AST/ALT found non significant difference change between all the parts of cabbage (leaves, stalks, roots, seeds and mix) which were (2.5+0.50, 2.5+0.55, 2.6+0.55, 2.8+0.20 and 2.5+0.55) respectively.

These results are confirmed by **Mohamed *et al.*, (2005) who** found that phenolic compounds (such as in onion, garlic and cabbage)have reduced the increase in serum levels of AST and ALT.

Moreover **Giakoustidis *et al.*, (2006)** stated that pretreatment with epigallocatechin-3- gallate (found in cauliflower) decreased serum leaves of AST and ALT.

The present results were in agreement with **Singab *et al*., (2005)** showed that flavonol glycosides reduced the elevated levels of the liver serum enzymes GOT,GPT and ALP.

Table (3) results present the serum of level of total cholesterol and triglycerides for negative control, positive control and other different groups of hepatitis rats fed on parts of cabbage (leaves, stalks, roots, seeds and mix).

It is clear from data of table (3) that the mean values of fasting serum T.C and T.G in positive control groups were (159.9+0.25 and 95.5+0.47mg/dl) respectively, being significantly higher when compared to the corresponding values in negative control groups which were (78.1+0.32 and 62.2+0.55 mg/dl) respectively.

Due to feeding on leaves, stalks, roots, seeds and mix, mean values decreased for serum levels of (T.C) and (T.G) compared to positive groups, the lowest significant recorded for mix group. For total cholesterol lowest value was 83.3+0.49 mg/dl. Also for triglycerides the lowest significant value recorded for seeds group which was 75.2+0.32 mg/dl.

Rombeau and Rolandelli (2001) reported that liver disease lead to increased serum lipids, impaired lipoprotein synthesis, and fat maldigestion& malabsorption. From the results of present work, it could be observed that cabbage parts had favorable effect on serum TC & TG. Such results supported with **Leung and Foster (1996); Blumenthal (2000); Sheppared (2005); Singh and Panda (2005)**. The present results (table 3) are in agreement with that of **Glore *et al.*, (1994).**

Jones *et al.*, (1999) showed that phytosterols, which are components contained in all plants, can be absorbed into the blood stream and nudge out some of the cholesterol. The food that show up the highest phytosterols seems to be the seeds. Other foods that contain high amount of phytosterol include lettuce, cucumbers. asparagus, okra, cauliflower, tomatoes and apricots. The authors recommended that from this group you can design recipes for tasty salads, soups and snacks, which are cholesterol lowering.

Tanaka *et al.*, (2003) illustrated that the broccoli and cabbage mixture showed cholesterol – lowering effects in hypercholestrolemic rats, raising a possibility that daily consumption of these vegetables may be useful in lowering serum TC and LDL-C leaves in hypercholesterolemic patients. **Baltimore (2005)** showed that more than 300 scientific studies point to an antioxidant found in broccoli and cabbage sprouts "sulforaphane glucosinolate (SGS)" as a factor in preventing multiple diseases including several types of cancer, high blood pressure, molecular degeneration and stomach ulcers. Naturally occurring antioxidant, may help reduce cholesterol levels in a matter of days.

Data of table (4) present the serum of lipoprotein fractions (HDLc, VLDLc, LDLc and AI) for negative control, positive control and other different groups of hepatitis rats fed on parts of cabbage (leaves, stalks, roots, seeds and mix).

It is clear that significant increased means for (C+ve) group recorded for serum level for VLDLc, LDLc and AI which were (19.1+0.36 mg/dl, 113.9+0.15mg/dl and 4.94+0.49) respectively. On the contrast, serum level of HDLc was found to be significantly decreased in (C+ve) group which was 26.9±0.15 mg/dl as compared to (C–ve) group being 42.1±0.36 mg/dl. These results are in agreement with **Hamed (2009) And Ali (2011).**

Due to feeding on diets containing the parts of cabbage (leaves, stalks, roots, seeds and mix) (7.5%) the significant highest increase in serum level of HDLc recorded for seeds group which was 39.4+0.45 mg/dl.

