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The effect of banana (Musaceae) and onion (Allium cepa) on liver functions and oxidative stress of diabetic rats

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Abstract

This study was conducted to investigate the effect of dried green and yellow Banana as well as dried onion and ready-made onion powder at 5 and 10% on liver functions and oxidative stress of diabetic rats. Sixty adult male rats were classified into 10 groups, Group (1) was kept as control negative group (six rats). Other rats (n=54) were injected by single intraperitoneal streptozotocin to induce diabetes then divided into 9 groups: Group (2) six diabetic rats were fed on basal diet (control positive group). Groups (3 to 6), diabetic rats were fed on basal diet supplemented with dried green banana with peels at 5% and 10% and yellow banana fruit with peels at 5% and 10%. Groups (7 to10), diabetic rats were fed on basal diet supplemented with dried onion without the peels at 5% and 10% and ready-made onion powder at 5% and 10%. The study continued for eight weeks. The results revealed that supplementation with either dried green, yellow banana fruit or onion, ready-made onion powder at 5% and 10 % caused a significant decrease ($P<0.05$) in the raised level of serum glucose andliver functions as well as improving the body weight status compared to the positive control group.In addition, dried green or yellow banana was more effective in decreasing the glucose levels and increasing the insulin concentrations than that of onion (dried or ready-made powder).It could be concluded that, green or yellow banana fruit with their peels, dried onion and ready-made onion powder improve the abnormal glucose level,alleviate liver functions and oxidative stress associated with diabetes. So,green or yellow banana fruit with their peels, dried onion and ready-made onion powder might be suitable for trail on diabetic patients.

Key words:green or yellow banana – onion- diabetes- Insulin activity- Liver functions- oxidative stress.

Introduction

Bananas and onions are popular plants in eating for the public.Oxidative stress plays a critical role in aging, obesity, nonalcoholic fatty liver disease, type 2 diabetes mellitus, depression and neuro degeneration ***(Peverill et al., 2014; Chattopadhyay et al., 2015; Czarny et al., 2018; Wadhwa et al., 2019)***. Indeed, many chronic diseases are caused by an increase in intracellular levels of reactive oxygen species (ROS) that causes tissue oxidative damage and induces mitochondrial dysfunction, endoplasmic reticulum stress, and inflammatory state. The maintenance of intracellular redox homeostasis depends on an efficient antioxidant system. Plant extracts have been increasingly reported as available nutritional antioxidants, including flavonoids, phenolic acids and phenolic diterpenes***(Guo, et al., 2020).***

Hyperglycemia and a higher basal metabolic rate are two of the multiple symptoms of diabetes mellitus ***(Bos and Agyemang, 2013).*** Elevated blood glucose causes ROS production and damage to cell membranes ***(Ha and Kim, 1999).*** There is a need to find more effective medications with fewer adverse effects as this condition becomes increasingly common. Despite lowering blood glucose levels, several medications have the potential to cause obesity and hyper and rogenemia ***(Latha et al., 2014).***

By 2000 and 2030, the number of people living in cities in emerging nations is expected to be doubled. According to***Wild et al., (2004),*** the number of adults over 65 years of age has increased, which appears to be the most significant demographic change susceptible to have higher diabetes prevalence worldwide. Diabetic-related deaths account for 86,478 deaths per year in Egypt, where the prevalence of the disease is around 15.56% among individuals aged 20-79. Approximately 2.2 million people in Egypt had prediabetes and 7.5 million people had diabetes, according to ***International Diabetes Federation (2013).*** By 2035, it is anticipated that this figure would soar to 13.1 million. According to estimates, 22% of diabetic patients in Egypt experienced peripheral neuropathy, 5% were legally blind, and 42% had diabetic retinopathy. According to ***Hegazi et al., (2015),*** diabetes is also the primary cause of leg amputation and end-stage renal disease in Egypt.

