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HYPOGLYCEMIC EFFECTS OF TARO MUCILAGE ON STREPTOZOTOCINE-INDUCED DIABETIC RATS

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ABSTRACT

In recent years, the use of foods with perceived health protective effects (i.e. functional foods) has received considerable attention for reducing disease risks. Mucilage is, in general, a water extract from some plants, a component with excellent prospects as an additive not only for the food industry, but also for other healthy and industrial uses. A numerous studies revealed that it composed of some ingredients which possessed multiples therapeutic properties on the experimental rats. With such point of views, the current study interests to separate, dehydrate the taro mucilage and utilize varied concentrations (1, 3 and 6%) of the product, in addition to 6% of whole and demucilage taro, in feeding of induced diabetes rat groups for two months. Such five groups were biologically and histologically compared with another two control groups fed on the basal diet, the first was non diabetes and the second was diabetes, negative and positive group, respectively.

The current work shows that the mucilage enhanced the deal with the diabetes disease through recovery the insulin secretion and lowered the glucose presence in rat blood serum to be close to the negative control than that fed on the other diets. The same pattern was also found in case of triglycerides and the cholesterol profile, i.e., lowered the harmful fractions, triglycerides, LDL and VLDL, and enhanced the desirable one, HDL. Liver (ALP, ALT and AST) and kidney (Uric acid, Urea and Creatinine) functions as well as lipid oxidation parameters (SOD, GSPx, GSH and TBARs) were pronounced lower in the mucilage groups than that of the other diabetic rat groups, on contrary of specific parameters of the positive group diet. On the other hand, a varied significant difference of body

and organs weight, especially heart and spleen, of rats fed on the mucilage diets compared with the other groups, with no significant differences among the different mucilage concentrations. Pancreatic histological examination detected that mucilage groups, especially 3 and 6%, seemed to be close to the negative control wherein, there was no histopathological changes in relative to the other diabetic rat groups. In general, involvement of taro mucilage in diets could be managed of diabetes and is known to improve liver, kidney functions and pancreatic histological examination during diabetes rat live.

Keywords: Taro mucilage, Lipid oxidation, diabetic, liver and kidney functions, pancreatic histological examination

INTRODUCTION

Diabetes mellitus is one of the major metabolic disorders, afflicting a large proportion of the population all over the world (Zimmet, *et al*., 2001). Diabetes is recognized for severe complications, which include diabetic nephropathy, neuropathy, and retinopathy (Gabir, *et al*., 2000). In any form of management of diabetes with insulin or drug, diet is a common factor. With respect to diet, plants and foods of medicinal value have proved to be very useful and are in wide usage as they combine two basic central factors: food and medication (Grower, *et al*., 2002).

The marine mucilages were composed of organic matter, together with a significant inorganic fraction. Elemental analysis revealed 12.5–32.2% of organic carbon, 0–7.3% of inorganic carbon and 1.0–3.7% of nitrogen (Giani *et al*, 2005). Plant mucilage sources, a complex carbohydrate with a great capacity to absorb water, should be considered a potential source of industrial hydrocolloid. It contains varying proportions of l-arabinose, d-galactose, l-rhamnose, and d-xylose, as well as galacturonic acid. The mucilage content found is influenced not only by the management of the crop but is also dependent on the temperature, irrigation and the rain. In some countries, small farmers use cactus mucilage to purify drinking water. Another traditional uses are for improving house paint, culinary uses (Sáenz, *et al*., 2004), inhibition of aluminum corrosion (El-Etre, 2003), preparation of a growth-promoting substance from okra mucilages (Hirose, *et al*., 2004), for dermatological therapies (Deters *et al*., 2005), reducing cardiovascular disease (CVD) risk factors,

preparing a food grade natural polysaccharide from Fenugreek mucilage which has been reported as a flocculant for tannery effluent treatment (Mishra, *et al*., 2004) and preparing a novel mucilaginous fraction of mustard seeds as a functional food against sporadic and obesity-associated colon cancer (Eskina, *et al*., 2007). The mucilage is part of dietary fiber, and generally refers to some part of the fruit, vegetables, grains, nuts and legumes that cannot be digested by humans (resistant to the digestive enzymes). The experiences mentioned above show the different responses in patients, with type II diabetes mellitus, using crude nopal stems and dried nopal, as mucilage sources, the first being hypoglycemic and the second showing only an attenuation effect in postprandial hyperglycemia. The rise of serum glucose was independent of the doses of nopal intake. The results suggested that they act by interfering with intestinal glucose absorption, perhaps reducing absorption through the soluble dietary fiber content of the nopal. In another study, (Frati-Munari *et al*., 1990) concluded that glycemia decreased in all patients tested following ingestion of *Opuntia ficus indica*, and reached statistically significant levels after 120 and 180 min. It was proposed that the soluble dietary fiber was not the only component responsible for the hypoglycemic action, and that there exists another, yet unexplained, hypoglycemic action of the pads. It was concluded that administration of *Opuntia streptacantha* sap to diabetic patients improved remarkably the general symptomatology of the patient, decreasing his glucose and insulin blood levels. (Sáenz, *et al*., 2004). Another study suggested that the Sweet potato mucilage might contribute, its antioxidant activities, against both hydroxyl and peroxyl radicals (Huang, *et al*., 2006).

Therefore, the current study scope is to extract the taro mucilage and investigate its role in managing the biological parameters of normal and induced diabetic rats.

MATERIALS AND METHODS

Materials

Taro tubers (*Colocasia esculenta*) were purchased from a local market at Giza, Egypt in the end of 2007 season. Streptozotocin drug was purchased from Sigma Chemical Co. (St.Louis. Mo). The

analytical kits (Glucose, Total cholesterol , High density lipoprotein cholesterol (HDL), Low density lipoprotein cholesterol (LDL), Triglycerides (TG), Alanine amino transferase (ALT), Aspartate amino transferase (AST), Alkaline phosphatase (ALP), Creatinine, Urea, Uric acid, Malondialdehyde (TBARs), Glutathione reduced (GSH), Glutathione peroxides (GSP_X) and superoxide dismutase (SOD), were obtained from Randox Laboratories Ltd., Diamond Road, Crumlin,Co., Antrim, United Kingdom, BT294QY. The insulin kit was obtained from Biosource Europe S.A.,B-1400 Nivelles, Belgium.

Methods

Extraction, preparation and dehydration of the mucilage:

The crude mucilage of taro was extracted by the procedure of El-Mahdy and El-Sebaiy (1984), as follows:

Taro tubers was cut into small pieces, blended with distilled water (1:4, w/w), heated at 70º c for 15 min., to inhibit the enzyme activities, cooled and squeezed through a very fine cotton textile. The crude mucilage was precipitated, from the resulting viscous solution, with, three volumes of acetone and washed with ethanol. The crude mucilage was overnight dried at 37º c in the oven.