Meanwhile in serum VLDLc, LDLc and AI levels it was found the significant decreases compared to (C+ve) group.

Maximum improvement of HDLc, VLDLc, LDLc and AI recorded also for seeds group showing (39.4+0.45 mg/dl, 15.0+0.55mg/dl, 29.2+0.26mg/dl and 1.14±0.1) respectively.

It is clear that the seeds group gave better the results considering lipoprotein fractions which were near that of the normal group.

These results supported by **Glore *et al.,* (1994)** showed that oat bran rice bran, legumes, broccoli, cabbage, carrots cauliflower, corn are good sources of soluble fiber which bind excess cholesterol and carries it out of the body. Soluble fiber has ability to reduce LDLc, total cholesterol without reducing the level of HDLc.The authors concluded that, people who consume more fruit and vegetables often have a lower prevalence of important risk factors for cardiovascular disease, including hypertension, obesity and type 2 diabetes. **Nosaka *et al.,* (2002)** reported that chromium helps to breakdown fats, so it may help lower LDLc and raise HDLc leaves. The authors suggested that vitamin C may help to increase the body absorption of chromium. Leading food source of chromium are: Broccoli, avocado, peamuts, cabbage. and sunflower seeds.

Nakashima *et al.,* (2003) found that the daily intakes of the tested beverage containing broccoli and cabbage are useful for lowering serum LDLc leaves in hypercholesterolemic patient. Also theis results supported by **Takai *et al.,* (2003)** who investigated the lowering effect of two types of canned beverage containing mixed green vegetables and fruits with or without broccoli and cabbage in a randomized double – blind study design.. The results showed that, serum LDLc levels in the test group were significantly reduced at 3.6%, 9 weeks after administration in comparison to the baseline leaves (155.7mg/dl in average). The average LDLc value at 9 weeks was 142.5 mg/dl and the reduction rate was 8.5%. But serum LDLc levels in the control group were not significantly reduced. Thus daily intake of the beverage tested containing broccoli & cabbage are useful for lowering serum LDLc leaves in hypercholesterolemic subjects.

Table (5) results present the glutathione peroxidas (GPX) (ng/ml), catalase (CAT) (mmol/l) and superoxide Dismutase (SOD) (u/l) for negative control, positive control and other different groups of hepatitis rats fed on parts of cabbage (leaves, stalks, roots, seeds and mix).

It is clear that in rats injected by Ccl4 without treatment (C+ve group) the mean value of GPX, CAT and SOD were (17.1+0.32ng/ml, 56.4+0.5mmol/l and 18.3+0.43u/l) respectively, but in (c-ve group) normal rats it were (42+0.95ng/ml, 78.2+0.321mmol/l and 39.3+0.47u/l) respectively. These findings denote that there were significant decrease in GPX, CAT and SOD. Due to feeding on the parts of cabbage (leaves, stalks, roots, seeds and mix.) the significant increase revealed compared to C+ve group. The seeds group achieved higher improvement of GPX, CAT and SOD being (43.5+0.5ng/ml, 70.2+0.2mmol/l and 40.5+0.55u/l) respectively. This data revealed also significant differences between leaves, stalks, roots and mix (7.5%) groups, but all values indicated significant differences as compared with c+ ve group. These results supported by **Sivaramakrishnan *et al.*, (2007) and Pradeep *et al.*, (2007),** found that a significant decrease in the activities of GSH dependent enzymes, GPX and CAT in "National Defense Education Act NDEA "-treated rats which may be due to decreased expression of these antioxidants during hepatocellular damage. Furthermore, the decreased levels of cellular GSH caused a reduction in the antioxidant activities, as GSH is a vital co-factor for these enzymes. The obtained results were in accordance with that reports by **Kweon *et al.*, (2003),** who demonstrated that NDEA induced hepatocellular injury by a substantial fall in hepatic GSH, GPX and CAT activity, which then improved by administration of antioxidants. **Boitier *et al.*, (1995)**, reported that in hepatocellular carcinoma there is a disturbance between oxidant and antioxidant balance, which is tilted towards oxidant side. These results agreed with **Wargovich, (1999),** who reported that cruciferous vegetables namely cabbage, brussels sprouts, cauliflower and broccoli are rich in anti-carcinogens. **Mittal *et al.*, (2006),** concluded that nitrosamines caused the generation of reactive "Reactive oxygen species ROS" resulting in oxidative stress which alter the antioxidant defense system in the tissues.