Traditionally, medicinal plants have been utilized with varying degrees of success to treat serious illnesses like diabetes. Antioxidant effects of some of these plants have been demonstrated, which may lessen the discomforts associated with diabetes ***(Gargouri et al., 2016).*** Due to their inexpensive cost, high nutritional value, and appealing sensory qualities, bananas are a popular food ***(Zandonadi, 2009).*** Green banana pulp is flavorless. It is low in sugar and aromatic chemicals and heavy in starch. Bananas are advised for Diabetic patients due to the high resistant starch content, which prevents lipids and glucose from being absorbed ***(Ramos et al., 2009).***

Nutrient contents in bananas vary, including total soluble solids (17.9%), vitamin C (12.7 mg/100 g), and vitamin A (12.4 mg/100 g). About 6 g of fiber can be found in a medium-sized banana. A medium-sized banana has between 450 and 467 mg of potassium, making bananas another excellent source of minerals ***(Pareek, 2016). Sidhu and Zafar, (2018)*** found phenolic chemicals such as p-coumaric, syringic, vanillic, salicylic, gallic, p-hydroxybenzoic, ferulic, sinapic, and gentisic. According to ***Rai et al., (2009),*** different portions of the plant have distinct pharmacological qualities and can be used to treat diabetes, diarrhea, scabies, and inflammations. A low-fat, low-sodium, and cholesterol-free diet can be achieved by consuming bananas, which are especially beneficial for individuals with kidney and cardiovascular problems, gout, arthritis, or ulcers in the gastrointestinal tract ***(Sumathy et al., 2011).***

This study was conducted to assess the effects of dry green and yellow bananas, dried onions, and ready-made onion powder at 5 and 10%on liver functions and oxidative biomarkers of diabetic rats.

Materials and Methods

The biological experiment and biochemical analysis were conducted at the Graduate lab, Nutrition and Food Science Department, Faculty of Home Economics, Helwan University.

Chemicals: Casein, vitamins, minerals, cellulose and Streptozotocin (STZ) were purchased from El-Gomhoria Company, Cairo, Egypt. **Kits** for blood analysis were purchased from Alkan Company for Biodiagnostic Reagents, Dokki, Cairo, Egypt.**Animals**:Sixty adult Male Sprague-Dawley rats weighing (200+10g) were purchased from the farm of experimental animals in Helwan, Egypt. **Plants:** green and yellow banana and onion were obtained from the Agriculture Research Centre. The ready-made onion was purchased from the local market.

Methods:

Preparation of banana and onion dried:

Banana fruits with peels were washed and the onion without the peels was washed and brushed under distilled water.Then it was boiled in boiling water to decrease the oxidative effect.It was air dried and hand peeled. Banana Fruits were dried using solar energy at National Research Center, Dokki, Giza, then was grinded by an electric Grinder.

Preparation of the basal diet:

The diets were formulated to cover the nutrient requirements of rats following the recommendations of the American Institute of Nutrition (AIN-93M). Ain-93M where diet was formulated for maintenance of adult rodents ***(Reeves, et al., 1993).***

Analytical Methods:

Dried banana or onion seeds were analyzed by standard methods for moisture, protein fat, ash and crude fiber according to the official methods ***(AOAC, 2019).***Total carbohydrate was calculated by difference. Mineral contents were determined according to the method of **(*AOAC, 2019),***using Atomic Absorption Spectrophotometer, Perkin-Elmer Model 2380 manufacture, USA.Total phenolic content (TPC) and total flavonoid content (TFC) of the samples were determined by the method of***(*Prieto et al., 1999; Singleton et al., 1999).***

Induction of Animal Model of Diabetes:

Diabetes was induced by a single intraperitoneal injection of freshly prepared streptozotocin (STZ) (60 mg/kg BW) of rat. Three days later, random blood samples were taken from therats eye, then the level of the blood glucose was assessed.The level ≥250 mg/dl was considered diabetic ***(Sarkar et al., 1996).***

Experimental animal design:

A total of sixty male healthy rats, weighing between (200+10g) were classified into 10 groups as follows: Group (1): The -ve control group (6 rats) were fed on the basal diet. Group (2): (were injected by single intraperitoneal streptozotocin to induce diabetes) The +ve control diabetic rats were fed on the basal diet.Groups (3 and 4):(were injected by single intraperitoneal streptozotocin to induce diabetes) Diabetic groups were fed on the basal diet supplemented with dried green banana at 5 and 10%, respectively. Groups (5 and 6): (were injected by single intraperitoneal streptozotocin to induce diabetes)diabetic groups were fed on the basal diet supplemented with dried yellow banana at 5 and 10%, respectively. Groups (7 and 8): diabetic groups were fed on the basal diet supplemented with

dried onion at 5 and 10%, respectively. Groups (9 and 10): diabetic groups were fed on the basal diet supplemented with dried ready-made dried onion at 5 and 10%, respectively.
At the end of the experimental period (8 weeks), rats were fasted over nightbefore sacrificing, blood samples were collected into a centrifuge tube without any anticoagulant and were centrifuged to obtain serum which was stored at-20°C until used for subsequent analysis.

Biochemical analysis:

Serum Glucose level was determined according to **(*Asatoorand King, 1954)*.Insulin hormone:**Insulin activity was estimated using enzyme linked immunosorbent assay ELISA method as described by ***(Clark and Hales, 1994).*** Serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were measured according to ***Reitman and Frankel (1957)*** and **Friedman and Young, (1997)** for ALP assay. Serum malondialdehyde (MDA) level and catalase (CAT) were determined by the method of ***(Lowry et al., 1951 and Claiborne,1985).***

Statistical Analysis:

The obtained results were analyzed according to SPSS program. ANOVA (Analysis of Variance)test was used to compare results among different groups.All differences were considered significant ($P<0.05$)***(Armitage and Berry, 1987).***

Results

Table (1) showed the proximate composition of dried green and yellow banana including (pulp and peels).It showed that protein and crude fibersare higher in green banana than yellow banana, while moisture, fat, ash, carbohydrates, total sugar and fructose are higher in yellow banana than green banana. Concerning micronutrients; the green banana records higher results in phosphorus, calcium and potassium than yellow banana. The antioxidant constituents in, the green banana records higher results in total phenols and total flavonoids than yellow banana.

The table also showed the macronutrients protein, ash, crude fiber, total sugar and fructose are higher in dried onion than ready-made onion powder, while dried onion records higher results in phosphorus, calcium and potassium than ready-made onion powder. In the antioxidants constituents are higher in the dried onion than the ready-made onion powder.

Table (1)

Chemical composition of dried green and yellow banana, dried onion and ready-made onion powder

Nutrients		Green Banana	Yellow Banana	Dried white Onion	Ready-made Onion powder
MACRONUTRIENTS					
Moisture	g / 100g dried	8.77	10.82	6.91	9.52
Protein		7.25	6.75	10.82	9.60
Fat		5.22	6.28	1.89	0.71
Ash		8.14	9.53	6.83	4.78
Crude fibers		13.21	9.85	9.92	8.62
Carbohydrates		65.55	66.33	70.46	71.55
Total sugar		8.81	37.5	43.4	22.4
Fructose		0.49	9.15	2.98	1.95
MICRONUTRIENTS					
Phosphorus (P)	mg	580.56	276.36	290	195.23
Calcium (Ca)		319.25	218.98	235.25	145.32
Potassium (K)		812.35	679.15	1326.23	986.57
ANTIOXIDANT CONSTITUENTS					
Total phenolic content* (mg GAE/100 g dry matter)		529.78	407.75	412.22	227.65
Total flavonoid content* (mg QE/100 g dry matter		335.25	211.18	223.45	95.65

* GAE: gallic acid equivalent, QE: Quercetin equivalent.

