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Protective Effect of Wheat Germ Powder and Oil on Metabolic Disturbances in Rats

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ABSTRACT

The objective of this work was to study the protective effect of wheat germ powder and oil on high fat and high fructose diet induced metabolic disturbances in rats. Thirty six male rats were distributed into (6) groups (6 rats) as following: Group (1): normal control rats (-ve) fed on basal diet, Group (2): fed on basal diet contained wheat germ powder 20 % , Group (3): fed on basal diet and received wheat germ oil (1.5 ml / kg.bw /day) orally , Group (4): (+ve) control: high fat diet and high fructose drinking (HF and HFr), Group (5): fed on HF and HFr contained wheat germ powder 20 % , Group (6): fed on HF and HFr and received wheat germ oil (1.5 ml / kg.bw /day) orally during the experimental period (6 weeks). Results showed wheat germ is high content of nutrients .The group fed HF and HFr showed significantly higher level of blood glucose, serum TG ,TC, LDL-c , VLDL-c , AST , ALT, ALP , creatinine, uric acid ,TNF α, leptin and resistin and decrease in serum HDL-c , GSH and CAT as compared to (-ve) control . While the groups fed high fat and high fructose diet containing WG and received WGO showed significant decrease in blood glucose, serum lipid profile, liver and kidney functions, TNF-α , leptin and resistin while increasing the (GSH) and (CAT) as compared to (+ve) control. From obtained results it can be recommend that consumption of wheat germ powder and oil may be beneficial for those which suffering from high glucose, triglycerides , total cholesterol diseases and can decrease the inflammatory response.

Keywords: Wheat germ**,** Metabolic disturbances , Lipid profile , α-tocopherol , Free fatty acids

INTRODUCTION

Wheat germ (WG) is a by-product of the flour milling industry . The germ is separated from the bran and starch during the milling process (Jensen *et al.,* 2004 and Lui, 2007). The germ is the most valuable part of the wheat and it represent about 2.5 % from the weight and an important in the food processing of high nutrition value (Zhu *et al.,* 2006). It is high sources of vitamins, minerals, fiber and proteins (Nichelatti and Hidvégi , 2002). WG is rich in tocopherols and B complex vitamins (Piras *et al*., 2009). WG protein contain high average of amino acids, especially the essential amino acids lysine, methionine and threonine (Yiqiang *et al* ., 2001). WG is helps to prevent heart diseases, cancers and diabetes. It is also helps to lower obesity and lateness ageing process (Zhu *et al*., 2006). WG containing as much as 10% oil used in many products (Dunford *et al.,* 2003).

Wheat germ oil (WGO) is extracted from the germ of the wheat kernel. WGO is beneficial source of essential fatty acids , protein, minerals and it is high source of vitamins "A, D , E, and B" (Irmak and Dunford, 2005). WGO is described as a natural antioxidant for its high vitamin E content, which inhibits inflammation (Paranich *et al.,* 2000 and Leenhardt *et al.,* 2008). WGO can lower oxidative stress (Alessandri *et al*., 2006), ameliorate lipid metabolism (Singh *et al*., 2006), decrease blood sugar and cholesterol levels (Ikmak and Dunford, 2005).

Metabolic disturbances is a status of at least three of the cardiovascular risk factors: hyperglycaemia , dyslipidemia , obesity , fat storage and hypertension. It is a case of oxidative stress , insulin resistance and chronic inflammation (Mohamed , 2014).

The aim of the present study was to analyze the wheat germ and research the possible protective effects of wheat germ powder and oil on rats fed on high fat and high fructose diet.

MATERIALS AND METHODS

Materials :

Wheat germ (WG) was obtained from South Cairo and Giza flour Mills and Bakeries Company, Cairo, Egypt.

Wheat germ oil (WGO) was obtained from El-Captain Company (CAP PHARMA), 6th October City, Egypt.

Chemicals: Fructose was purchased from the International Company for Scientific and Medical Supplies, Cairo, Egypt. Casein, cellulose, all vitamins and minerals were obtained from El-Gomhoryia Company for chemicals, El-Mansoura City, Egypt. Kits were obtained from Biodiagnostic Company, Giza, Egypt.