***Biochemical results of Diabetes*:**

Table (6) present the fasting serum sugar (mg/dl) for negative control, positive control and other different groups of diabetes rats fed on parts of cabbage (leaves, stalks, roots, seeds and mix).

From above mentioned data a significant increase of control (+ ve) group (202.6+0.36 mg/dl) as compared to control (–ve) group (76.2+0.30 mg/dl) was recorded. This results agree with **Elsaeed (2012)**.

During feeding diet containing the parts of cabbage (leaves, stalks, roots, seeds and mix) a significant difference between mentioned groups in serum glucose was found. Maximum reduction of glucose recorded for seeds group (73.2±0.32mg/dl) compared to (C+ve) group, being (202.6±0.36 mg/dl), it was clear that the seeds group gave better results than other cabbage parts diets.

Vijay & Vimutka (2014) found the significant decrease in blood glucose and liver glycogen observed in the rats treated with the cabbage extracts ($P<0.05$).

Jankowski *et al.*, (2000) found daily that administration of anthocyanins decreased sugar concentration in urine and blood serum.

Administration of red cabbage extract improves the blood glucose levels in diabetic rats. This effect may be due to its content of anthocyanins which have antidiabetic properties. **Nizamutdinova *et al.*, (2009)** reported that the administration of anthocyanins markedly decreased glucose levels and increasing utilization of glucose by tissues in diabetic rats.

Data of **table (7)** present the values of serum AST, ALT, AST/ALT and ALP U/L for negative control, positive control and other different groups of diabetes rats fed on parts of cabbage (leaves, stalks, roots, seeds and mix).

Table (7) results showed the high significant increase in AST, ALT, AST/ALT and ALP for control positive groups which were (65.3±0.47U/L, 25.1±0.20U/L, 2.6±0.025 and 329.2±0.25U/L) respectively, compared to control negative groups which were (40.3±0.47 U/L، 18.3±0.47U/L, 2.2±0.052 and 219±0.2 U/L) respectively, these changes were due to the injection with alloxan which also had some adverse reactions and caused laboratory abnormalities in diabetes rats.

Due to feeding on cabbage leaves, stalks, roots, seeds and mix at 7.5% level, the significant decrease of (AST, ALT. AST/ALT and ALP) for rats was evident compared with control (+ve) group.

Maximum decrease of (AST, ALT, AST/ALT and ALP) recorded for seeds groups which were (42.3±0.49, 19.3±0.49, 2.2±0.076 and 205.1±0.26 U/L) respectively.

Mona and Sorial (2008) studied the effect of feeding rats with diets containing 10% of cabbage fiber, and they found the activities of liver enzymes were lower in serum of rats fed with 10% of cabbage fibers as compared with control group.

Orhan *et al.*, (2007) reported a possible mechanism of reduced enzymes activities and the hepato protective effect of cabbage which may be related to their antioxidant effect of the phenolic and flavonoids compounds. **Hussein (2012)** found that rats fed on dried cabbage diets had lower ALT and AST.

Table (8) results present the serum level of total cholesterol and triglycerides for negative control, positive control and other different groups of diabetes rats fed on parts of cabbage (leaves, stalks, roots, seeds and mix).