Biological feeding experiment:

Forty two young male Albino rats, average weight of 160±5 g., were maintained in the animal house of the Ophthalmology Research Institute, Giza, Egypt. The rats were kept under normal healthy laboratory condition; 25±2°c. temperature adjust and 12 hr light–dark cycles. Animals were adapted on free access of water and fed on a basal diet for one week before the initiation of the experiment. The basal diet is composed of (as g/kg diet): Casein, 10%; cellulose, 5%; corn oil, 10%; corn starch, 70%; salt mixture, 4% and vitamin mixture, 1%, according to Lane Peter and Pearson (1971), Hegested *et al*.,(1941) and Camplell,(1961).

After the adaptation period, the diabetes disease was induced by individual about one ml intraperitoneally injection of 36 rats with exactly 50 mg streptozotocine, dissolved in 0.2 m mole sodium citrate at pH 4.5/kg of a rat body weight, and the negative control was

injected by sodium citrate only, according to the method described by Lutz and Pardridge (1993). Blood samples were collected after 48 hours of injection and glucose levels were determined. Rats with blood glucose level higher than 280.09 mg/dl were considered to be diabetic. Such successful rats were divided into 6 groups (6 rats of each) and fed on the following diets scheme for 60 days:

- Diabetic rats fed on basal diet, positive control, P. control named,
- Diabetic rats fed on basal diet containing 1% mucilage, 1% mucilage named,
- Diabetic rats fed on basal diet containing 3% mucilage, 3% mucilage named,
- Diabetic rats fed on basal diet containing 6% mucilage, 6% mucilage named,
- diabetic rats fed on basal diet containing 6% whole taro, 6 % whole taro named,
- Diabetic rats fed on basal diet containing 6% dehydrated minced taro tubers after mucilage extraction, 6% demucilage taro named, and in addition to the previously mentioned group,
- Non diabetic rats fed on basal diet, named negative control, N. control.

Biochemical parameters assays:

At the end of the experimental period, rats were weighed, killed by diethyl ether and their organs were weighted. Blood samples were, also, collected from the animal eye plexuses. Each sample was collected into both heparinized tubes to obtain the plasma and into a free coagulation dry clean centrifuge glass tube to prepare serum. Blood samples were left for15 min at room temperature, then the tubes were centrifugated for 15 min at 3000 g and the clean supernatant serum was frozen kept at -20 $^{\circ}$c until analysis. Serum glucose and insulin were determined according to Trinder (1969) and Temple *et al*., (1992), respectively. Serum cholesterol profile, total (TC), high density lipoprotein (HDL), low density lipoprotein (LDL), VLDL-cholesterol and triglycerides (TG.) were determined by using the methods described by Waston (1960), Assmann (1979), Wieland and Seidel (1983), Wallach (1992) and Fossati and Prencipe (1982), respectively. Liver functions, alkaline phosphatase (ALP) was measured using the method of Varley *et al*., (1980), alanine

aminotransferase (ALT) and aspartate aminotransferase (AST) activities were assayed by the method of Bergmeyer and Harder (1986). Kidney functions, creatinine, urea and uric acid were measured using the method of Varley *et al*., (1980), Henry (1974), Fawcett and Scott (1960) and Caraway (1955), respectively. The activity of lipid peroxidation level, malondialdehyde, malondialdehyde (TBARs), total serum glutathione reduced (GSH), serum glutathione peroxides (GSPx) and superoxide dismutase (SOD) were calorimetrically measured according to the method of Meltzer *et al*., (1997), Ellman (1959) , Rotruck *et al*. (1973) and Marklund and Marklund (1974), respectively.

Statistical analysis:

The resulted data were subjected to statistical analysis using the standard analysis of variance as outlined by Snedecor and Cochran (1980) and the differences among means of diet effects were tested for the least significance differences value (LSD) at 0.05 probabilities by using Duncan's multiple range tests by SAS (1987) program.

Histopathological examination:

Sample from the pancreas was collected from rats in all groups at the end of experiments (60 days), fixed in 10% neutral buffered formalin, dehydrated in alcohol, cleared in xylol and embedded in paraffin. 4μ thick sections were prepared and stained with Hematoxylene and Eosin (Yoon *et al*., 2001).

RESULTS AND DISCUSSION

Data presented in Table (1) show that initial body weights did not significantly differ among the groups and at the end of experimental, regardless of the diet variation, there was no significant differences among all the tested rat groups, except in case of the P. control which was the lowest weight, agreed with Kumar *et al*., (2005). Decreased body weight observed in diabetic rats is due to excessive breakdown of tissue proteins (Ravi *et al*., 2004). These results are in accordance with results previously reported after streptozotocin treatment of diabetic rats (Yanardag *et al*., 2003). The same Table shows no significant differences in liver, kidney and brain weight, determined as g, among all the tested rat groups and the significant differences in the corresponding record, calculated as % of

the final weight, was due to the significant variation in rat weights. The variances in weights of experimental rat organs are also monitored for indirect diabetes diagnosis and it was reported that the weights of the liver and kidney were increased in diabetic rats (Hwang *et al.,* 2005). On contrary, there were significant differences in heart and spleen weight of the tested rat groups, in both calculation forms, i.e. g or %, and the organ weight of the mucilage rat groups fall at intermediate of the control, whole and demucilage taro groups.

Table (1): Body and organ weights of streptozotocin-induced diabetic rats fed on different concentrations of taro mucilage (1, 3 and 6%), whole and demucilage taro (6%).