Table (2) shows the initial body weight(IBW)was not significantly different among all groups. The positive control group (diabetic rats) had significant decrease ($P<0.05$) in the final body weight (FBW), body weight gain% (BWG%) and feed efficiency ratio (FER) compared with the -ve control group. The total feed intake was less in the diabetic rats compared with the -ve control group. Supplementation with all different treatment at the different levels significantly increased the FBW, BWG% and FER compared with the +ve control group. Green banana at (10%) caused significant increase ($P<0.05$) for the FBW as compared to the group fed on green banana at (5%), while there were no significant change in the FBW between the groups fed yellow banana at 5% or 10%. There was a significant difference in FBW between the group fed on green or yellow banana at 10%, with no change in BWG% and FER between the same groups.

Regarding onion, there was a significant increase in the FBW at the group fed 10% dried onion compared to the groups 5% dried onion. The same trend was clearly observed at the groups fed on ready-made onion powder, and no change in the FBW between the groups fed dried onion or ready-made onion powder. There were no significant changes in the BWG% or FER between the groups fed either green banana at 5 or 10%, and between the groups fed yellow banana at the same levels. The same trend was observed between the groups fed on dried onion or ready-made onion powder.

Supplementation with the different treatment numerically increased the mean FI for all rats compared to the +Ve control group but still lower when compared to the -ve control group. Dried onion at 10% caused no changes in the FBW, BWG% and FER compared with the group fed on ready-made onion

powder at 10%. The highest increase in the FBW, BWG% and FER was recorded at the group fed on green banana at 10%. In addition, green or yellow banana was more effective in increasing the FBW, BWG% and FER as compared to onion (dried or ready-made powder).

Table (2)

The effect of dried green, yellow banana,dried onion and ready-made onion powder on body weight of diabetic rats

Parameters / Groups	IBW (g)	FBW (g)	BWG%	FI (g/day/rat)	FER
Control(-ve)	201.36±0.48^{a}	260.36±1.98^{a}	29.30±1.02^{a}	20.00	0.049±0.01^{a}
Control (+ve)	202.66±0.42^{a}	188.16±2.63^{h}	7.15±1.31^{f}	15.00	0.016±0.03^{d}
Green Banana (5%)	201.93±0.94^{a}	244.30±1.53^{c}	20.99±0.91^{cd}	16.00	0.044±0.01^{abc}
Green Banana (10%)	201.20±2.29^{a}	251.20±1.51^{b}	24.89±1.10^{b}	17.50	0.048±0.01^{ab}
Yellow Banana (5%)	201.50±2.55^{a}	243.33±0.84^{cd}	20.85±1.93^{cd}	15.50	0.045±0.03^{abc}
Yellow Banana (10%)	199.26±0.64^{a}	244.10±0.34^{c}	22.50±0.24^{bc}	15.80	0.047±0.004^{ab}
Dried onion (5%)	200.70±1.38^{a}	232.66±1.02^{g}	15.96±1.26^{e}	14.00	0.038±0.02^{c}
Dried onion (10%)	200.00±1.08^{a}	238.00±0.81^{ef}	19.01±1.04^{cde}	14.50	0.044±0.02^{abc}
Ready-made onion powder(5%)	199.00±1.16^{a}	234.33±1.24^{fg}	17.77±1.04^{de}	14.38	0.041±0.02^{bc}
Ready-made onion powder(10%)	199.46±2.21^{a}	239.66±0.62^{de}	20.19±1.21^{cd}	14.70	0.046±0.02^{ab}

*Values were expressed as Means ± SE.