It is clear that (table 8) the mean values of fasting serum (TC) and (TG) in positive control groups were (141.4±0.45 and 88.5±0.55 mg/dl) respectively, being significant higher than corresponding values in negative control groups which were (78.3±0.47 and 62.0±0.25 mg/dl) respectively.

Due to feeding on leaves, stalks, roots, seeds and mix diets, the values of means decreased for TC and TG compared to C+ve groups. The lowest significant values recorded for seeds groups which were (77±0.15 and 67.3±0.49 mg/dl) respectively. This showed that the seeds group was the best treatment compared to anther treatments groups.

Nizamutdinova *et al.*, (2009) reported that administration of anthocyanins markedly decreased the serum triglycerides levels of diabetic rats.

Mona and Sorial (2003) found that dietary fiber in cabbage was lowering the serum total lipid, total cholesterol, triglycerides levels and LDLc than for rats fed on control diet.

Data of **table (9)** present the serum of lipoprotein fractions (HDLc, VLDLc, LDLc and AI) for negative control, positive control and other different groups of diabetes rats fed on parts of cabbage (leaves, stalks, roots, seeds and mix).

It is clear that the significant increase values occured for C+ve group in serum level of, LDL, VLDL, and AI which were (93.3±0.45 mg/dl, 17.7±0.30mg/dl and 3.7±0.18) respectively, as compared to normal rats C-ve group were (23.7±0.5 mg/dl, 12.1±0.45mg/dl and 0.9±0.003) respectively.

Waqar and Mahmood (2010) reported the ethanolic extract of cabbage caused reduction in serum LDL, while increased HDL significantly.

On the contrast side in serum, level of HDL was found the significant decreased in (+ve) group which was 30.4±0.45 mg/dl, as compared to (-ve) group which being 42.2±0.55 mg/dl.

Due to feeding on diets containing the parts of cabbage (leaves, stalks, roots, seeds and mix,) the significant increases of HDL as compared to (+ve) group was recorded, and the best treatment was found for seeds group which was (44.3±0.49 mg/dl) as compared to C+ve group (30.4±0.45 mg/dl.).

Meanwhile for VLDL, LDL and AI levels it was indicated significant decreases compared to C+ve group.

Maximum improvement of LDL, VLDL and AI recorded for seeds group showed (19.2+0.32mg/dl, 13.5+0.30mg/dl and 0.74+0.04) respectively, as compared to (C+ve) group which were (93.3+0.45mg/dl، 17.7+0.30mg/dl and 3.7+0.18) respectively.

It is clear that the seeds group gave better results in lipoprotein fraction that were near that of the normal group.

Kasahara and Aoki (2001) evaluated the hypolipidemic effect of cabbage on human, and showed that HDLc level increased significantly by taking cabbage 2 weeks after the start of the diet.

Mona and Sorial (2003) found that dietary fiber in cabbage was lowering the serum total lipid, total cholesterol, triglycerides and LDLc than for those rats fed on control diet.

Table (10) results present the glutathione peroxidas (GPX) (ng/ml), catalase (CAT) (mmol/l) and superoxide dismutase (SOD)(u/l) of negative control, positive control and other different groups of diabetes rats fed on parts of cabbage (leaves, stalks, roots, seeds and mix).

It is clear that in rats injected with alloxan without curing diet (C+ve) revealed low mean values of GPX, CAT and SOD which were (12+0.5 ng/ml, 39.2+0.6mmol/l and 13.5+0.4 u/l) respectively, but in normal rats (C-ve) group values were (42.3+0.49 ng/ml, 78.5+0.50 mmol/l and 38.9+0.26 u/l) respectively. This denoted that there were significant increases in GPX, CAT and SOD due to diabetes mellitus.

Due to feeding on the parts of cabbage (leaves, stalks, roots, seeds and mix) the significant increased of enzymes activities compared to (C+ve) group was evident.

The seeds group showed highest improvement which was significant for GPX and CAT which were (38.5+0.51 ng/ml and 65.3+0.6mmol/l) respectively, but for SOD the roots group gave the best significant result (38.5+0.55u/l) as compared to C+ve group 13.5+0.4u/l.

