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Evaluation of the Efficacy of Corn Silk and Vitamin D on Hyperlipidemia and Obesity in Experimental Rats

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ABSTRACT

Obesity is one of the health problems that have serious consequences, especially as they have been transformed from individual cases into whole societies. This has resulted in an increase in the prevalence of obesity-related diseases. The current study was conducted to evaluate the therapeutic role of the powder and extracts (aqueous and alcoholic) of corn silk, either alone or in addition to vitamin D on high blood lipids and obesity in the experimental rats as well as an assessment of the nutritional value of corn silk. The biological study was carried out on fifty-four male rats, weighing 150 ± 10 g. They were divided into two main groups: the negative control group (6 rats fed on standard diet for the duration of the experiment) and the rest 48 rats were fed on a high fat diet for six weeks to cause obesity. The fat-fed rats were randomly divided into eight groups (6 rats each), one of them served as a positive control group and the other groups were treated by corn silk as follows; two of them were fortified by corn silk powder and corn silk powder with vitamin D. The other five groups were treated by corn silk tea (aqueous extract), ethanol extract, vitamin D, corn silk tea with vitamin D, and ethanolic extract with vitamin D for six weeks. The results revealed significant decreases in the final weight, percentage of body weight gain and body fat, adiposity index, in addition to serum cholesterol, triglycerides, low density lipoproteins, very low density lipoproteins, atherogenic index, malondialdehyde, leptin hormone and homocysteine. On the other hand, the results showed significant increases in the levels of high density lipoproteins and adiponectin. The treated rats showed a significant improvement in liver fat and improved antioxidant enzymes by a significant increase in the total capacity levels of antioxidants and superoxide dismutase compared to positive control group. The study concluded that the best results obtained were for the groups that were treated by the corn silk, either powder or extract, with vitamin D. Therefore, the study recommends by consumption of corn silk extract whether aqueous or alcoholic with vitamin D as a syrup, as well as in fortification of some food products for obese people or those with hyperlipidemia.

Keywords: obesity - hyperlipidemia- corn silk - vitamin D - adiponectin - leptin - homocysteine - antioxidants.

INTRODUCTION

Obesity is one of the most critical problems nowadays and impacts about 300 million people worldwide (Londono-Lemos, 2018). Obesity is an exaggerated fat cumulation in the body, it emanates as a result of increasing energy intake than energy expenditure . It is connected with behavioral and genetic, metabolic components, and the speedy evolution of obesity might reflect other peril laborers like fat storage and metabolism, dietary fat intake, and lifestyle (Power and Schulkin, 2008). High fat diet is an effective cause of oxidative stress through its alteration of oxygen metabolism. The fatty deposits which is a result of high fat diets are susceptible to the risk of oxygen reactions which may override antioxidant system capability of the cells, this causes lipid peroxidation which directly share in aggravation of atherosclerosis (Khan *et al.*, 2006)

Nowadays , it has been directed much attention towards the identification of plants antioxidant that can be used for human consumption .Corn silk was a byproduct of maize, it has been consumed traditionally as a medicine owing to its antioxidant properties, phytochemical ingredients and free radical scavenging activity (Nurhanan and Wan Rosli, 2012 ; Vijitha and Saranya, 2017).Corn silk include several ingredient, inclusive vitamins, protein, carbohydrates, K, Ca , Mg, stigmasterol, sitosterol, saponins , alkaloids, flavonoids, and tannins (Guo *et al.*, 2009). Corn silk extract prevents expression of genes contributory in adipocyte differentiation, fat synthesis and fat cumulation, in addition to enhancement the expression of genes implicated in lipolysis and fat oxidation, moreover, preventing piling up body fat and body weight altitude in experimental animals (Lee *et al.*, 2016). Vitamin D has attracted numerous scientific attention in recent years, especially due to its recently described function in metabolism regulation and cell proliferation. Due to deficiency of vitamin D, the incidence of obesity has risen and has become a public health concern. Previously reports revealed that obesity was linked with vitamin D scarcity, this deficiency can account for the vernacular orientations in the spread of obesity and for solo differences in its onset and intensity. The expansion of obesity metabolic consequences in HFD-induced obesity can be reduced by ameliorative vitamin D (Heaney, 2004 ; Kota *et al.*, 2011 and Verma *et al.,* 2016) Interestingly, in non-diabetic adults who have low vitamin D levels, various markers of insulin resistance were noticed (Gannage-Yared *et al.*,2009). Stein *et al.* (2009) reported an inverse relation between body mass index and vitamin D level; where they showed that each raise in BMI of 1 kg/m2 was associated with a reduction of 1.3 nmol/l in 25-OHvit.D. This can be explained according to Fallahi (2015), the prospective implicit mechanism is that obesity leads to decrease vitamin D bioavailability through several likely mechanisms such as catching vitamin D in fat mass, reduce vitamin D biosynthesis by reduced physical activity and reduced exposure to sunlight and hepatic steatosis and reduced 25-hydroxy vitamin D synthesis in obese individuals. The purpose of this study is to evaluate the extent of using corn silk, either in its powder form or its aqueous and alcoholic extracts, and vitamin D in amelioration of blood lipid profile and antioxidant parameters in obese and hyperlipidemic rats.