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

Table (3) shows the positive control group (diabetic rats) had significant (P<0.05) increase in glucose levels and significant decrease in Insulin concentrations as compared to the -ve control group. Supplementation with all tested materials at 5 and 10% significantly (P<0.05) decreased the mean of glucose and significant increase in the insulin concentrations compared with the +ve control group. Green banana at (10%) caused significant (P<0.05)decrease for serum glucose as compared to the group fed on green banana at (5%)(31.40 VS 23.74%), in addition there was significant decrease in glucose level between the groups fed yellow banana at 5% or 10%(21.25 VS 17.29%). There was a significant difference in serum glucose levels among the groups fed green or yellow banana at the different levels. The glucose level was significantly decreased at the group fed dried onion at 10% compared with the groups fed on dried onion at 5% (16.92 VS 14.36%). The same trend was clearly observed at the groups fed on ready-made onion powder (15.35 VS 10.93%). There were no significant changes in serum glucose between the group fed either dried onion (10%) or ready-made onion powder at 10%.

Green banana at (10%) caused significant (P<0.05)increase for insulin concentration as compared to the group fed on green banana at (5%), however no significant changes in insulin concentration between the groups fed yellow banana at 5% or 10%.A significant difference in insulin concentrations were observed among the groups fed green or yellow banana at the different levels. No significant changes in the insulin concentration at the groups fed either dried onion at 10% or 5%, as well as the groups fed on ready-made onion powder. A significant change in serum insulin between the group fed either dried onion (10%) or ready-made onion powder at 10% was seen in table (3). In addition, dried green or yellow banana was more effective in increasing the insulin concentration compared with onion (dried or ready-made powder). The highest decrease in the glucose levels and insulin concentrations were recorded at the group fed on green banana at 10%.

Table (4) shows the green and yellow bananas as well as dried and ready-made onion powder significantly increased the mean value of serum catalase(CAT) and significantly lowered the mean value of malondahyde(MDA) as compared to the +ve control group (table 4).Green banana at 10% caused a significant increase in serum CAT as compared to the group fed on green banana at 5%. However, there was no change in serum CAT between the groups fed either yellow banana at 5% or 10%.

There was no change in serum CAT between the groups fed on dried banana at 5 and 10%, the same trend was clear between the groups fed on ready-made onion powder at 5 and 10 %.Serum MDA has not changed at the groups fed green banana at 5% and 10%, as well as the groups fed on yellow banana at 5 and 10%.

Table (3)

The effect of dried green, yellow banana, onion and ready-made onion powder on glucose and insulin concentrations of diabetic rats

Parameters / Groups	Glucose (mg/dl)	%of glucose reduction	Insulin (mIU/ml)
Control(-ve)	97.11±1.54^{h}	Zero	19.58±0.84^{a}
Control (+ve)	280.26±1.70^{a}	Zero	5.90±0.12^{g}
Green Banana (5%)	213.70±3.55^{f}	23.74	13.87±0.20^{c}
Green Banana (10%)	192.24±2.25^{g}	31.40	15.80±0.21^{b}
Yellow Banana (5%)	231.80±3.27^{d}	17.29	12.26±0.12^{d}
Yellow Banana (10%)	220.70±0.77^{e}	21.25	12.53±0.13^{d}
Dried onion (5%)	240.00±1.11^{c}	14.36	10.33±0.17^{ef}
Dried onion (10%)	232.83±1.02^{d}	16.92	11.06±0.08^{e}
Ready-made onion powder (5%)	249.60±0.78^{b}	10.93	9.63±0.23^{f}
Ready-made onion powder (10%)	237.23±1.82^{cd}	15.35	9.86±0.31^{f}

*Values were expressed as Means ± SE.

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

Table (4)

The effect of dried green, yellow banana, onion and ready-made onion powder on serum oxidative stress of diabetic rats

Parameters / Groups	CAT U/ML	MDA nmol/ml
Control(-ve)	7.03±0.08^{a}	107.84±3.29^{g}
Control (+ve)	2.93±0.22^{h}	179.33±2.46^{a}
Green Banana (5%)	5.33±0.10^{c}	122.37±1.33^{f}
Green Banana (10%)	6.16±0.08^{b}	118.30±1.52^{f}
Yellow Banana (5%)	4.86±0.13^{de}	134.74±1.07^{e}
Yellow Banana (10%)	5.10±0.04^{cd}	129.89±0.50^{e}
Dried onion (5%)	3.99±0.23^{g}	146.66±0.62^{c}
Dried onion (10%)	4.15±0.07^{fg}	140.29±1.45^{d}
Ready-made onion powder (5%)	4.36±0.02^{fg}	153.00±1.08^{b}
Ready-made onion powder (10%)	4.50±0.07^{ef}	142.67±1.95^{cd}

*Values were expressed as Means ± SE.

