THE EFFECT OF CUMIN ON INDUCED DIABETES IN RATS

Mutaa A. Abed* Omar H. Azeez**

* Department of Physiology, College of Veterinary Medicine, University of Mosul, Mosul-IRAQ.
** Department of Pathology and Microbiology, Faculty of Veterinary Medicine, University of Duhok, Duhok-IRAQ.

Keywords ;Cumin ,Diabetes ,Rats.
(Received 22 April 2013,Accepted 22September 2013)

ABSTRACT

The present study was conducted to evaluate the effect of Cumin on diabetes mellitus induced by alloxan in rats. Male Wister rats were used, and randomly divided into five groups (6-8 rats for each group): The first group: was administered distilled water and served as normal control, the second group: induced diabetes by single subcutaneous injection of alloxan 100 mg/kg.body weight and served as diabetic control, the 3,4,5 groups was administered 50,100,200 gm/kg of rat's forage respectively for four weeks, then diabetes are induced in this groups by same route as above. Cumin treatment in all doses lead to significant decrease glucose levels, and triglyceride and significant decrease in cholesterol level in dose 100, 200 gm/kg of forage and no change occur in total protein level. These results indicate that cumin have a role in delaying of diabetes through the effects of cumin in decrease some biochemical parameters.

INTRODUCTION

Diabetes mellitus is a metabolic disorder characterized by resistance to the action of insulin, or insufficient secretion, or both (1). The major clinical manifestation of the diabetes state is hyperglycemia, however, insulin deficiency and/or insulin resistance also are associated with disturbance in lipid and protein metabolism (2).WHO indicates that diabetes mellitus is one of the major killers of humans in our time (3). Management of diabetes without any side effect is still a challenge to the medical system; this had led to

an increasing demand for natural products with antidiabetic activity and fewer side effects (4).

Spices form an important class of food adjuncts in human diet, besides enhancing the taste and flavor of foods; spices exhibit a wide range of physiological and pharmacological properties (5).

Cumin (Cuminum Cyminum), a small, annual herbaceous plant of the Umbelliferae family. Cumin is a popular spice all over the world, especially in Latin America, North Africa, and all over Asia. It has known to the Egyptians 5,000 years ago and formed an important medicine of ancient Egypt (6, 7).

Fruit are the medical part of cumin, cumin has numerous uses such as drug and spicy for about a thousand years ago (8). Cumin is used as a stimulant, antispasmodic, carminative particularly in veterinary practice and antimicrobial agent. Cumin is used widely in traditional medicine to treat flatulence, digestive disorders and diarrhea and in the treatment of wounds (9), Fungitoxic (10), cumin also help ease and increase secretion of milk in lactating women (11), also uses for cold and fever (12).Cumin contain volatile oils (13).Also cumin contain vitamins like vitamin C, and A, also contain amino acids, proteins, minerals, starch tannin and fibers (14), In addition to flavones (15), and Glucosides (16).

Cumin are used for treatment diabetes, recent researches record the activity of extraction of cumin to decrease the level of glucose in normal and in alloxan-induced diabetic rats (17) and decrease lipid profile (18, 19).

In addition to decrease levels of uric acid and total proteins (20) and decrease level of creatinin (21).

The present study was conducted to evaluate the effect of Cumin on diabetes mellitus induced by alloxan in rats.

MATERIAL AND METHODS

Animals: Male albino rats, 3-4 months old and 167-218 gm body weight were housed in hanging cages in the animal house of the college of veterinary medicine-University of Mosul, and maintained under laboratory controlled of temperature (22 ±2) and light (14 hour light and 10 hour dark), pelleted food and tap water were given.

Induction of diabetes: Rats were fasted for 48 hour before inducing diabetes with alloxan (Molekala-England). Diabetes was induced by a single subcutaneous injection of alloxan in a dose of 100 mg/kg of body weight (22). Rats were allowed to drink 5% glucose solution overnight to prevent hypoglycemia. Alloxan treated animals were monitored by periodic testing for glucosuria using Lilly Test Tap and ketonuria using chemstrip MH 5000/k (Boehrinher, Mannheim, Germany) (23).

Plant: Cumin was purchased from the local market in Mosul, and it's identify was confirmed biochemically in the Research Center of the college of Science, university of Mosul. The cumin was powdered before uses.