Experimental rats: Thirty six male Sprague-Dawley rats weighing 140±10g, were obtained from Agriculture Research Center, Giza, Egypt.

Methods:

Preparation of wheat germ : The wheat germ was ground into powder then stored in polyethylene bags until used.

Chemical analysis of wheat germ: Moisture, crude protein, crude fibers, crude fat and ash contents were analyzed as described in the A.O.A.C (2000). Total carbohydrates were calculated by the difference as described in FAO,(1982). Minerals content included (Ca, P, K ,Mg , Fe and Zn) were determined according to Chapman and Pratt (1978). Free fatty acids, acid, peroxide and iodine values were analyzed as described in the A.O.A.C (2000). α-tocopherol was quantitatively determined by method based on a gas- liquid chromatographic separation (Slover *et al*., 1969).

Biological assay:

Diets: Basal diet was prepared according to (Reeves *et al.,* 1993). High fat (HF) and high fructose (HFr) diet, component of basal diet containing 20% fat (15% beef tallow + 5% corn oil) combined with fructose added in drinking water at 13% w/v which is similar to concentration of soft drinks (Light *et al*., 2009).

Experimental Design : All animals were kept under standardized conditions and provided free access to basal diet and water for 1week before the beginning of the experiment for adaptation. Ethical guidelines were maintained in animal handling during the study and permission was obtained from the concerned department. After adaptation period the animals were randomly assigned into six groups (6 rats) as following:

Group (1): Normal control group (-ve control) fed on basal diet.

Group (2): received basal diet contained WG 20g /100g/ diet.

Group (3): received basal diet and WGO (1.5) ml / kg.bw /day (1400 mg/kg.bw/day) by oral gavages according to (Karabacak *et al.*, 2011).

Group (4): High fat and High fructose diet group (+ve control). (HF and HFr).

Group (5): HF and HFr diet contained WG 20g /100g/ diet.

Group (6): HF and HFr diet and received WGO (1.5 ml / kg.bw /day) orally.

During the experimental period (6 weeks), feed intake, body weight gain and Feed efficiency ratio (FER) were determined according to Chapman *et al.* (1950).

Biochemical Analysis :

Determination of blood glucose : Blood glucose levels were measured according to Barham and Trinder (1972).

Determination of serum lipid profile : Serum total cholesterol (TC), triacylglycerol (TG), high density lipoprotein cholesterol (HDL-c), Low density lipoprotein cholesterol (LDL-c) and very low density lipoprotein cholesterol (VLDL-c) were determined according to Richmod (1973); Fossati and Principe (1982) ; Friedewald *et al.,* (1972), and Lee and Nieman, (1996), respectively.

Determination of liver and kidny functions : Serum alanine aminotransferase (ALT), aspartate aminotransferase (AST) , alkaline phosphates (ALP) enzymes activity , creatinine and uric acid described by (Reitman and Frankel , 1957 ; Kind and King , 1954 ; Henry , 1974 and Fossati, *et al.,* 1980) , respectively.

Determination of antioxidant parameters: Serum glutathione (GSH) and catalase (CAT) were estimated by the methods of Beutler *et al.,* (1963) and Claiborne (1985).

Determination of serum resistin, tumor necrosis factor alpha (TNF-α) and leptin levels: Serum resistin, TNF-α and leptin were measured according to the methods that had previously described by (Thorell, 1973, Beutler *et al.,* 1985 and Maffei *et al.,* 1995), respectively.

Statistical analysis: Data were statistically analyzed of variance "ANOVA" test at ($P \leq 0.05$) according to Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Chemical composition and minerals content of wheat germ:

Chemical composition and minerals content of wheat germ were illustrated in Table (1). Tabulated data revealed that moisture, crude protein, crude fat, ash , total carbohydrates, and crude fiber were (10.16 , 28.15 ,11.87, 4.50, 45.32 and 14.61 g/100g) respectively. On the other hand results of calcium, phosphorus, potassium, magnesium, iron and zinc were observed in the same table.