Group	Rat weight		Liver weight		Kidney weight		Heart weight		Spleen weight		Brain weight	
	Initial (g)	Final (g)	(g)	As %	(g)	As %	(g)	As %	(g)	As %	(g)	As %
N. control	161.8 ^{a} ±2.362	256.0 ^{a} ±1.633	6.88 ^{ab} ±0.303	2.69 ^{bc} ±0.127	1.35 ^{ab} ±0.078	0.53 ^{d} ±0.029	0.52 ^{d} ±0.010	0.20 ^{d} ±0.005	0.54 ^{c} ±0.014	0.21 ^{d} ±0.005	1.33 ^{a} ±0.048	0.52 ^{b} ±0.016
P. control	163.5 ^{a} ±2.380	232.3 ^{c} ±15.47	7.24 ^{a} ±0.967	3.10 ^{a} ±0.393	1.39 ^{ab} ±0.094	0.58 ^{ab} ±0.029	0.80 ^{ab} ±0.056	0.35 ^{ab} ±0.019	0.84 ^{a} ±0.051	0.37 ^{a} ±0.019	1.22 ^{b} ±0.072	0.53 ^{ab} ±0.010
1% Mucilage	162.8 ^{a} ±2.217	252.0 ^{a} ±6.055	6.86 ^{ab} ±0.366	2.72 ^{bc} ±0.112	1.33 ^{ab} ±0.045	0.53 ^{d} ±0.018	0.59 ^{c} ±0.063	0.24 ^{cd} ±0.028	0.64 ^{b} ±0.025	0.26 ^{c} ±0.010	1.31 ^{a} ±0.045	0.52 ^{ab} ±0.005
3% Mucilage	162.5 ^{a} ±2.082	251.0 ^{ab} ±4.967	6.78 ^{ab} ±0.374	2.71 ^{bc} ±0.118	1.35 ^{ab} ±0.065	0.54 ^{cd} ±0.033	0.62 ^{c} ±0.069	0.25 ^{cd} ±0.026	0.64 ^{b} ±0.050	0.26 ^{c} ±0.017	1.30 ^{ab} ±0.024	0.52 ^{b} ±0.017
6% Mucilage	162.3 ^{a} ±2.217	250.0 ^{ab} ±3.560	6.23 ^{ab} ±0.917	2.49 ^{c} ±0.336	1.36 ^{ab} ±0.083	0.55 ^{bcd} ±0.030	0.62 ^{c} ±0.042	0.25 ^{cd} ±0.013	0.59 ^{bc} ±0.026	0.24 ^{cd} ±0.010	1.31 ^{a} ±0.058	0.53 ^{ab} ±0.021
6% Whole taro	162.8 ^{a} ±2.217	248.3 ^{ab} ±2.363	7.09 ^{a} ±0.157	2.86 ^{ab} ±0.054	1.42 ^{ab} ±0.102	0.57 ^{bcd} ±0.036	0.74 ^{b} ±0.034	0.30 ^{bc} ±0.017	0.79 ^{a} ±0.097	0.33 ^{cd} ±0.035	1.33 ^{a} ±0.042	0.54 ^{ab} ±0.013
6% Demucilage taro	162.5 ^{a} ±2.082	244.5 ^{ab} ±5.000	7.08 ^{a} ±0.244	2.90 ^{ab} ±0.055	1.45 ^{a} ±0.061	0.59 ^{a} ±0.017	0.83 ^{a} ±0.162	0.42 ^{a} ±0.047	0.87 ^{a} ±0.047	0.36 ^{ab} ±0.013	1.33 ^{a} ±0.061	0.55 ^{a} ±0.024

-Means, within the same column, followed by the same letter are not significantly different at <0.05.

- Means are followed by the corresponding Standard deviation.

Even so, at the end of experiment, the P. control groups still suffering from the hyperglycemia, i.e, the serum glucose value was dramatically higher as a result of diabetes induction by intraperitoneally injection of streptozotocine (Table, 2). On contrary, the serum glucose of N. control group, which represent the normal case, feeding on basal diet all over the experiment, was the lowest value, concurrent with Kumar *et al*., (2005). The utilization of mucilage in the diet revealed a detectable and highly significant decrement in the serum glucose than the involvement of whole or demucilage taro. Such beneficial effect is due to the presence of mucilage which contained some bioactive compounds and it could be

confirmed by monitoring the significant higher decrement as a result of mucilage exceeded, especially in 3 and 6% diets. It could be, also, regarded to the mucilage content of dietary fiber, e.g., polysaccharide, agreed with Hirose, *et al*., (2004), which possess phagocytosis activating, reticuloendothelial potentiating, and anticomplementary activating activities (Gonda, *et al*.,1993) that plays a vital role in management of glucose in ordinary and diabetes cases. Also, Kiho *et al.,* (1994) reported that the structural of polysaccharides, in some food ,e.g., mushroom, is linked to the hypoglycemic activity. The (1-4) linked and/or (1-6) linked residues in a β (1-6) branched (1-3) β-D-glucan is needed for the hypoglycemic effect in diabetic mice. The viscosity of the polysaccharide also affects the hypoglycemic activity and the high molecular polysaccharide weight possessed a better antidiabetic activity than its degraded products with lower molecular weights (Kiho *et al.,* 1994 and Kiho *et al.*,2001). Mechanism linking dietary fiber with glucose metabolism, first, the effects of dietary fiber on insulin sensitivity. The physical and chemical properties of fiber aid in early signals of satiation and enhanced signals of satiety, thus reduction total energy intake. Second, the beneficial effects of fiber on glucose metabolism may the result of delayed gastric emptying rate, slowed digestion and absorption of food. Fiber regulates several metabolic hormones that affect glucose metabolism. Dietary fiber may be explained by increased intestinal proglucagon gene expression. Proglucagon encodes several proglucagon-derived peptides know to modulate intestinal absorption capacity and pancreatic insulin secretion (Ylonen *et al*., 2003).

Insulin level in the diabetes patients is a vital estimation to diagnose of endogenous hyperinsulinism and overcome such danger disease symptomatic (Vezzosi *et al*., 2003). Therefore, the result in Table (2) recorded the serum insulin in the tested rat groups at the end of the biological experiment. It shows that there was a reverse pattern with rats serum glucose, i.e., the higher insulin level conjugated with the lower serum glucose amount. These data indicate that mucilage can affect both the metabolic and genetic structure of the bacterial community as shown by a greater catabolic potential for carbohydrates. Benizri *et al*., (2007). It is well known that a significant decrement should be found in insulin level as a result of diabetes induction in rats. The current research shows that such decrement is still found in the normal rat group, N. control, than the

other induced diabetes rat groups. But the mucilage groups were the lower varied and seemed to be closed to the normal rat group in relative of the other groups, demucilage and whole taro and P. control. Such observation could be due to the presence of some bioactive compounds in the mucilage, including 4-hydroxy isoleucine, is a novel amino acid known to facilitate insulin secretion (Sauvaire, *et al*., 1998). A significant detectable increment in serum secretion could be noticed as a result of utilizing the higher mucilage concentration in the diets, 3 and 6%.

Table (2): Serum glucose and insulin levels in in streptozotocin-induced diabetic rats fed different concentrations of taro mucilage (1, 3 and 6%), whole and demucilage taro (6%).

Group	Serum glucose (mg/dl)	Serum Insulin (uIU/ml)
N. control	106.44 [e] ±3.126	47.055 [a] ±1.603
P. control	239.62 [a] ±21.324	27.695 [e] ±1.350
1% Mucilage	147.740 [c] ±7.248	39.775 [c] ±1.292
3% Mucilage	122.995 [d] ±8.470	42.400 [b] ±2.014
6% Mucilage	126.623 [d] ±4.057	42.435 [b] ±0.911
6% Whole taro	178.985 [b] ±9.653	36.930 [d] ±2.165
6% Demucilage taro	170.668 [b] ±13.585	36.708 [d] ±2.275

-Means, within the same column, followed by the same letter are not significantly different at <0.05.

- Means are followed by the corresponding Standard deviation.