These data revealed also significant changes between leaves, stalks, roots, seeds and mix (7.5%) groups and the differences were remarkable as compared to (C+ve) group.

Ragini *et al.,* (2011). reported that the antioxidant enzymes SOD and CAT play an important role in reducing cellular stress. SOD scavenges the superoxide radical by converting it to hydrogen peroxide and molecular oxygen. CAT is a heme protein, which causes reduction of hydrogen peroxides, and protects higher tissues from the highly reactive hydroxyl radicals. **Vijay and Vimukta**, **(2014)** showed a concentration dependent improvement in the levels of superoxide dismutase, catalase and reduced glutathione along with decrease in the thiobarbituric acid reactive substance levels ($P<0.05$), and these results suggest the antidiabetic and antioxidant potential of *Brassica oleracea var. italica* in streptozotocin induced diabetic rats.

Tables:

Table (1): Effect of Cabbage on Glucose of Hepatitis Rats:

Groups / Parameters	Glucose (mg/dl)
Control (-)	76.1±0.26[e]
Control (+)	158.2±0.58[a]
Leaves	82.2±0.73[c]
Stalks	86.2±0.73[b]
Roots	80.1±0.75[d]
Seeds	70.1±0.56[f]
Mix	79.2±0.83[d]
LSD	1.162

- Values denote arithmetic ± Standard deviation of the mean.
- Means with different letters (a,b,c,d,e,f,g) in the same column differ significantly at P<0.05, while those with similar letters are non significant by different.
- Using one way ANOVA test.

Table (2): Effect of Cabbage on Liver Enzyme (AST, ALT, AST/ ALT, Alp) of Hepatitis Rats:

Groups / Parameters	AST (U/L)	ALT (U/L)	AST/ALT (RATIO)	ALP (U/L)
Control (-)	40.3±0.72[f]	18.1±0.36[f]	2±0.15[b]	219.1±0.66[g]
Control (+)	77.4±0.45[a]	29.1±0.45[a]	2.8±0.15[a]	394.3±0.43[a]
Leaves	60.1±0.65[c]	23.2±0.32[c]	2.5±0.50[ab]	320.6±0.58[c]
Stalks	63.2±0.62[b]	25.2±0.55[b]	2.5±0.55[ab]	324±0.45[b]
Roots	59.1±0.55[d]	22.3±0.49[d]	2.6±0.55[ab]	315±0321[d]
Seeds	52.1±0.37[e]	20.2±0.49[e]	2.8±0.20[ab]	290.2±0.62[e]
Mix	58.2±0.32[d]	23.1±0.56[c]	2.5±0.55[ab]	230±0.45[f]
LSD	0.959	0.825	0.741	0.906

- Values denote arithmetic ± Standard deviation of the mean.
- Means with different letters (a,b,c,d,e,f,g) in the same column differ significantly at P<0.05, while those with similar letters are non significant by different.
- Using one way ANOVA test.

Table (3): Effect of Cabbage on Total Cholesterol, Triglycerides of Hepatitis Rats:

Groups / Parameters	TC (mg/dl)	TG (mg/dl)
Control (-)	78.1±0.32[g]	62.2±0.55[g]
Control (+)	159.9±0.25[a]	95.5±0.47[a]
Leaves	122±0.1[c]	87.9±0.15[b]
Stalks	135.3±0.43[b]	80.3±0.49[d]
Roots	86±0.30[d]	78.2±0.52[e]
Seeds	84.3±0.47[e]	75.2±0.32[f]
Mix	83.3±0.49[f]	82.9±0.20[c]
LSD	0.637	0.731

- Values denote arithmetic ± Standard deviation of the mean.
- Means with different letters (a,b,c,d,e,f,g) in the same column differ significantly at $P<0.05$, while those with similar letters are non significant by different.
- Using one way ANOVA test.