Wheat germ recorded the highest values of minerals in potassium, phosphorus and magnesium (981.4 , 898.3 and 310.9 mg/ 100g) followed by calcium and zinc which recorded (83.5 and13.24 mg/ 100g) . While iron recorded the lowest value (6.75 mg/ 100g). Data are in good accordance with Brandolini and Hidalgo, (2012) found that WG included (10% - 15%) lipids , (26% - 35%) proteins , (17%) sugars , (1.5% - 4.5%) fibre and (4%) minerals. The results are similar to that obtained by (Bilgicli *et al* ., 2006 ; Bilgicli and Ibanoglu, 2007 and Sudha *et al*., 2007). While, El-Manfaloty, (2010) stated that mineral composition of WG was (9.07) Fe , (11.24) Mn , (1.59) Cu , (17.38) Zn , (312) Mg , (100) Ca , (70) Na , (440) K , (705) P , (344) S and (300) Se mg/100g .

Table 1. Chemical composition and minerals content of wheat germ (dry weight basis)

Content of nutrients in wheat germ			
(g/100 g)		**(mg/100g)**	
Moisture	10.16	Calcium	83.5
Crude Protein	28.15	Phosphorus	898.3
Crude Fat	11.87	Potassium	981.4
Ash	4.50	Magnesium	310.9
Carbohydrates	45.32	Iron	6.75
Crude Fiber	14.61	Zinc	13.24

Chemical properties of wheat germ oil :

Free fatty acids, acid , peroxide, iodine values and α-tocopherol of WGO were reported in Table (2). Free fatty acids of WGO was (5.13%),which may be due to its increase unsaturated fatty acid content. El-Shami *et al*., (2011) found the free fatty acid value of WGO was in the range of (4.5-5.0 %) . Acid , peroxide and iodine values of WGO were (0.77g/100g), (1.66 meq/kg) and (117.24 g/100g) respectively. Higher unsaturated fatty acid content is considered as an indicator for decrease oxidative stability. These results confirm with Mithat and Hasan (2016) who revealed that peroxide values of samples of WGO were (1.68, 1.45 and 2.73 meq / kg oil). Furthermore El-Shami *et al*., (2011) explained that iodine value was range of (115-120 g/100g). α-tocopherol of WGO was (1720 mg / kg^{-1} .

These data are in accordance with Arshad *et al*., (2008) who found that α-tocopherol of WGO was 1660 mg kg^{-1}. In many studies, α-tocopherol contents were determined as 1300-2700 mg kg^{-1} (Wang and Johnson 2001). Wheat germ is one of the greatest natural sources of α-tocopherol (Dunford 2001). Moreover WGO is a product with a very high nutritional value such as alpha-linolenic acid (ALA) (omega-3 fatty acid), α-tocopherol (vitamin E), and other bioactive compounds, including policosanols and sterols (Tong and Lawrence.,2001.; Eisenmenger and Dunford, 2008; Yuldasheva *et al*., 2010).

Table 2. Chemical properties of wheat germ oil

Variables	Free fatty acids (%)	Acid value (g/100g)	Peroxide value (meq/kg)	Iodine value (g/100g)	α-tocopherol (mg /kg^{-1})
wheat germ oil	5.13	0.77	1.66	117.24	1720

Meq : Milliequivalent

Effect of wheat germ and wheat germ oil on feed intake, body weight gain and feed efficiency ratio in rats fed HF and HFr diet :

Data presented in Table (3) showed that the positive control group (HF and HFr) recorded slightly decrease in FI and increase in BWG and FER as comparable with negative control (-ve). All groups had recorded no significant difference in FI comparable with positive control group, except group fed HF and HFr supplemented with WG had recorded significant increase.

Regarding BWG and FER showed significant reduction in all groups comparable with positive control group. On the other hand all groups showed significantly lower in FI except group fed HF and HFr supplemented with WG had recorded no significant difference ,while recorded significant increase in BWG except groups (2) had recorded no significant difference as compared to negative control (-ve). Furthermore FER showed noticeable increase in the different experimental groups as comparable with negative control (-ve). These results may be due to wheat germ had contained rich amounts in dietary fiber. Also wheat germ has a high content of oil that is rich in essential fatty acids and include vitamins B1, B2, B6, and other biologically active compounds, which improve health status (Yuldasheva *et al.,* 2010). These data are confirmed with the study of (Fouad *et al.* 2014). Additionally Zeinab *et al* .,(2010) who reported that diet supplemented with wheat germ oil improved the food consumption, body weight gain and FER in rats .