Serum total cholesterol and triglyceride levels are also strongly related to the degree of diabetic control rats. The increased total cholesterol and triglyceride levels observed in diabetic rats may be the result of impaired liver function caused by the damage done by streptozotocin, which acts either directly or indirectly by enhancing the plasma glucose level (Van Horn, 1996 and Hwang *et al* ., 2005). The present study shows a noticeable significant decrement (Table 3) in triglycerides (TG) and harmful form of cholesterol (LDL and

VLDL) as a function of mucilage diets, in all concentrations, utilization in feeding the diabetes rats in a comparison with the rats fed on the other tested diets, whole and demucilage taro, and basal taro. Such results were in accordance with that found by Aller, *et al*., (2004) and could be due to the presence of dietary fiber and its polysaccharides and consequently, a diet high in fiber has been linked to a decreased risk of cardiovascular disease (CVD), independent of dietary fat intake, energy intake and other dietary factors (Wolf, *et al*., 1999). On the other hand, the health role of the mucilage was concentration dependent, wherein triglycerides (TG) and harmful form of cholesterol were decrease and the desirable cholesterol form was enhanced as the mucilage concentration was raised in the diets (Table 3). The mechanism by which fiber lowers blood cholesterol remains undefined. Evidence suggests that some soluble fibers bind bile acids or cholesterol during intraluminal formation of micelles. The resulting reduction in cholesterol content of liver cells leads to an up-regulation of LDL receptors and thus increased clearance of LDL cholesterol (Anderson, *et al*., 1986).

Although it is possible that the fermented products of these mucilages decreased liver capacity for *de novo* triglyceride and fatty acid synthesis through inhibition of key enzyme activities, particularly glycerol-3-phosphate acyltransferase and fatty acid synthase (Boban *et al*., 2006). Cholesterol profile and TG amount in the mucilage groups were changed to be more closed to that of the N. control group, agreed with that of Eskina, *et al*., (2007), confirmed the article that several metaanalyses have shown that the consumption of soluble fiber reduces total cholesterol and LDL-cholesterol levels (Brown, *et al*., 1999 and Ripsin, *et al*., 1992).

Liver is the most important organ in the metabolism of drugs and other substances. Liver cell destruction shows its effects mostly as impairment in the liver cell membrane permeability, which results in the leaking out of tissue contents into the blood stream. In diabetic rats, the activity of serum ALP was significantly increased by relative 256.28% to their normal levels (Table 4), supporting our findings, that the liver was necrotized in diabetic rats. Therefore, the increase in the activity of ALP in serum is mainly due to the leakage of these enzymes from the liver cytosol into the blood stream (Mansour *et al*., 2002), which gives an indication on the hepatotoxic effect of streptozotocin. On the other hand, the administration of mucilage

extract and whole taro to diabetic rats reduced ALP activity towards its normal values. In turn, mucilage was more effective than whole taro. The increase in ALP activity in serum is an indicator of liver destruction. In our study, serum ALP activity was controlled by mucilage treatment. The decrease in ALP activity in diabetic rats given demucilage extract shows liver damage.

Table (3): Serum triglycerides, Total cholesterol, HDL-cholesterol, LDL-cholesterol, and VLDL-cholesterol in streptozotocin-induced diabetic rats fed different concentrations of taro mucilage (1, 3 and 6%), whole and demucilage taro (6%).

Group	Triglycerides (mg/dl)	Total cholesterol (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	VLDL
N. control	76.283 ^{cd} ±5.004	76.283 ^{c} ±5.004	31.635 ^{c} ±3.766	27.165 ^{cd} ±3.797	15.257 ^{cd} ±5.004
P. control	108.963 ^{a} ±6.165	111.463 ^{a} ±9.926	24.715 ^{d} ±2.039	55.285 ^{a} ±2.039	21.793 ^{a} ±6.165
1% Mucilage	91.703 ^{bcd} ±10.036	91.703 ^{b} ±10.036	37.133 ^{b} ±6.041	36.268 ^{b} ±6.041	18.341 ^{bcd} ±10.036
3% Mucilage	75.238 ^{d} ±17.524	86.225 ^{bc} ±10.940	49.335 ^{a} ±4.320	21.845 ^{de} ±4.320	15.048 ^{d} ±17.524
6% Mucilage	87.305 ^{bcd} ±7.816	89.705 ^{b} ±7.081	52.785 ^{a} ±3.997	19.260 ^{e} ±4.002	17.461 ^{bcd} ±7.816
6% Whole taro	103.845 ^{ab} ±18.533	91.198 ^{b} ±5.759	40.413 ^{b} ±1.010	29.918 ^{c} ±1.278	20.769 ^{ab} ±18.533
6% Demucilage taro	92.660 ^{abc} ±4.753	92.660 ^{b} ±4.753	40.393 ^{b} ±1.882	29.788 ^{c} ±1.882	18.532 ^{abc} ±4.753

-Means, within the same column, followed by the same letter are not significantly different at <0.05.

- Means are followed by the corresponding Standard deviation.

Data presented in Table (4) shows that AST and ALT (the appreciate indicators of liver function) were affected by the mucilage implantation in the rat diets. It could be found a significant decrease in both AST and ALT in the mucilage diabetes rat groups than the other diabetes rat groups. Such trend was confirmed by the explanation of El-Etre, (2003), who reported that the extracted mucilage contains mainly polysaccharide which is a mixture of mucilage and pectin which possess an ameliorating role of liver function indicators, i.e., AST and ALT, as reported by Saleh *at al*., (2008). The liver function enhancement was more detectable as the mucilage was increased,

wherein AST and ALT values were lowered to be more ordinary to the value of the normal rat group (N. control).

Kidney functions possessed a mucilage dependent model resemble to that of the liver functions corresponding rat groups. Uric acid is the major product of purine nucleotides, adenosine and guanosine; urea is the major nitrogen containing metabolic product of protein metabolism and creatinine is endogenously produced and released into body fluids and its clearance measured as an indicator of glomerular filtration rate (Burtis and Ashwood, 1996). The higher creatinine clearance rate in the diabetic animals suggests hyperfiltration in these animals. The diabetic rats had increased levels of uric acid, urea and creatinine, which are considered as significant markers of kidney function (Liu *et al.,* 2006), which is in agreement with the present result. This means that the kidney functions indicators as discovered from Table (4) were ameliorated because of the mucilage utilization in diabetes rats. It may also due to the presence of some bioactive compounds in the mucilage led to an enhancement in Kidney functions confirmed the observation of (Motawi and Haggag, 1992) and implementation of the mucilage water extract of fenugreek seeds to improve kidney function during diabetes in southeast of Asia.