Experimental design: Animals randomly were divided into five groups, each consisting of 6-8 rats. Group 1: Served as negative control group ; Group 2:Induced Diabetes and served as positive control group ; Group 3: normal rats received cumin 50gm /kg of forage for four weeks ; Group 4: normal rats received cumin 200 gm /kg of forage for four weeks ; Group 5: normal rats received cumin 100 gm /kg of forage for four weeks. After four weeks diabetes are induced in groups: 3,4,5, and after 24 hours of injection, blood samples were collected for biochemical parameters.

Samples collection: Blood samples were collected from the orbital plexus of vein into clean dry centrifuge tubes allowed to clot, serum was separated after centrifugation at 1500 rpm for 15 minutes (24), serum biochemical parameters were measured using colorimetric assay kits (Bicon,DiagnosticGmbh, Burbach, Germany).

Statistical analysis: All data analyzed by one way analysis of variance, the specific group differences were determined using Duncan multiple range test; the accepted level of significance was $P< 0.05$ (25).

RESULT

Induced diabetes by alloxan lead after four weeks to a significant increase in levels of glucose (Table 1), with decreased significantly level of total proteins (Table 4). And no significant effect on both cholesterol and triglyceride levels (Table 2, 3).

Table 1,3: is indicating that administration of cumin in all doses lead to significant decrease levels of both serum glucose and serum triglyceride when compare with diabetic groups.

As shown in table (2) there are significant decrease in serum cholesterol level in groups received cumin in dose100, 200 gm/ kg of forage, with no significant effect in 50 gm / kg of forage.

Our result shown that administration of cumin in all doses lead to decrease serum total protein levels when compared with the diabetic group, but there are a significant changes in groups which treated with cumin doses 50, 100 gm/ kg of forage (table 4).

Table (1): Effect of cumin on serum glucose level in rats.

Groups	Serum glucose level (mg/dl)			
	Time zero	Time after treatment (hour)		
		2 hour	4 hour	24 hour
Control	**A** 91.64± 6.38	**A** 94.94± 4.01	**A** 96.34± 3.16	**A** 74.79± 2.63
Alloxan	**A** 85.27 ± 4.54	**E** 426.15± 3.78	**E** 464.99 ± 2.13	**D** 364.59 ± 5.61
Cumin 50 gm/kg of forage	**A** 83.84 ± 3.10	**C** 281.25 ± 7.11	**C** 288.22± 6.87	**A** 103.94± 6.45
Cumin 100 gm/kg of forage	**A** 90.63 ± 2.85	**B** 203.57 ± 9.62	**BC** 243.68 ± 5.99	**A** 49.06 ± 4.76
Cumin 200 gm/kg of forage	**A** 99.03 ± 6.3	**A** 73.76 ± 6.11	**B** 209.16 ± 4.13	**B** 196.31 ± 6.6

No. of rats (6-8) in each group
Data is the mean ± SEM
Different letters indicate significant differences between groups horizontally and vertically at $P < 0.05$

Table (2): Effect of cumin on serum cholesterol level in rats.

Groups	Serum cholesterol level (mg/dl)	
	Time zero	Time after 24 hour
Control	**C** 183.75 ± 7.59	**C** 155.99 ± 6.74
Cumin 50 gm/kg of forage	**C** 183.01 ± 9.57	**C** 171.27 ± 8.82
Cumin 100 gm/kg of forage	**C** 173.36 ± 4.77	**A** 44.09 ± 6.79
Cumin 200 gm/kg of forage	**C** 153.22 ± 6.11	**B** 87.54 ± 3.11

No. of rats (6-8) in each group

Data is the mean ± SEM
Different letters indicate significant differences between groups horizontally and vertically at P < 0.05

Table (3): Effect of cumin on serum Triglyceride level in rats.

Groups	Serum Triglyceride (mg/dl)	
	Time zero	Time after 24 hour
Control	**CD** 57.85 ± 4.97	**D** 62.88 ± 5.83
Cumin 50 gm/kg of forage	**BCD** 54.07 ± 6.08	**BC** 48.41 ± 3.98
Cumin 100 gm/kg of forage	**CD** 59.05 ± 5.62	**A** 27.93 ± 5.78
Cumin 200 gm/kg of forage	**BC** 44.17 ± 3.91	**BC** 42.92 ± 2.29

No. of rats (6-8) in each group
Data is the mean ± SEM
Different letters indicate significant differences between groups horizontally and vertically at P < 0.05

Table (4): Effect of cumin on serum Total protein level in rats.