Table 3. Nutritional indicators of experimental groups

Parameters Groups	Feed intake g/day/rat	Body weight gain (g)	FER
G1:Negative Control (ve-)	18.14 ± 1.13 [a]	112.14 ± 2.33 [e]	0.147 ± 0.04 [d]
G2: Basal diet + WG	16.39 ± 1.68 [b]	113.23 ± 3.19 [d]	0.164±0.06 [c]
G3: Basal diet + WGO	16.64 ± 1.75 [b]	112.25 ± 2.11 [e]	0.160±0.03 [c]
G4:Positive Control (ve+)	17.16 ± 2.17 [b]	152.18 ± 3.48 [a]	0.211±0.07 [a]
G5: HF and HFr diet + WG	18.56 ± 2.08 [a]	134.45± 3.17 [b]	0.172±0.03 [b]
G6: HF and HFr diet + WGO	17.40 ±2.31 [b]	130.01 ± 3.34 [c]	0.177±0.05[b]

All results are expressed as mean ± SD
Values with the same letters indicate insignificant difference and vice versa.
WG: wheat germ WGO : wheat germ oil FER : Feed efficiency ratio

Effect of wheat germ and wheat germ oil on blood glucose levels in rats fed HF and HFr diet :

Data illustrated in Table (4) indicated that blood glucose levels were significantly higher in positive control group (HF and HFr) as comparable with those in the control rats .The effects of HF and HFr diet blood glucose was quite different in was observed at weeks 6 for all groups . However, the blood glucose levels in groups HF and HFr and treated with WG and WGO were improved to normal group. It could be concluded that feeding on WG and WGO led to significant lower in blood glucose level when comparable with positive control group. The decrease of blood glucose was observed after four weeks of feeding till the end of experimental period, also, WGO led to a more decrease of blood glucose level comparing with the WG especially the end of experimental period .The effect of WG and WGO on blood glucose levels in rats could be attributed to the biological benefits of its constituents. These data are in accordance with Cara *et al*., (2001) demonstrated that WG is a good source of phytosterol mainly β sistosterol and octacosanol which regulates of insulin and inhibiting glucose -6-phosphatase . Also our results showed that wheat germ is a source of dietary fibers. These findings are in agreement with Marangoni and Poli (2008) revealed that higher fiber content lower the glycemic index of foods. Also high fiber intake has been associated to a reduction risk of diabetes (Meyer *et al*., 2000 and Wannamethee *et al* ., 2009). Additionally Fouad *et al* .,(2014) mentioned that diabetic groups which consumption on diets supplemented with WG and chitosan and combination of them showed significantly lower in serum glucose level comparable with (+v) control. Moreover Orabi *et al* .,(2016) who indicated that administration of WGO alone or with sucrose showed significantly lower in blood glucose level compared to control group.

Table 4. Blood glucose levels (mg/ dl) of experimental groups

Parameters Groups	Initial blood glucose (mg/ dl)	Blood glucose after 2 weeks (mg/ dl)	Blood glucose after 4 weeks (mg/ dl)	Final blood glucose after 6 weeks(mg/ dl)
G1:Negative Control (ve-)	103.44±20.11 [a]	99.35 ±10.12 [c]	99.39 ±16.91 [c]	100.07 ±15.84 [c]
G2: Basal diet + WG	100.22 ±18.92 [a]	102.03 ±17.33[c]	97.56 ±14.73 [c]	95.61 ±15.11 [c]
G3: Basal diet + WGO	102.40 ±17.75 [a]	99.53±15.32 [c]	97.83±15.22 [c]	94.51 ±13.43 [c]
G4:Positive Control (ve+)	104.83 ±21.08 [a]	190.30±35.86 [a]	260.15±40.21 [a]	272.87 ±30.12 [a]
G5: HF and HFr diet + WG	102.09±20.85 [a]	150.34±30.24 [b]	159.10±28.47 [b]	137.50 ±25.25 [b]
G6: HF and HFr diet + WGO	103.04±21.85 [a]	147.12±28.09 [b]	140.23±25.56 [b]	133.60 ±20.17 [b]