For studying the effect of taro mucilage (1,3 and 6 %) , whole taro (6%) and demucilage taro (6 %) on free radical production, the activities of SOD, GSH-Px , GSH and level of TBARs were measured in Table (5). SOD, GSH-Px and GSH activities were significantly decreased in streptozotocin-induced diabetic rats and TBARs was significantly increased untreated diabetic rats (P. control) compared to control rats (N. control). Administration of diabetic rats with different concentrations of mucilages (1, 3, and 6%) , whole taro (6 %) and and demucilage taro (6 %) reduced TBARs level and increased SOD, GSH-Px, GSH activities compared with untreated diabetic rats. The highest antioxidant enzymes activities and the lowest value of TBARs were observed by rats fed on the diet supplemented with two concentrations of taro (3 and 6 %). Hyperglycemia in diabetic animals can cause oxidative stress, depleting the activity of the antioxidative defense system and resulting in elevated levels of oxygen free radicals Lee (2006). The possible sources of oxidative stress in diabetes might include autooxidation of

glucose, decreased tissue and plasma concentrations of superoxide dismutase, catalase and glutathione reduced (Kowluru and Chan 2007). Present results are in agreement with those obtained by Li (2007) who found that, polysaccharide was decreased blood glucose and increased the activity of serum SOD, which suggests that the antioxidant activity of polysaccharide is one of the mechanisms of hypoglycemic activity.

Table (4): Liver (ALP, AST and ALT) and kidney (uric acid, urea and createnine) function estimation in streptozotocin-induced diabetic rats fed different concentrations of taro mucilage (1, 3 and 6%), whole and demucilage taro (6%).

Group	Liver functions			Kidney functions		
	ALP (Unit/l)	AST (Unit/l)	ALT (Unit/l)	Uric acid (mg/dl)	Urea (mg/dl)	Createnine (mg/dl)
N. control	76.147 ^{f} ±0.418	33.913 ^{e} ±1.733	24.033 ^{d} ±5.770	2.233 ^{d} ±0.101	23.280 ^{e} ±0.441	0.843 ^{f} ±0.022
P. control	271.300 ^{a} ±2.029	74.700 ^{a} ±3.948	60.630 ^{a} ±3.965	2.925 ^{a} ±0.048	64.486 ^{a} ±3.389	1.625 ^{a} ±0.088
1% Mucilage	116.287 ^{c} ±1.690	52.640 ^{c} ±2.399	43.718 ^{b} ±3.551	2.665 ^{b} ±0.021	39.391 ^{c} ±1.228	1.256 ^{c} ±0.048
3% Mucilage	111.848 ^{d} ±3.473	46.513 ^{d} ±2.728	35.495 ^{c} ±2.507	2.580 ^{c} ±0.022	36.386 ^{d} ±0.839	1.185 ^{d} ±0.034
6% Mucilage	97.751 ^{e} ±1.599	43.238 ^{d} ±2.176	34.800 ^{c} ±3.222	2.520 ^{c} ±0.037	34.119 ^{d} ±1.478	1.103 ^{e} ±0.025
6% Whole taro	122.533 ^{b} ±2.027	58.458 ^{b} ±4.038	42.283 ^{b} ±2.485	2.740 ^{b} ±0.082	40.968 ^{c} ±1.363	1.356 ^{b} ±0.025
6% Demucilage taro	125.414 ^{b} ±1.906	59.880 ^{b} ±2.112	42.488 ^{b} ±2.273	2.743 ^{b} ±0.028	46.146 ^{b} ±2.409	1.413 ^{b} ±0.035

-Means, within the same column, followed by the same letter are not significantly Different at <0.05.

- Means are followed by the corresponding Standard deviation.

Microscopically examination graphics of the pancreas of the tested rat groups were showed in Figure (1). It shows that there was no histopathological changes in the N. control after 2 months of feeding on the basal diet (Slide 1). Meanwhile, pancreas of diabetic rat fed on the same diet for the same period revealed a hyperplasia and a hypertrophy of B cells of islets of langerhan's (Slide 2) as well as a cystic dilatation of pancreatic duct (Slide 3). These examination noticed results are in agreement with Nematalla *et al*., (2007).

Table (5): Effect of taro mucilage (1, 3 and 6%), whole taro (6%) and demucilage taro (6 %) on antioxidant enzymes activities (SOD, GSH-Px, GSH) and TBARs concentration in diabetic rats.

Group	SOD U/gHb	GSH-Px U/gHb	GSH (Unit/l)	TBARs (mg/dl)
N. control	305.885 [a] ±33.047	168.735 [a] ±8.533	39.693 [a] ±0.382	0.556 [g] ±0.017
P. control	81.710 [d] ±3.251	76.913 [d] ±12.927	18.888 [f] ±0.801	3.001 [a] ±0.200
1% Mucilage	156.818 [c] ±13.867	93.683 [c] ±2.241	31.470 [c] ±0.981	1.815 [d] ±0.143
3% Mucilage	207.193 [b] ±13.213	111.128 [b] ±6.975	34.548 [b] ±1.267	1.460 [e] ±0.186
6% Mucilage	208.728 [b] ±32.561	122.305 [b] ±9.885	36.330 [b] ±0.351	0.905 [f] ±0.035
6% Whole taro	148.635 [c] ±18.748	89.435 [c] ±1.819	26.208 [d] ±2.062	2.228 [c] ±0.082
6% Demucilage taro	158.210 [c] ±13.690	86.325 [cd] ±4.144	23.258 [e] ±2.624	2.650 [b] ±0.100

-Means, within the same column, followed by the same letter are not significantly different at <0.05.
- Means are followed by the corresponding Standard deviation.

A slight hypertrophy of islets of langerhan's was the only histopathologicl finding observed in pancreas of rat group pancreas sample fed on the 1% mucilage diet for the same period (Slide 4). However, the pancreas sample of 3% and 6% mucilage rats groups showed no histopathological changes (Slides 5 and 6, respectively). Pancreas Examined sample of rat group fed on 6% whole taro showed a hypertrophy of langerhan's islets (Slide 7) and the corresponding sample of rat group fed on the 6% demucilage diet revealed vacoullation of some islets cells of langerhan's (Slide 8).

In general, it could be concluded that the suggested taro mucilage diets improved the diabetic status of rats. Such effect of mucilage in rats may be mainly due to the high amount of dietary fiber. The dietary fiber is both soluble and insoluble. These fibers would facilitate a slower absorption of glucose in the gastrointestinal tract (Cummings, 1985 and Wolver and Jenkins 1986). The effect of fermentation products of dietary fiber (such as acetate, propionate, and butyrate) should also be considered in the amelioration of diabetic status (Berggren, *et al*., 1993 and Bourquin, *et al*., 1996). Consequently, because of the current work shows a beneficial role of

mucilage in management of many biological factors in induced diabetes rats, therefore, it has the potential to be used as a food supplement, including the preparation of diabetic foods.