Table (4): Effect of Cabbage on HDL, VLDL, LDL and AI of Hepatitis Rats:

Groups / Parameters	VLDL (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	AI (ratio)
Control (-)	12.1±0.26[e]	42.1±0.36[a]	23.9±0.32[g]	0.86±0.047[e]
Control (+)	19.1±0.36[a]	26.9±0.15[f]	113.9±0.15[a]	4.94±0.49[a]
Leaves	17.2±0.32[b]	34.4±0.45[d]	70.4±0.36[c]	2.55±0.25[c]
Stalks	16.1±0.49[c]	30.6±0.58[e]	88.9±0.36[b]	3.42±0.40[b]
Roots	15.6±0.51[c]	36±0.1[c]	34.4±0.45[d]	1.39±0.026[d]
Seeds	15.0±0.55[cd]	39.4±0.45[b]	29.9±0.26[f]	1.14±0.1[d]
Mix	16.6±0.32[c]	34.9±0.15[d]	31.8±0.45[e]	1.39±0.036[d]
LSD	0.730	0.640	0.615	0.460

- Values denote arithmetic ± Standard deviation of the mean.
- Means with different letters (a,b,c,d,e,f,g) in the same column differ significantly at $P<0.05$, while those with similar letters are non significant by different.
- Using one way ANOVA test.

Table (5): Effect of Cabbage on GPX, CAT and SOD of hepatitis Rats:

Groups / Parameters	GPX (ng/ml)	CAT (mmol/l)	SOD (u/l)
Control (-)	42±0.95[b]	78.2±0.321[a]	39.3±0.47[b]
Control (+)	17.1±0.32[e]	56.4±0.5[g]	18.3±0.43[f]
Leaves	38.4±0.45[c]	64.4±0.45[e]	28±0.55[e]
Stalks	35.2±0.65[d]	60.2±0.58[f]	29.1±0.32[d]
Roots	41.4±0.45[b]	69±0.3[c]	30.1±0.75[c]
Seeds	43.5±0. 5[a]	70.2±0.2[b]	40.5±0.0[a]
Mix	39.3±0.43[c]	65.4±0.45[d]	38.6±0.47[b]
LSD	1.000	0.735	0.914

- Values denote arithmetic ± Standard deviation of the mean.
- Means with different letters (a,b,c,d,e,f,g) in the same column differ significantly at P<0.05, while those with similar letters are non significant by different.
- Using one way ANOVA test.

Table (6): Effect of Cabbage on Glucose of Diabetes Rats:

Groups / Parameters	Glucose (mg/dl)
Control (-)	76.2±0.30[f]
Control (+)	202.6 ±0.36[a]
Leaves	98.0±0.20[c]
Stalks	118.1±0.32[b]
Roots	90.3±0.45[e]
Seeds	73.2±0.32[g]
Mix	95.3±0.47[d]
LSD	0.623

- Values denote arithmetic ± Standard deviation of the mean.
- Means with different letters (a,b,c,d,e,f,g) in the same column differ significantly at P<0.05, while those with similar letters are non significant by different.
- Using one way ANOVA test.

Table (7): Effect of Cabbage on Liver Enzyme (AST, ALT, AST/ALT, Alp) of Diabetes Rats:

Groups / Parameters	AST (U/L)	ALT (U/L)	AST/ALT (ratio)	ALP (U/L)
Control (-)	40.3±0.47[g]	18.3±0.47[g]	2.2±0.062[c]	219±0.2[d]
Control (+)	65.3±0.47[a]	25.1±0.20[a]	2.6±0.25[a]	329.2±0.25[a]
Leaves	48.3±0.47[c]	22±0.1[c]	2.2±0.50[bc]	220.3±0.55[c]
Stalks	51.4±0.45[b]	23±0.1[b]	2.2±0.1[bc]	225±0.25[b]
Roots	44.3±0.47[e]	20.9±0.49[e]	2.1±0.02[bc]	211.9±0.3[f]
Seeds	42.3±0.49[f]	19.3±0.49[f]	2.2±0.76[bc]	205.1±0.26[g]
Mix	46.3±0.43[d]	21.6±0.37[d]	2.1±0.052[b]	216.4±0.45[e]
LSD	0.818	0.633	0.107	0.605

- Values denote arithmetic ± Standard deviation of the mean.
- Means with different letters (a,b,c,d,e,f,g) in the same column differ significantly at $P<0.05$, while those with similar letters are non significant by different.
- Using one way ANOVA test.