All results are expressed as mean ± SD
Values with the same letters indicate insignificant difference and vice versa.
WG: wheat germ WGO : wheat germ oil

Effect of wheat germ and wheat germ oil on lipid profile in rats fed HF and HFr diet :

The obtained results in Table (5) illustrated that highly significant elevation in TG, TC, LDL-c and VLDL-c ratio concurrent with highly significant reduction in HDL-c in positive group rats as comparable with (-v) control. Administration of WG and WGO to normal rats induced non-significant changes in all tested lipids parameters compared with negative control group. The groups fed HF and HFr diet and receiving WG and WGO recorded significant improvement in all tested lipid parameters when compared with positive group rats. Our results were in the same trend with Abd El-Hafez.,(2013) who reported that decreased in triglyceride and cholesterol may be attributed to effects of high fiber content and high dose of β-carotene and tocopherols in wheat germ . These results are similar to the study of Saleh , (2016) who indicated that utilization of WGO caused a significant lower of total lipids, T.G, total

cholesterol, LDL-c and VDL-c levels and significant improvement of HDL-c as comparison with (+v) control.

The effects of wheat germ oil may be attributed to blend of its Vitamin E, octacosanol, linoleic and linolenic acids. In addition, wheat germ oil (WGO) has a number of other nutritional and health benefits factors like high content of vitamin E and phytosterol ,which may be the reason of its decrease triglyceride (Jonnala *et al*., 2005 and Alessandri *et al*., 2006).

Table 5. Levels of serum lipid patterns of different experimental groups

Parameters / Groups	Triglycerides (mg/ dl)	Total Cholesterol (mg/ dl)	HDL-c (mg/ dl)	LDL-c (mg/ dl)	VLDL -c (mg/ dl)
G1:Negative Control (ve-)	66.40 ±5.11^{d}	86.40 ±13.89^{d}	50.60 ± 13.21^{a}	22.52 ±5.71^{d}	13.28±2.22^{c}
G2: Basal diet + WG	67. 32 ±6.28^{d}	86.20 ±13.49^{d}	47.15 ± 13.43^{b}	25.59 ±6. 80^{d}	13.46±2.92^{c}
G3: Basal diet + WGO	66.55 ±9.13^{d}	84.63 ±12.15^{d}	47.40 ± 13.51^{b}	23.92 ±5.77^{d}	13. 31 ±3.10^{c}
G4:Positive Control (ve+)	112.80 ±16.07^{a}	152.41 ±24.10^{a}	32.60 ± 8.30^{d}	97.25 ±14. 33^{a}	22.56 ±5.71^{a}
G5: HF and HFr diet + WG	105.20 ±16.30^{b}	109.80 ±20.30^{b}	42.00 ± 12.92^{c}	46.76 ±12.51^{b}	21.04 ±4.55^{a}
G6: HF and HFr diet + WGO	92.20 ±12.10^{c}	97.22 ±14.21^{c}	44.40 ± 13.52^{bc}	34. 38 ±9.64^{c}	18.44 ±3.40^{b}

All results are expressed as mean ± SD
Values with the same letters indicate insignificant difference and vice versa.
WG: wheat germ WGO : wheat germ oil

Effect of wheat germ and wheat germ oil on liver and kidney functions levels in rats fed HF and HFr diet :

Data in Table (6), cleared that elevated significantly in AST, ALT, ALP, creatinine and uric acid in (+v) group as comparable to (-v) control. Addition of WG and WGO lead to decrease of these parameters in these groups. The most decrease was obtained in group (6) followed by group (5) respectively when compared with (+v) control. The results are in agreement with Abd El-Hameed *et al*. (2013) who found that WGO decrease the oxidative stress by change the liver enzymes activity. Furthermore Saleh ,(2016) who reported that WGO had the ability to safeguard the liver from acute CCl4-induced tissue damage. Abdel Fattah *et al*. (2011) stated that, rats feeding WGO recorded significantly lower injury and betterment in liver functions. Our data are also in the same line with Barakat *et al*.,(2011) who indicated that addition of WG to the diet caused betterment in kidney function. These results were in agreement with Megahed (2011) and Abdou *et al* .,(2017) demonstrated that the supplementation of vitamin E and WGO caused an improvement in the levels of creatinine and urea as well as AST and ALT activities.