Groups	Serum Total protein level (g/dl)	
	Time Zero	Time After 24 hour
Control	**BC** 5.09 ± 0.73	**A** 3.87 ± 0.36
Cumin 50 gm/kg of forage	**CD** 5.37 ± 0.35	**A** 4.05 ± 0.52
Cumin 100 gm/kg of forage	**D** 5.90 ± 1.03	**A** 4.11 ± 0.6
Cumin 200 gm/kg of forage	**AB** 4.36 ± 0.52	**A** 4.05 ± 0.14

No. of rats (6-8) in each group
Data is the mean ± SEM
Different letters indicate significant differences between groups horizontally and vertically at P < 0.05

DISCUSSION

The result from present study showed that injection of alloxan leads to significant increase of glucose level, and this result are agree with (4, 26, 27) in rats. This may due to destruction of β-cells of pancreas by alloxan which lead to stop production of insulin (28). Also causes diminishes of inters of glucose to cells leads to increase its level in blood (29). Alloxan reacts with two SH- groups in the sugar binding side of glucokinase resulting in the formation of the disulfide bond and inactivation of the enzyme (30).

From the result of present study showed that treatment with cumin 50,100,200 gm/kg of forage lead to decrease serum glucose level when compare with diabetic control group, this results are agree with result of (31) in rabbit, and in diabetic rats (17, 18, 21). The effect of cumin may due to its ability to inhibit α-glucosiadse (32), this enzyme are responsible about degrades disaccharide like sucrose, and polysaccharide like starch to monosaccharide (33), (34) refer that treatment with polyphenolic compound extracted from black cumin in rats leads to decrease serum glucose level as a result to the effect of α-glucosiadse.

The hypoglycemic effect of cumin may due to presence of flavones (15), which found that flavones have an effect to inhibit α-glucosiadse, and Aldose reductase (35), also flavones cause decrease absorption of glucose from intestine through decrease glucose transport processes that depend on calcium (36), similar effect were found in flavones of soybean (37).

Other possible mechanism to decrease of serum glucose level due to cumin administration may due presence of Cuminaldehyde (32), this substance have an ability to inhibit α-glucosiadse, and Aldose reductase, and these both enzyme are work to prevent rises of insulin level in the body (38).

Treatment with cumin resulted decrease serum blood cholesterol, this results were agree with (18,19,39) in normal and diabetic rats induced by alloxan, and don't agree with results of (40) in rats.

The cholesterol reduction effect of cumin may due to it's activity as antioxidant, which shown that there are an increase in activity of Superoxide dimutase & catalase (41), also presence of flavones in cumin which work as antioxidant via inhibit oxidation of

lipoproteins, and increase activity of low density lipoproteins (42), similar results were shown from (43) in mice when treated with soybean seeds contains flavones.

The lowering of cholesterol levels may be due to sterol that presence in cumin (44), Sterol acts to decrease estrification of cholesterol in gastric cells and reveres the unestrified cholesterol again to intestine (45). Also sterols increase cholesterol acyltransferase Acyl CoA, and increase production of bile acids and oxidation of lipoproteins and increase activity of lipase & liver lipase Lipoprotein lead to decrease cholesterol level (46), similar lowering effect of cholesterol were shown in treatment with extract of *Moringooleiferm Lam* (47), and *Terminalia bellerica Roxb* (48) because they contain sterol.

Significant decrease of blood triglyceride levels were observed in rats treated with cumin, this result agree with (13) in alloxan-induced diabetic rats, and result of (49) in type 2 diabetic patient, this lowering effect may due to presence of unsaturated fatty acids in cumin (44), (50) refer that treatment with unsaturated fatty acids present in fish oil leads to decrease serum triglyceride level in normal and alloxan-induced diabetic rats.

The role of fatty acids may due to its effect in facilitate metabolism processes of very low density lipoprotein, and chylomicrone (51).

From our result we observed that alloxan lead to decrease total protein level, and this due to decrease synthesis, and increase catabolism protein (52).

When rats treated with cumin in all doses lead to non-significant increase in serum total protein level when compared with control, but when compared with zero time there are a significant increase in total protein level when rats treated with cumin in doses 50,100 gm/kg of forage.

This effect may due to that cumin have characteristics similar to insulin (39) where play a prominent role in synthesis of proteins through increase translation of mRNA (51).

Our study indicate that cumin have a role in delaying of diabetes through decrease some biochemical parameters.

تأثير نبات الكمون على استحداث داء السكر بالجرذان

مطاع عبد المطلب عبد*، عمر حسن عزيز**
* فرع الفسلجة و الكيمياء الحياتية والأدوية، كلية الطب البيطري، جامعة الموصل، الموصل، العراق.
** فرع الأمراض والأحياء المجهرية، كلية الطب البيطري، جامعة دهوك، دهوك، العراق.