Table (8): Effect of Cabbage on Total Cholesterol and Triglycerides of Diabetes Rats:

Groups / Parameters	T.C (mg/dl)	T.G (mg/dl)
Control (-)	78.3±0.47[e]	62.0±0.25[g]
Control (+)	141.4±0.45[a]	88.5±0.55[a]
Leaves	114.3±0.49[c]	75.2±0.30[c]
Stalks	120.6±0.56[b]	78±0.15[b]
Roots	78.3±0.47[e]	70.2±0.55[e]
Seeds	77±0.15[f]	67.3±0.49[f]
Mix	89.2±0.37[d]	72.3±0.47[d]
LSD	0.778	0.741

- Values denote arithmetic ± Standard deviation of the mean.
- Means with different letters (a,b,c,d,e,f,g) in the same column differ significantly at $P<0.05$, while those with similar letters are non significant by different.
- Using one way ANOVA test.

Table (9): Effect of Cabbage on HDL, VLDL, LDL and AI of Diabetes Rats:

Groups / Parameters	HDL (mg/dl)	LDL (mg/dl)	VLDL (mg/dl)	AI (ratio)
Control (-)	42.2±0.55[b]	23.7±0.5[g]	12.1±0.45[e]	0.9±0.003[f]
Control (+)	30.4±0.45[e]	93.3±0.45[a]	17.7±0.30[a]	3.7±0.18[a]
Leaves	38.9±0.20[c]	60.4±0.15[c]	15.0±0.2[bc]	1.9±0.15[c]
Stalks	32.0±0.45[d]	73±0.45[b]	15.6±0.45[b]	2.8±0.1[b]
Roots	42.1±0.32[b]	22.3±0.15[e]	14. 0±0.47[c]	0.86±0.04[e]
Seeds	44.3±0.49[a]	19.2±0.32[f]	13.5±0.30[d]	0.74±0.04[e]
Mix	38.8±0.32[c]	26.9±0.32[d]	14.5±0.45[c]	1.07±0.03[d]
LSD	0.680	0.631	0.683	0.176

- Values denote arithmetic ± Standard deviation of the mean.
- Means with different letters (a,b,c,d,e,f,g) in the same column differ significantly at $P<0.05$, while those with similar letters are non significant by different.
- Using one way ANOVA test.

Table (10): Effect of Cabbage on GPX, CAT and SOD of Diabetes Rats:

Groups / Parameters	GPX (ng/ml)	CAT (mmol/l)	SOD (u/l)
Control (-)	42.3±0.49[a]	78.5±0.50[a]	38.9±0.26[a]
Control (+)	12±0.5[g]	39.2±0.6[g]	13.5±0.4[g]
Leaves	30.4±0.45[f]	48.4±0.45[e]	26.4±0.55[e]
Stalks	31.6±0.47[e]	40.2±0.51[f]	25±0.3[f]
Roots	36.4±0.36[c]	58.2±0.26[c]	38.5±0.55[b]
Seeds	38.5±0.51[b]	65.3±0.6[b]	33.4±0.40[c]
Mix	33.9±0.26[d]	53.1±0.40[d]	30.2±0.47[d]
LSD	0.779	0.858	0.761

- Values denote arithmetic ± Standard deviation of the mean.
- Means with different letters (a,b,c,d,e,f,g) in the same column differ significantly at $P<0.05$, while those with similar letters are non significant by different.
- Using one way ANOVA test.

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