Table 6. Serum activity of AST , ALT , ALP enzymes and levels of creatinine and uric acid of experimental groups

Parameters	liver functions			kidney functions	
Groups	AST (µ/ml)	ALT (µ/ml)	ALP (µ/ml)	Creatinine (mg/dl)	Uric acid (mg/dl)
G1:Negative Control (ve-)	38. 11 ±6.07^{d}	25. 32 ±4.08^{d}	26.15±5.02^{d}	0. 91 ±0.15^{c}	2. 26 ±0.03^{c}
G2: Basal diet + WG	35. 42 ±5.18^{e}	23. 45 ±4.11^{e}	26.45±5.13^{d}	0. 93 ±0.11^{c}	2. 17 ±0.21^{c}
G3: Basal diet + WGO	34. 27 ±5.21^{e}	23. 15 ±3.12^{e}	24.96±4.55^{d}	0. 92 ±0.15^{c}	2 .13 ±0.25^{c}
G4:Positive Control (ve+)	61. 32 ±9.24^{a}	37. 66 ±6.38^{a}	48.32±7.07^{a}	3. 62 ±0.34^{a}	4. 97 ±0.03^{a}
G5: HF and HFr diet + WG	48. 39 ±7.54^{b}	32. 73 ±5.55^{b}	42.11±6.16^{b}	1. 83 ±0.44^{b}	3 .06±0.59^{b}
G6: HF and HFr diet + WGO	43. 42 ±6.17^{c}	28. 52 ±5.24^{c}	38.75±6.26^{c}	1. 54 ±0.18^{b}	2. 87 ±0.33^{bc}

All results are expressed as mean ± SD
Values with the same letters indicate insignificant difference and vice versa.
WG: wheat germ WGO : wheat germ oil

Effect of wheat germ and wheat germ oil on glutathione, catalase , TNF-α , leptin and resistin, in rats fed HF and HFr diet :

The obtained results in Table (7) indicated that the positive control group (HF and HFr) recorded significantly reduction in the activity of glutathione (GSH) and catalase (CAT) concurrent with significant elevation in TNF-α , leptin and resistin as comparable to (-v) control. The data also demonstrated that GSH and CAT enzymes activity in the groups fed HF and HFr diet and receiving WG and WGO recorded significant increase . Regarding TNF-α , leptin and resistin were tended to match control value when compared with positive group rats. Our results indicated that administration of WG and WGO showed significant higher in glutathione (GSH) and catalase (CAT) enzyme activates and lowered in TNF-α , leptin and resistin.

Table 7. Serum levels of Glutathione, catalase , TNF-α , Leptin and Resistin, of experimental groups

Parameters / Groups	GSH (mg/ dl)	CAT (µ /l)	TNF-α (pg/ml)	Leptin (pg/ml)	Resistin (ng/ml)
G1:Negative Control (ve-)	21.43±3.52^{a}	375.44±45.16^{a}	2.03±0.17^{e}	3.05±0.11^{c}	2.42±0.08^{c}
G2: Basal diet + WG	16.53±2.94^{b}	292.56±25.08^{c}	4.81±0.64^{c}	3.37±0.03^{c}	3.26±0.12^{b}
G3: Basal diet + WGO	17.98±3.49^{b}	331.61±35.61^{b}	3.61±0.45^{d}	3.11±0.09^{c}	3.01±0.17^{b}
G4:Positive Control (ve+)	9.52±1.14^{d}	115.43±19.08^{e}	6.40±0.11^{a}	5.81±0.21^{a}	5.26±0.07^{a}
G5: HF and HFr diet + WG	14.67±2.75^{c}	244.77±22.11^{d}	5.33±0.42^{b}	4.15±0.03^{b}	3.66±0.05^{b}
G6: HF and HFr diet + WGO	15.49±2.45^{c}	265.33±24.17^{c}	5.02 ±0.31^{b}	3.86±0.03^{c}	3.41±0.13^{b}

All results are expressed as mean ± SD
Values with the same letters indicate insignificant difference and vice versa.
WG: wheat germ WGO : wheat germ oil