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

On the other hand, dried onion at 10% caused a significant decrease in serum mal ondahyde(MDA) as compared to the group fed on dried onion at 5% as well as the groups fed on ready-made onion powder at 5 and 10%.It was obvious that green or yellow banana was more effectively in modulating the oxidative stress by increasing the level of catalase(CAT) and lowering the level of MDA than that of onion supplementation.

Table (5)

The effect of dried green, yellow banana, onion and ready-made onion powder on liver functions of diabetic rats

Parameters / Groups	AST	ALT	ALP
		μ/L	
Control(-ve)	26.16±1.38^{g}	17.37±1.22^{f}	103.41±2.51^{g}
Control (+ve)	88.20±3.14^{a}	66.14±2.05^{a}	151.39±1.88^{a}
Green Banana (5%)	43.76±0.55^{ef}	37.51±0.55^{d}	126.07±0.81^{e}
Green Banana (10%)	41.11±0.50^{f}	32.51±0.74^{e}	121.79±1.31^{f}
Yellow Banana (5%)	48.89±0.61^{d}	40.44±0.78^{d}	134.97±0.83^{bcd}
Yellow Banana (10%)	44.90±0.51^{e}	38.10±1.02^{d}	130.36±1.43^{d}
Dried onion (5%)	53.76±0.63^{bc}	44.77±1.84^{c}	137.07±0.77^{b}
Dried onion (10%)	51.60±0.61^{cd}	44.20±1.51^{c}	134.21±0.69^{bc}
Ready-made onion powder (5%)	56.27±0.71^{b}	50.47±1.02^{b}	130.18±0.70^{d}
Ready-made onion powder (10%)	52.40±0.63^{cd}	45.96±1.09^{c}	131.24±1.78^{cd}

*Values were expressed as Means ± SE.

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

Liver functions are increased due to STZ injection as compared to the -ve control rats as shown at Table (5). Supplementation with the tested materials at 5% and 10% significantly (P<0.05) improved the liver functions (AST, ALT and ALP) of diabetic rats as compared to the +ve control group. There was a significant difference in serum ALT and ALP between the groups fed green banana at 5% and 10% as well as the yellow banana at the same percentage. On the other hand, serum liver functions didn't change due to dried onion supplementation at 5% and 10%, moreover, the same trend was clearly observed at the groups fed ready-made onion powder at the tested levels. It was clear that, banana supplementation (green or yellow) was more effective in lowering the elevated liver functions than dried onion. The most liver functions improvement was observed at the group fed on green banana at 10%.

Discussion

The results showed that induction of streptozotocin resulted to a considerable rise in blood glucose levels. This could be because STZ destroys Langerhans islets β-cells, which leads to an increase in oxidative stress by undermining the intrinsic antioxidant mechanism and generating more free radicals ***(Negm, 2020 and García-Sánchez, 2020).*** Reactive oxygen species can cause oxidative damage, which can lead to uncontrollably high blood sugar levels, among other undesirable outcomes ***(Pitocco et al., 2010).***