الخلاصة

أجري هذا البحث لمعرفة تأثير نبات الكمون Cumin على قابلية الأصابة بداء السكر المستحدث بالالوكسان. تم استخدام ذكور جرذان مختبرية من نوع Wister وقسمت عشوائياً الى خمسة مجاميع (كل مجموعة 6-8 جرذان): تامجموعة الأولى: أُعطيت الماء المقطر وعدت مجموعة سيطرة موجبة، المجموعة الثانية: حقنت تحت الجلد بمادة الالوكسان Alloxan وبجرعة 100 ملغم/كغم من وزن الجسم لأستحداث داء السكر تجريباً وعدت مجموعة سيطرة سالبة، المجاميع: 3،4،5 أُعطيت نبات الكمون بتركيز 50،100،200 غم/كغم علف على الترتيب ولمدة أربعة أسابيع، بعدها تم أستحداث داء السكر بالالوكسان. أظهرت النتائج أن أعطاء نبات الكمون وبكافة التراكيز قد أدى ألى أنخفاض معنوي في مستوى الكلوكوز والكليسيريدات الثلاثية، والى أنخفاض معنوي في مستوى الكولسترول عند المعاملة بالتراكيز 100،200 غم/كغم علف، ولم يكن لنبات الكمون أي تأثير على مستوى البروتين الكلي. نستنتج من الدراسة الحالية ألى أن نبات الكمون يمتلك دوراً في تأخير الاصابة بداء السكر من خلال التأثير المخفض لبعض الأختبارات الكيموحيوية.

REFERENCES

1- Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. (2002). Diabetes Care.23:S5-S20.
2- Vats, V.; Grover, J.K. and Rathi, S.S. (2002). Evaluation of anti-hyperglycaemic and hypoglycaemic effect of Trigonella foenum-graecum Linn., Ocimum sanctum Linn and Pterocarpus marsupium Linn in normal and alloxanised diabetic rats. J Ethnopharmacol. 79: 95-00.
3- Ashok, K.T.and Madhusudana, R.J. (2002): Diabetes mellitus and multiple therapeutic approaches of phytochemicals:present. Status and future prospects Current Science. 83(1):30-38.
4- Galletto, R.; Siqueira, V.L.; Ferreira, E.B.; Oliveira, A.J. and Bazotti, R.B. (2004). Absence of Antidiabetic and hypolipidemic effect of Gymnema sylvestre in non diabetic and alloxan diabetic rats. Brazilian Archives of Biology and Technology .47: 545-551.
5- Babu, P.S. and Srinivasan, K. (1997).Hypolipidemic action of curcumin, the active principle of turmeric (Curcuma longa) in streptozotocin induced diabetic rats. Mol. Cell Biochem. 166: 169–175.
6- Krishna, De. A. (2000). Recent Trends in Spices and Medicial Plants Reseacrh.Associated Publishing Co., New Delhi, India.
7- Thomas, S.C. Li. (2000). Medicinal Plants. Technomic Publishing Company. Pennsylvania. USA.

8- Agarwal V.; Gupta, V.; Nepali K.; Suri O.P. and Dhar K.L. (2010). Chemical and biological characteristics of Cuminum cyminum. J. Nat. Conscientia. 1: 148-156.

9- Peter, K.V. (2001). Handbook of herbs and spices (Volume 1). 1st . ed. Cambridge, England. pp: 164-167.

10- Singh, G. and Upadhyay, R.K.(1991). Fungitoxic activity of cuminaldehyde, main condtituent of the cuminum cyminum oil. Fitoterapia. 62:86.

11- Sharma, R.; and Kaur, D. (2012). An Update on Pharmacological Properties of Cumin. IJRPS. 2(4),14-27.

12- Singh V.B.; and Singh K. (1996). Spices New Age International (P) Limited Publishers, Delhi.

13- El-Ghorab AH.; Nauman M.; Anjum FM. ; Hussain S.and Nadeem M. A. (2010). Comparative Study on Chemical Composition and Antioxidant Activity of Ginger (Zingiber officinale) and Cumin (Cuminum cyminum). J. Agric. Food Chem. 58 (14), 8231–8237.

14- Johri. R.K. (2011). Cuminum cyminum and Carum carvi. Pharmacognosy. 5 (9): 63-72.

15- Ishikawa, T.; Takayanagi, T. and Kitajima, J.(2002). Water soluble constituent of cumin: Monoterpenoid glucosides. Chem Pharm Bull. 50:1471-1478.