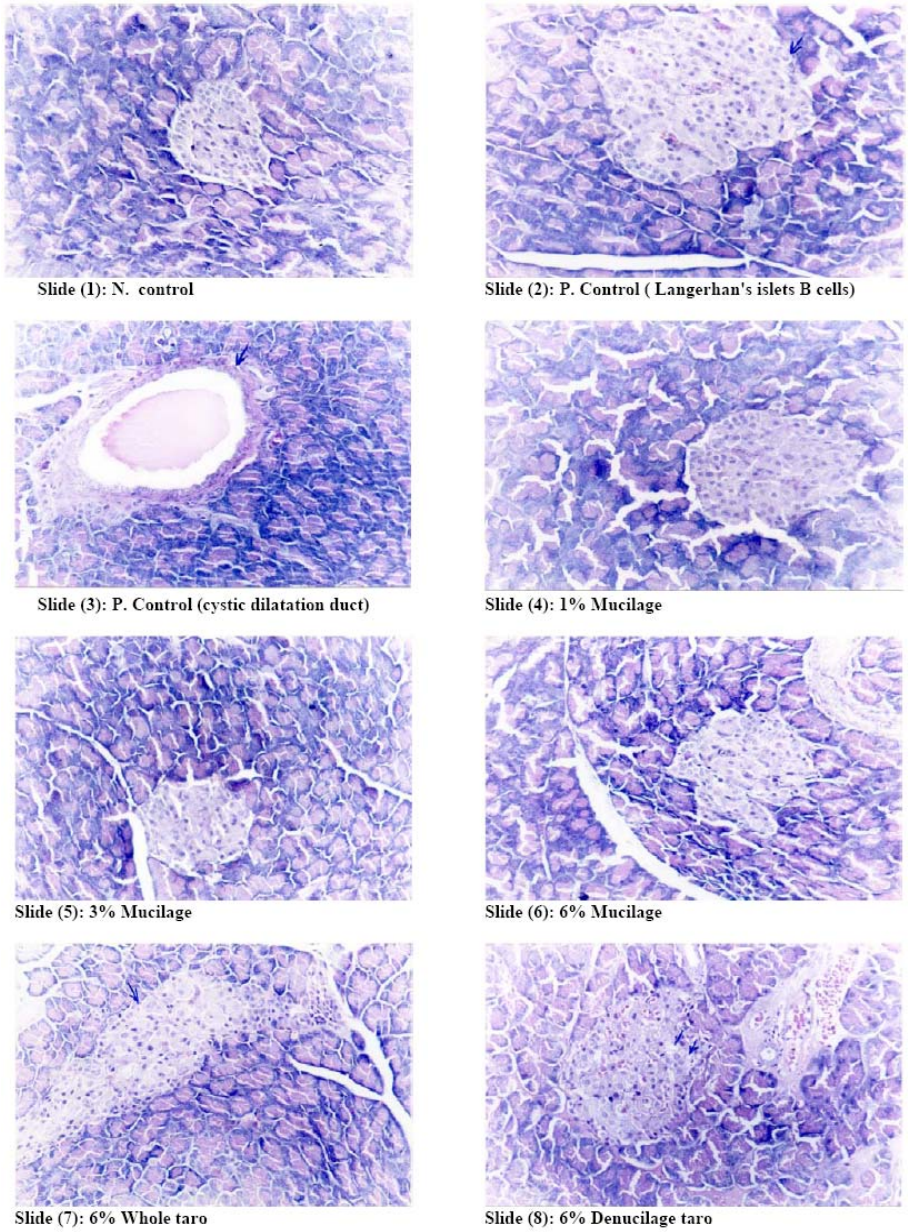

Figure (1): Histopathological changes in pancreas samples of the tested rat groups

REFERENCES

Aller, R.; Antonio de Luis, D.; Izaola, O.; La Calle, F.; del Olmo, L.; Fernandez, L.; Arranz Teresa, J. M. and Hernandez, G. (2004). Effect of soluble fiber intake in lipid and glucose levels in healthy subjects: a randomized clinical trial. Diabetes Research and Clinical Practice, 65: 7–11.

Anderson, J. W. and Tietyen-Clark, J. T. (1986). Dietary fiber: hyperlipidemia, hypertension and coronary artery disease. Am. J. Gastroenterol., 81: 907–919.

Assmann, G. (1979). A fully enzymatic colorimetric determination of HDL-cholesterol in the serum. Internist, 20: 559-565.

Benizri, E.; Nguyena, C.; Piutti, S.; Slezack-Deschaumes, S. and Philippot, P. (2007). Additions of maize root mucilage to soil changed the structure of the bacterial community. Soil Biology & Biochemistry, 39:1230–1233.

Berggren, A. M.; Bjorck, I. M. E.; Nyman, E. M. G. L. and Eggum, B. O. (1993). Short chain fatty acids content and pH in caecum of rats given various sources of carbohydrates. J Sci. Food Agric., 63:397-404.

Bergmeyer, H. U. and Harder, M. (1986). A colorimeteric method of determination of serum glutamic oxaloacetic and glutamic pyruvic transaminase. Clin. Biochem., 24: 28 - 34.

Boban, P. T., Nambisn, B. and Sudhakaran, P. R. (2006). Hypolipidaemic effect of chemically different mucilage in rats: a comparative study. British Journal of Nutrition, 96: 1021-1029.

Bourquin, L. D.; Titgemeyer, E. C.; Garleb, K. A. and Fahey, G. C. (1996). Fermentation of various dietary fiber sources by human fecal bacteria. Nutr. Res., 16:1119- 11131.

Brown, L.; Rosner, B.; Willet, W. and Sacks, F. (1999). Colesterol lowering effects of dietary fiber: a metanalysis. Am. J. Clin. Nutr., 69:30–42.

Burtis, C.A., Ashwood, E.R., (1996). Enzymes, Teitz Fundamentals of Clinical Chemistry, 4th edition.NBSaundersCompany, Philadelphia, USA, pp. 312–335.

Camplell, T. A. (1961). Methodology of protein evaluation. RAG.Nutr.Document R.101 adds. 37, June Melting, New York.

Caraway, W. T. (1955). Determination of uric acid in serum by a carbonate method. American Journal of Clinical Pathology, 25: 840-845.

Cummings, J. H. (1985). Cancer of the large bowel. In: Trowel H, Burkitt D, Heaton K, editors. Dietary fiber, Fiber depleted foods and diseases. London7 Academic Press, pp.161- 189.

Deters, A. M.; Lengsfeld, C. and Hensel, A. (2005). Oligo- and polysaccharides exhibit a structure-dependent bioactivity on human keratinocytes in vitro. Journal of Ethnopharmacology 102:391–399.

El-Etre, A.Y. (2003). Inhibition of aluminum corrosion using *Opuntia* extract. Corrosion Science, 45:2485–2495.

Ellman, G.L.(1959). Tissue sulfhydrl groups. Archieves of Biochem. and Biophys., 82:70–77.

El-Mahdy, A. R. and El-Sebaiy, L. A. (1984). Preliminary studies on the mucilages extracted from okra fruit, Taro Tubers, Jew's Mellow leaves and fenugreek seeds. Food Chem., 14:237-249.

Eskina, N. A. M.; Rajub, J. and Birdb, R. P. (2007). Novel mucilage fraction of *Sinapis alba* L. (mustard) reduces azoxymethane-induced colonic aberrant crypt foci formation in F344 and Zucker obese rats. Phytomedicine 14: 479–485.

Fawcett, J. K. and Scott, J. E.(1960). Enzymatic colorimetric method for determination urea in serum, plasma and urine. J. Clin. Path., 13,156-162.