These results may be due to antioxidant such as vitamin E, total phenols and flavonoid , which protect unsaturated fat in the body from oxidation (Yousef *et al*., 2006 ; Leenhardt *et al*., 2008 ; Katiyar *et al.* 2011 and Zhu *et al.,* 2011). These data are in parallel with those obtained by Ayman *et al*.,(2016) showed that oral supplementation of WGO showed significantly higher the activity of GPx and SOD as compared to the (+v) control. The authors

found that WGO decreased TNF-α level and increased glutathione in the brain and this was lead to the high content of α-tocopherol in the oil (El-Marasy *et al*., 2012). Controlling diabetes and insulin resistance can be achieved via modulation of inflammatory cytokines and adipokines (Zhang and Gao, 2016). Several investigations have shown that high leptin level is associated with increased risk of developing diabetes (Tong *et al.,* 2005).

CONCLUSION

Wheat germ powder and oil can improve the lipid profile, reduce blood glucose level and inflammatory cytokines as well as it can protect the body from the side effects of metabolic disturbances, and recommended research also need to enter wheat germ powder and oil within the food plan and diabetic diet.

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التأثير الوقائى لمسحوق وزيت جنين القمح على الإضطرابات الايضية فى الفئران

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يهدف هذا البحث الى دراسة التأثير الوقائى لكل من مسحوق و زيت جنين القمح على الإضطرابات الايضية فى الفئران المغذاة على حمية عالية الدهون والفركتوز. وقد أجريت الدراسة على ٣٦ من ذكور فئران التجارب قسمت عشوائيا الى ستة مجموعات تحتوى كل منها على (٦) فئران كالاتى : المجموعة (١) تغذت على الوجبة القياسية كمجموعة ضابطة سالبة والمجموعة (٢) تغذت على الوجبة القياسية المضاف لها ٢٠% من مسحوق جنين القمح و المجموعة (٣) تغذت على الوجبة القياسية بالاضافة الى اعطاء الفئران زيت جنين القمح (١.٥ مل /كجم من وزن الجسم) بالانبوبة المعدية والمجموعة (٤) تغذت على الوجبة القياسية المضاف لها (١٥% دهن حيوانى + ٥% زيت ذرة) وفركتوز (١٣% وزن / حجم فى مياه الشرب) كمجموعة ضابطة موجبة و المجموعة (٥) تغذت على الوجبة مرتفعة الدهون والفركتوز مع إضافة ٢٠% من مسحوق جنين القمح والمجموعة (٦) تغذت على الوجبة مرتفعة الدهون والفركتوز مع اعطاء الفئران زيت جنين القمح (١.٥مل/كجم من وزن الجسم) بالانبوبة المعدية لمدة ستة اسابيع . وقد أظهرت النتائج احتواء جنين القمح على نسب عالية من العناصر الغذائية . كما أوضحت النتائج ان المجموعة التى تناولت الحمية عالية الدهون والفركتوز اظهرت ارتفاع فى مستوى السكر والدهون فى الدم و إضطراب فى وظائف الكبد والكلى وزيادة فى نسبة السيتوكينات الالتهابية و انخفاض الليبوبروتينات مرتفعة الكثافة والجلوتاثيون و الكتاليز بالمقارنة بالمجموعة الضابطة السالبة بينما أدى إضافة كل من مسحوق وزيت جنين القمح الى الحمية عالية الدهون والفركتوز الى انخفاض ملحوظ فى مستوى سكر ودهون الدم ومؤشرالاورام و الليبتين و الريسيستين وتحسن فى وظائف الكبد والكلى وارتفاع فى الليبوبروتينات مرتفعة الكثافة والجلوتاثيون و الكتاليز بالمقارنة بالمجموعة الضابطة الموجبة . ومن خلال النتائج التى تم الحصول عليها توصى الدراسة بتناول مسحوق وزيت جنين القمح حيث انه غنى بالعناصر الغذائية كما إنه قد يكون مفيد لأولئك الذين يعانون من إرتفاع الجلوكوز و الدهون الثلاثية و الكولستيرول .

الكلمات المفتاحية : جنين القمح , الاضطرابات الأيضية , دهون الدم , الفا توكوفيرول , الأحماض الدهنية الحرة