16- Kitajima, J.; Ishikawa, T.; Fujimatu, E.; Kondho, K. and Takayanagi, T. (2003).Glycosides of 2-C-methyl-D-erythritol from the fruits of anise, coriander and cumin. Phtochemistry. 62:115-120.

17- Talpur, N.; Echard, B.; Ingram, C.; Bagchi, D. and Preuss, H. (2005). Effects of a novel formulation of essential oils on glucose-insulin metabolism in diabetic and hypertensive rats: a pilot study. Diabetes Obes Metab.7(2):193-9.

18- Dhandapani, S.; Subramanian, V.R.; Rajagopal, S. and Namasivayam, N. (2002). Hypolipidemic effect of Cuminum cyminum L. on alloxan-induced diabetic rats. Pharmacol Res. 46:251-255.

19- Aruna, K.; Rukkumani, R.; Varma, P.S. and Menon, V.P. (2005). Therapeutic role of cuminum cyminum on ethanol and thermally oxidized sunflower oil induced toxicity. Phytother Res. 19(5):416-21.

20- El Bagir, N.M. ; Limtithal, T.O.F.; Ahmed, A.; Hasab, E.M. and Anton, C.B. (2010). Clinical laboratory serum values in rabbits fer doets containing black cumin seed.Journal of Animal and Veterinary Advances. 9(19):2532-2536.

21- Jagtap, A.G. and Patil, P.B. (2010). Antihyperglycemic activity and inhibition of advanced glycation end product formation by Cuminum cyminum in streptozotocin induced diabetic rats. Food Chem Toxicol.,48(8-9):2030-6.

22- Katsumata, K. and Katsumata, Y. (1990). The potentiating effect of the simultaneous administration of tolbutamide, glibenclamide, and gliclazide on the development alloxan-induced diabetes ion rats. Hom Metab Res., 22 :51-52.

23- Szkudelski T. (2001). The mechanism of alloxan and streptozotocin action in β cells of the rat's pancrease. Physiol Res. 50: 536-546.

24- Fox JG.; Cohen BJ.and Loew FM.(1984). Laboratory Animal Medicine. Academic press London, U.K.: 19-120.

25- Bruning, J.L. and Kintz, B.L. (1977). Computational Handbook of Statistics. 2ed ed .Scott Foresman and Co.Glenveiw .Illionois USA . 75-80,102-138.

26- LinoCde, S.; Diogenes, J.P.; Pereira, B.A.; Faria, R.A.; Andrade, Neto. M.; Alves, R.S.; DeQueiroz, M.; Sousa, F.C. and Viana, G.S. (2004). Antidiabetic activity of Bouhinia forficata extracts in alloxan diabetic rats. Biol. Pharm. Bull . 27(1): 125-127.

27- Aziz, O.H. (2009). Effect of soybean seeds alone or in combination with insulin or glibenclamide on serum lipid profiles in alloxan-induced diabetic rats. Iraqi Journal of Veterinary Sciences .23(10): 17-23.

28- deCarvalho, E.N.; deCarvalho, N.A.S. and Ferreiva, L.M. (2003). Experimental model of induction of diabetes mellitus in rats. Acta Cir Bras . 18.

29- Nelson, D.L. and Cox, M.M. (2005). Lehninger Principles of Biochemistry. 4th ed. Worth Publishers. USA . Pp., 790-885.

30- Lenzen, S. and Mirzaie-Petri, M. (1991): Inhibition of glucokinase and hexokinase from pancreatic B-cells and liver by alloxan, alloxantin, dialuric acid, and *t*-butylhydroperoxide. Biomed Res. 12: 297-307.

31- Roman-Ramos, R.; Flores-Saenz, J.L. and Alarcon-Aguilar, F.J. (1995). Anti-hyperglycemic effect of some edible plants.J Ethnopharmacol. 48(1):25-32.

32- Lee, H.S. (2005) Cuminaldehyde: Aldose Reductase and α-Glucosidase Inhibitor Derived from Cuminum cyminum L. Seeds.J Agric Food Chem. 53 (7): 2446–2450.

33- Fujita, H.; Yamagami, T. and Ohshima, K. (2001). Fermented soybean derived water-soluble touchi extract inhibits glucosidase and is antiglycemic in rats and humans after single oral treatment. J Nurt . 131: 1211-1213.