Fossati, P. and Prencipe, L. (1982). The determination of triglycerdes using enzymatic methods. Clin. Chem., 28: 2077-2081.

Frati-Munari, A., Jim!enez, E., Ariza, C.R., (1990). Hypoglycemic effect of Opuntia ficus indica in noninsulin-dependent diabetes mellitus patients. Phytotherapy research, 40:195–197.

Gabir, M. M.; Hanson, R. L.; Dabelea, D.; Imperator, G.; Roumain, J. and Bennette, P. H. (2000). Plasma glucose and prediction of micro vascular disease and mortality: evaluation of 1997 American

Diabetes Association and WHO criteria for diagnosis of diabetes. Diabetes care, 23:1113- 1118.

Giani, M.; Berto, D.; Zangrando, V.; Castelli, S.; Sist, P. and Urbani, R. (2005). Chemical characterization of different typologies of mucilaginous aggregates in the Northern Adriatic Sea. Science of the Total Environment, 353:232– 246.

Gonda, R; Tomoda, M.; Ohara, N. and Takeda, K. (1993). Arabinogalactan core structure and immunological activity of urokanan C—an acidic polysaccharide from rhizome of Curcuma longa. Biol. Pharm. Bull., 16:235-238.

Grower, J. K.; Yadav, S. and Vats, V. (2002). Medicinal plants of India with anti-diabetic potential. J. Ethnopharmacol, 81:81 -100.

Hegested, D. M.; Mills, R. C.; Elvehijem, C. A. and Hart, F.B. (1941). Choline in the nutrition of check . J.Biol.Chem.,138:459.

Henry, R. J. (1974). Clinical Chemistry, Principles and Technichs, 2 nd Edition, Harper and Raw, p. 525.

Hirose, K.; Endo, K. and Hasegawa, K. (2004). A convenient synthesis of lepidimoide from okra mucilage and its growth-promoting activity in hypocotyls. Carbohydrate polymers, 339:9–19.

Huang, D.; Chen, H.; Hou, W.; Lin, C. and Lin, Y. (2006). Sweet potato (*Ipomoea batatas* [L.] Lam_Tainong57) storage root mucilage with antioxidant activities in vitro. Food Chem., 98:774–781.

Hwang, H. J.; Kim, S. W.; Lim, J. M.; Joo, J. H., Kim, H. O.; Kim, H. M. and Yun, J. W. (2005). Hypoglycemic effect of crude exopolysaccharides produced by a medicinal mushroom *Phellinus baumii* in streptozotocin-induced diabetic rats. Life Sciences 76 : 3069–3080.

Kiho, T., Kochi, M., Usui, S., Hirano, K., Aizawa, K. and Inakuma, T., (2001). Antidiabetic effect of an acidic polysaccharide (TAP) from *Tremella aurantia* and its degradation product (TAP-H). Biological and Pharmaceutical Bulletin 24, 1400–1403.

Kiho, T., Sobue, S. and Ukai, S., (1994). Structural features and hypoglycemic activities of two polysaccharides from a hot-water

extract of Agrocybe cylindracea. Carbohydrate Research 251, 81–87.

Kowluru, R. A. and Chan, P.-S. (2007).Oxidative Stress and Diabetic Retinopathy Experimental Diabetes Research, 1-12.

Kumar, G. S.; Shetty, A. K.; Sambaiah, K. and Salimath P. V. (2005). Antidiabetic property of fenugreek seed mucilage and spent turmeric in streptozotocin-induced diabetic rats. Nutrition Research, 25:1021–1028.

Lane Peter ,W. and A.E.G. Person (1971). Dietary Requirements in the Laboratory: Animal Principles and Practice, Acad. Press , London and New York. p142.

Lee, J. S. (2006). Effect of soy protein and genistein on blood glucose, antioxidant enzyme activities, and lipid profile in streptozotocin-induced diabetic rats. Life Sciences, 79: 1578-1584.

Li, X. M. (2007). Protective effect of Lycium barbarum polysaccharides on streptozotocin-induced oxidative sress in rats. International Journal of Biological Macromolecules, 40 : 461-465.

Liu, C. T.; Wong, P. L.; Lii, C. K.; Hse, H. and Sheen L. Y. (2006). Antidiabetic effect of garlic oil but not diallyl disulfide in rats with streptozotocin-induced diabetes. Food and Chemical Toxicology 44 , 1377–1384.

Lutz, L. A. and W. M. Pardridge (1993). Insulin therapy normalizes glucose transporter mRNA but not immunoreactive transporter protein in streptozotocin diabetic rats. Metabolism, 42 (8): 939-944.

Mansour, H.A., Newairy, A.-S.A., Yousef, M.I., Sheweita, S.A., (2002). Biochemical study on the effects of some Egyptain herbs in alloxan-induced diabetic rats. Toxicology 170,221-228.

Marklund, S. and G. Marklund (1974). Involvement of the superoxide anion radical in the autoxidation of pyrogallol and a convenient assay for superoxide dismutase. Eur. J. Biochem. 47:469-474.

Meltzer, H. M., Folmer, M., Wang, S., Lie, Q., Maage, A. and Mundal, H. H. (1997). Supplementary selenium influences the response to fatty acid induced oxidative stress in humans. Biological Trace Element Research 60:51-67.

Mishra, A.; Yadav, A.; Agarwal, M. and Bajpai , M. (2004). Fenugreek mucilage for solid removal from tannery effluent. Reactive & Functional Polymers, 59: 99–104.

Motawi, M. M. and Haggag, A. A.(1992). Fenugreek mucilage as an adjeunt in pharmaceutical practice. Egypt. Pharm. Bull., 44:304-309.

Nematalla, K. H. M.; Sayed-Ahmed, E. F. and Osman, M. M. (2007). Effects of α-lipoic acid and brewr's yeast on reducing blood sugar in aged diabetic rats. J. Biol. Chem. Environ. Sci., 2:467-488.

Ravi, K., Ramachandran, B., Subramanian, S., (2004). Protective effect of Eugenia jambolana seed kernel on tissue antioxidants in streptozotocin induced diabetic rats. Biological and Pharmaceutical Bulletin 27,1212–1217.

Ripsin, C.; Keenan, J. and Jacobs, D. (1992). Oat products and lipid lowering. JAMA 267: 3317–3325.

Rotruck, J. J., Pope, A. L., Ganther, H. E., Swanson, A. B. (1973). Selenium: biochemical role as a component of glutathione peroxides. Science 179, 588–590.

Sáenz, C.; Sepúlveda, E. and Matsuhiro, B. (2004). *Opuntia* spp mucilage's: a functional component with industrial perspectives. Journal of Arid Environments, 57:275–290.

Saleh, M. A. M.; Mohamed Ebtesam, A. and Doeidar Mona, M. M. (2008). A comparative biological study, related to the therapeutically effects of pan bread provided with some natural foodstuffs utilized, on the experimental rats. J. Agric. Sci. Mansoura Univ., 33:331-343.