Diabetes and its related symptoms, like mood problems, can be effectively managed with a banana starch intervention, according to research by ***Bai et al. (2022).*** Previous investigations on the starch from bananas have demonstrated that unripe banana-enriched starch is useful in mitigating diabetic rats' condition ***(Konda et al., 2020 and Lotfollahi et al., 2020).*** The acquired data support previous research showing that treating diabetic rats with banana starch might greatly improve their health. These findings may suggest that if a person with diabetic problems eat unripe bananas, it could be a useful supply of resistant starch. Green banana reduced glucose intolerance and dyslipidemia, as demonstrated by ***Rosado et al. (2020). Dos Santos Bueno et al. (2018)*** and ***Agustin et al. (2019)***they reported a decrease in glycemia following treatment with resistant starch, which is similar with this findings***(Matsuda et al., 2016).*** A rise in plasma glucose levels may be associated with changes in the insulin response. Insulin resistance and diabetes mellitus, which are linked to cardiovascular illnesses, may result from this situation ***(Arnold et al., 2018).***

Famakin et al. (2016) observed a substantial reduction in glucose levels when compared plantain (Musa paradisiaca) based functional dough meals to metformin medication. The study also examined the nutritional qualities, glycemic index, and antidiabetic characteristics of the plantain. When compared to the control groups of rats, ***Bai et al. (2022)*** observed that the diabetic rats receiving the banana starch (BS) intervention had a substantial 25% reduction in their insulin resistance index.The blood glucose concentration and immobility time scores in rats were correlated with the three-week administration of banana peel flakes ***(Meliala et al., 2020).*** Among healthy people and those with metabolic syndrome who are prediabetic, resistant starch found in banana peel flakes improves insulin resistance and glucose homeostasis, among other positive effects ***(Bodinham et al., 2014).***

Recent research ***(Abouzed et al., 2018 and Lolok et al., 2019)*** have also reported the impact of supplementing with onions in lowered blood glucose levels. The beneficial effect on blood glucose levels may be attributed to phytochemicals like quercetin and allyl-propyl disulfides, which are found in onion peels and bulbs. These phytochemicals may improve insulin sensitivity and promote glucose metabolism in peripheral tissues in diabetic rats by up-regulating the expression of insulin receptors and glucose transporters. Therefore, by altering the expression of insulin receptors and glucose transporters and enhancing glucose metabolism in the peripheral tissues of diabetic rats, phytochemicals found in onions are predicted to increase insulin sensitivity ***(Jung et al., 2011).*** According to ***Ülger and Çakiroglu (2020),*** lyophilized onion powder may act as a preventative measure against developing hyperglycemia.

It is well known that an increase in oxidative stress can be induced by hyperglycemia, resulting in significant decrease in nonenzymatic antioxidant and endogenous antioxidant enzyme activities ***(Li et al., 2015).*** The activities of studied enzymes of the antioxidative defense system such as CAT were significantly reduced while the level of MDA was increased in alloxan-induced diabetic rats***(Bolduc et al., 2019).*** In the STZ –induced or alloxan diabetic rats, weak antioxidant enzymatic activities, elevated lipid peroxidation, and lowered non-enzymatic antioxidant levels were reported ***(Masood et al., 2021andNegm, 2020).*** To protect the body against ROS-mediated oxidative damage, antioxidant enzymes are released including superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), and glutathione reductase (GR) ***(Sacan et al., 2021).*** Excess blood glucose and recurrent non-enzymatic glycation of proteins promote the generation of O_2 and H_2O_2 and this might be the reason behind the reduced activities of CAT ***(Karigidiand Olaiya, 2020).*** The limited activation of

antioxidant enzymes due to the presence of H_2O_2 and other hydrogen radicals was recently reported ***(Bauer, 2019).***

Oxidative stress is the main cause of liver and kidney injury in diabetic rats ***(Admassu et al., 2018).*** MDA is a toxic cytokine harmful to life and health; moreover, it is the final product in the process of peroxidation reactions ***(Majidi et al., 2021).*** In the process of peroxidation, MDA leads to the cross-linking of macromolecular cellular compounds, which further leads to the poisoning of cells, resulting in toxicity ***(Abood et al., 2020).*** Therefore, the level of MDA can be used to determine the extent of cellular peroxidation. Previous publications have reported decreased activities of antioxidant enzymes, including SOD, and CAT, in the pancreases, livers, and kidneys of diabetic mice; these reports are consistent with the present conclusions ***(Zhang et al., 2017).***
Musa paradisiaca paste reduced the level of malondialdehyde, which indicated a decrease of free radicals, showing that the antioxidant effect of banana fruit may be protecting the brain from oxidative damage ***(Fidrianny et al., 2014).***