34-Ani, V. and Akhilender, Naidu. K. (2008). Antihyperglycemic and antibacterial activities of polyphenolic components of black/bitter cumin Centratherum abthelminticum (L.) kuntze seeds. European Food Research & Technology . 226 (4):897-903.

35- Lee, H.S. and Kim, M.K. (2001). Rat intestinal R-glucosidase and lens aldose reductase inhibitory activities of grain extracts.Food Sci. Biotechnol .,10: 172-177.

36- Vedavanam, K.; Srijayanta, S.; O' Reilly, J.; Raman, A. and Wiseman, H. (1999). Antioxidant action and potential antidiabetic properties of an isoflavonoid containing soybean phytochemicalse extract (SPE). Phytother. Res. 13 (7): 601-608.

37- Bhathena, S.J. and Velasquez, M. T. (2002). Beneficial role of dietary phytoestrogens in obesity and diabetes. M J C N . 76(6): 1191-1201.

38- Mooradian, A.D. and Thurman, J.E. (1999). Drug therapy of postprandial hyperglycemia. Drugs. 57:19-29.

39-Prince, D.S.; Kamalakkannan, N. and Menon, V.P. (2004). Antidiabetic and antihyperlipidemic effect of alcoholic Syzigium cuminiseeds in alloxan induced diabetic Albino rats. J Ethnopharmacol. 91 (203): 209-213.

40- Sambaiah, K. and Srinivasan, K. (1991). Effect of cumin, cinnamon, ginger, mustard and tamarind in induced hypercholesterolemic rats. Nahrung. 35(1):47-51.

41-Gagandeep, D.S.; Mendiz, E.; Rao, A.R. and Kale, R.K. (2003). Chemopreventive effects of Cuminum cyminum in chemically induced forestomach and uterine cervix tumors in murine model systems. Nutr Cancer . 47:171-180.

42- Arliss, R.M. and Biermann, C.A. (2002). Do soy isoflavones lower cholesterol, inhibit atherosclerosis and play a role in cancer prevention. Holist Nurs Pract . 16(5): 40-48.

43- Kirk, E.A.; Sutherland, P.; Wang, S.A.; Chait, A. and Boen, C. (1998). Dietary isoflavones reduce plasma cholesterol and atherosclerosis in (57BL/6) mice but not LDL receptor deficient mice. J Nutr . 128 (6): 954-959.

44- Hamid, S.; Hifza, A.; Bushra, K. and Khan, J.I. (2004. Lipid studies of cuminum cyminum fixed oil. Pak J Bot . 36(2): 395-401.

45- Matvienko, O.A.; Douglas, S.L.; Swanson, M.; Arudt, B., Raiuwater, D.L.; Stewart, J. Alekel, O.L. and (2002). Asingle daily doses of soybean phytosterol in ground but decrease serum total cholesterolemic men. A. J. C. N. 76 (1): 57-64.

46- Moghadasian, M.H. (2000). Pharmacological properties of plant sterols in vivo and in vitro observation. Life Sci. 67(6): 605-615.

47- Ghasi, S.; Nwobodo, E. and Ofili, J.O. (2000). Hypocholesterolemic effects of crude extract of leaf of Moringa oleifera Lam in high-fat diet fed wistar rats. Journal of Ethnopharmacology. 69 21–25.

48- Latha, R.C.R. and Daisy, P. (2010). Influence of Terminalia bdlerica Roxb. Fruit Extracts on Biochemical Parameters in Streptozotocin Diabetic Rats.International Journal of Pharmacology. 6 (2): 89-96.

49- Andallu, B. and Ramya, V. (2007). Anti-hyperglycemic, cholesterol-lowering and HDL–raising effects of cumin (Cuminum cyminum) seeds in type 2 diabetes. Journal of Natural Remedies. 7(1): 142 - 149.

50- Mahmud, I.; Hossain, A.; Hossain, S.; Hannan, A.; Ali, L. and Hashimoto, M. (2004). Effect of Hilsa- hilsa fish oil on the atherogenic lipid profile and glycaemic status of streptozotocin treated type 1 diabetic rats. Clin Exp Pharmacol Physiol . 31 (1-2): 76-81.

51- Murray, R.K.; Granner, D.K. and Mayes, D.A. (2003). Rod well VW. Harper's Illustrated Biochemistry. 26th ed. Appeton and lange. U.S.A. 180,223-352.

52-Mansour, H.A. and Newairy, A.A. (2000). Ame-lioration of impaired renal function associated with diabetes by Balanites aegyptiaca fruits in streptozo-tocin induced diabetic rats. Journal of the Medical Research Institute 21: 115–125.