SAS, (1987). Statistical Analysis System. Release 6.03. SAS Institute Inc., Carry, NC, USA.

Sauvaire, Y.; Petit, P.; Broca, C.; Manteghetti, M.; Baissac, Y. and Fernandez, A. L. V. J. (1998). 4-Hydroxy iso-leucine, a novel amino acid potentiator of insulin secretion. Diabetes, 47:206-210.

Snedecor, G. W. and Cochran, W. G. (1980)" .Statistical methods". Book, p. 420. 7th Ed. Iowa Stat. Univ. Press, Ames, Iowa, USA.

Temple, R. C.; Clark, P. M. and Hales, C. N. (1992). Measurement of insulin secretion in type 2 diabetes: problems and pitfalls. Diabetic Med., 9:503-512.

Trinder, P. (1969). Determination of glucose in blood using glucose oxidase with an altemative oxygen acceptor. Am. Clin. Biochem., 6:24-27.

Van Horn, L. V., (1996). Lipid metabolism and choices for persons with diabetes. In: Powers, M.A. (Ed.), Handbook of Diabetes Medical Nutrition Therapy. Aspen Publishers Inc., Gaithersburg, MD, pp. 336–359.

Varley, H., Gewenlock, A. and Bell, M. (1980). Practical Clinical Biochemistry. Vol. 1. 5th ed., pp. 741, 897. London: William Heinemen Medical. Books, Ltd.

Vezzosi, D.; Bennet, A.; Fauvel1, J.; Boulanger, C.; Tazi, O.; Louvet, J. and Caron, P. (2003). Insulin levels measured with an insulin-specific assay in patients with fasting hypoglycaemia related to endogenous hyperinsulinism. European Journal of Endocrinology, 149:413–419.

Wallach, J. (1992). Interpretation of Diagnostic Tests. A synopsis of aboratory medicine, 5 th Ed. A little brown hand- book, Boston.

Waston , D. A. (1960). Simple method for the determination of serum cholesterol. Clin. Chem. Acta., 5:589-596.

Wieland, H. and Seidel, D. (1983). A fully enzymatic colorimetric determination of HDL-cholesterol in the serum. J. Nutr., 109: 760 - 766.

Wolf, A.; Manson, J.; and Stamfer, M. (1999). Long term intake of dietary fiber and decreased risk of coronary heart disease among women. JAMA, 281:1998–2004.

Wolver, T. M. S. and Jenkins, D. J. A.(1986.). Effect of dietary fiber and foods on carbohydrate metabolism. In: Spiller GA, editor. CRC handbook of dietary fiber in human nutrition. Florida7 CRC Press Inc, pp. 87-119.

Yanardag, R., Bolkent, S., Tabako˘glu-O˘guz, A.and Ozsoy-Sac¸an, O. (2003). Effects of Petroselinum crispum extract on pancreatic B

cells and blood glucose of streptozotocin-induced diabetic rats. Biological and Pharmeutical Bulletin 26, 1206–1210.

Ylonen, K. Y., Saloranta, C., Kronberg-Kippila, C. and Groop, L. (2003). Associations of dietary fiber With glucose metabolism in nondiabetic relatives of Subjects With Type 2 Diabetes. Diabetes Care, 26 : 1979-1985.

Yoon , B. I. ; Choi, Y. K.; Kim, D . Y.; Hyun, B. H.; Joo, K. H.; Rim, H. J. and Lee, J. H. (2001). Infectivity and pathological changes in murine clonorchiasis: Comparison in immunocompetent and immunodeficient mice. J. Vet. Med. Sci.,63(4): 421-425.

Zimmet, P.; Alberti, K. G. M. M. and Shaw, J. (2001). Global and societal implications of the diabetes epidemic. Nature, 414:782-787.

التأثيرالخافض للموسيلاج المستخلص من القلقاس على الفئران المصابة بمرض السكر

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لوحظ في السنوات الأخيرة إزدياد الاهتمام باستخدام الأغذية كعوامل للمحافظة على الصحة (كما فى الأغذية الوظيفية) وكذلك تقليل أخطار المرض. وعامة فإن الميوسيلاج ، المستخلص من بعض المزورعات، عبارة عن مركب ذو صفات متميزة كمادة مضافة غير محددة الأستخدام فى التصنيع الغذائى فقط ، بل أيضا تمتد إلى الإستخدمات الصحية والصناعية. وقد أوضحت العديد من الدراسات أنه يتكون من بعض المكونات التى تمتلك بعض الصفات العلاجية لفئران التجارب.

ومن خلال وجهة النظر تلك فإن الدراسة الحالية قامت بفصل الميوسيلاج من القلقاس وتجفيفة واستخدامه بتركيزات مختلفة (1، 3، 6%) وذلك بالاضافة الى استخدام القلقاس الكامل او المنزوع منه الميوسيلاج (6%)، لمدة شهرين فى تغذية الفئران التى تم إصابتها بمرض السكر. وتم مقارنة تلك المجموعات من الفئران بمجموعتين أخرتين من الفئران الكونترول ثم تغذيتهما على الوجبة الاساسية ، الاولى وهى الكونترول السالب اى بدون معاملة والثانية الكنترول الموجب التى تم اصابتها بمرض السكر.

وقد أظهرت نتائج الدراسة ان استخدام الميوسيلاج يؤدى إلى تحسين التعامل مع مرض السكر فى الفئران من خلال تنشيط عملية افراز الأنسولين وخفض مستوى الجلوكوز فى سيرم دم الفئران إلى المستوى الذى يماثل الموجود فى الكنترول السالب. كما لوحظ ان تقييم اختبارات الجلسريدات الثلاثية ، والكولسترول الضارة وكذلك عناصر أكسدة الدهون قد إنخفضت إنخفاضا ملحوظا فى المجموعات التى غذيت على الميوسيلاج عن تلك المجموعات الاخرى ، وعلى العكس من المجموعة الكنترول الموجبة. كذلك فقد وجد أن هناك اختلافات معنوية فى وزن الجسم والأعضاء ، خاصة القلب والطحال ، فى الفئران التى غذيت على وجبات الميوسيلاج مقارنة بالمجموعات الأخرى ، مع عدم وجود إختلافات معنوية فى داخل تركيزات الميوسيلاج المستخدمة. وقد أظهرت نتائج الفحص التشريحى للبنكرياس أن مجموعات الميوسيلاج، خاصة (3 ، 6%) تكون أقرب فى التركيب التشريحى لعينة الكنترول السالب حيث لوحظ عدم وجود تغيرات ملموسة مقارنة بمجموعات الفئران الأخرى. وعامة فإن استخدام ميوسيلاج القلقاس فى الوجبات من الممكن ان ينظم ويحسن من وظائف الكبد والكلى ونتائج الفحص التشريحى للبنكرياس خلال فترة حياة الفئران المصابة بمرض السكر.