Masood et al., (2021) showed that onion supplementation also brought significant improvement in antioxidant enzyme activities among the treated diabetic rats. Another benefit that is offered by onion supplementation was the prevention of membrane lipid peroxidation. Previous studies proved that onion possesses strong hypolipidemic properties ***(Ebrahimi-Mameghani et al., 2018).***

Conclusion

The current study suggested that green banana, yellow banana, dried onion and onion powder may have beneficial effects against diabetes by lowering glucose levels and suppressing oxidative stress when given in a certain amount and this holds the hope of a new generation of functional foods.

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تأثير الموز والبصل على وظائف الكبد والإجهاد التأكسدي في الفئران المصابة بمرض السكر

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الملخص العربي

أجريت هذه الدراسة لمعرفة تأثير الموز الأخضر والأصفر المجفف وكذلك البصل المجفف ومسحوق البصل الجاهز بنسبة 5 و10% على وظائف الكبد والإجهاد التأكسدي في الفئران المصابة بمرض السكر. تم تقسيم 60 ذكر فأر بالغ إلى 10 مجاميع، المجموعة (1) وتم الاحتفاظ بها كمجموعة ضابطة سالبة. تم حقن الفئران (العدد = 54) بمادة الستربتوزوتوسين لاحداث مرض السكري ثم تم تقسيمها إلى 9 مجموعات: المجموعة (2)، تم تغذية الفئران المصابة بالسكري على النظام الغذائي الأساسي (مجموعة ضابطة موجبة). المجموعات من (6:3)، تم تغذية الفئران المصابة بداء السكري على نظام غذائي أساسي مدعم بفاكهة الموز الأخضر المجفف مع القشوربنسبة 5% و10% ، الموز الاصفر المجفف مع القشور بنسبة 5% و10% على. المجموعات من (10:7)، تم تغذية الفئران المصابة بداء السكري على النظام الأساسي المدعم بالبصل المجفف بدون القشوربنسبة 5% و10% ومسحوق البصل الجاهز بنسبة 5% و10% .و كانت مدة الدراسة ثمانية أسابيع. أظهرت النتائج أن إضافة فاكهة الموز الأخضر أو الأصفر المجفف أو البصل ومسحوق البصل الجاهز بنسبة 5% و10% أدى إلى انخفاض معنوي ($P<0.05$) في ارتفاع مستوى الجلوكوز في الدم ووظائف الكبد وكذلك تحسين مستوى السكرفي الدم. كما تحسن حالة وزن الجسم والإجهاد التأكسدي مقارنة بالمجموعة الضابطة الموجبة. بالإضافة إلى ذلك، كان الموز الأخضر أو الأصفر المجفف أكثر فعالية في خفض مستويات الجلوكوز وزيادة تركيز الأنسولين من البصل (المسحوق المجفف أو الجاهز). ويمكن الاستنتاج أن ثمار الموز الأخضر أو الأصفر بقشورها والبصل المجفف ومسحوق البصل الجاهز تعمل على تحسين التمثيل الغذائي غير الطبيعي للجلوكوز، وارتفاع نسبة الدهون في الدم، كما يخفف من وظائف الكبد والإجهاد التأكسدي المرتبط بمرض السكري. لذا فإن فاكهة الموز الأخضر أو الأصفر مع قشورها والبصل المجفف ومسحوق البصل الجاهز قد تكون مناسبة لمرضى السكري.

الكلمات المفتاحية: الموز الأخضر أو الأصفر – البصل – مرض السكري – نشاط الأنسولين – وظائف الكبد –الاجهاد التأكسدي.