MATERIALS AND METHODS

Materials:

Plants: Fresh ears of corn were gained from the farmers in Mit ghamr city, El -Mansoura, Egypt.

Chemicals: The utilized kits in biochemical analysis were gotten from Gama trade Company, Cairo, Egypt. Vitamin D3 (Cholecalciferol), manufactured by Medical Union Pharmaceutical (MUP) was purchased from the Pharmacy.

Animals: Fifty-four normal male albino rats of Sprague Dawley strain, with a weight ranged from 150 to 160g were obtained from the experimental animal house in Food Technology Research Institute, Agric. Res. center, Giza, Egypt.

Methods:

Preparation of corn silk powder and its extracts:

Corn silk (CS) was collected then washed with distilled water and dried for 24 hrs using a hot air oven at 60°C until it turned brown. The dried material was ground by using a grinder, and then stored in a drying cabinet at 4±1°C until used. Corn silk tea extract (CSTE) was prepared separately by putting 72 mg of corn silk powder in boiled water (60 ml) for 15 min as mentioned by Sahib *et al.* (2012). This extract was prepared freshly every day and given three times a day in a dose of 5 ml / rat by using a stomach tube. Corn silk ethanolic extract (CSEE) was prepared as described by Emmanuel *et al.* (2016) and was given orally in a dose of (400 mg/kg b.wt.) according to Bhaigyabati *et al*. (2012) by a stomach tube.

Vitamin D was given orally (by stomach tube) to the obese rats in a dose of 12.5µg (500 IU) /kg daily for 6 weeks (Farhangi *et al*., 2017).

Gross chemical analysis:

Chemical constituents of corn silk: moisture, protein, crude fibers, fat content and ash contents were determined according to the methods described in the (AOAC 2005). Total carbohydrates were calculated by difference.

Phenolic compounds:

Determination of total phenols and total flavonoids were estimated according to Slinkard and Singleton (1977) and Zhishen *et al.* (1999), respectively.

Vitamins and minerals:

Vitamin A, vitamin E and ascorbic acid (vitamin C) were demonstrated as described by Parrish (1977) and Jimano *et al*. (2000) and A.O.A.C. (1975), respectively. Selenium (se) was analyzed by method of Kumpulainen *et al.* (1983). Determination of zinc (Zn), iron (Fe), cupper (cu), magnesium (Mg), and calcium (Ca) were done according to Chapman and Pratt (1961).

Animals and experimental design:

Rats were inhabited in crates under sanitary status and fed on a basic diet, which has been formed as described by NRC (1995), for 3 days for adaptability, thereafter 6 rats remained on the basic diet feeding during the experiment period to represent the negative control. The other rats were fed for 6 weeks on a high fat diet, which consisted of the basic diet plus 200 g of ghee/ Kg diet, which replaced an amount of corn starch, to hatch obesity (Bhatt *et al.*, 2006). The obese groups, with weights ranged from 255 to 260 g, were fed on the fat-rich diet during the period of the experiment and were divided up to eight groups as follows Group 1 (positive control) which received the high fat diet only. The other groups were treated daily as follows: Group 2 treated with 10 % corn silk powder (CSP), group 3 received 5ml/rat (three times a day) Corn silk tea (CST) and group 4 received 400 mg/kg b.wt. corn silk ethanolic extract (CSEE). Group 5 treated with 12.5 µg Vitamin D (V.D) whereas group 6 received a combination of CSP and V.D, group 7 received CST and V.D and group 8 received CSEE and V.D for six weeks. The body weight gain was recorded weekly. Body weight gain percentage (BWG%) was calculated by the following formula:

(Final weight (g) - initial weight(g)/ initial weight(g))×100.

At the end of the experiment, the rats were fasted overnight then , weighed thereafter sacrificed and immediately blood samples were collected from the portal vein, then centrifuged to obtain serum which was stored at -20°C until further biochemical analysis. The body fats were carefully removed and weighed to calculate the adiposity index (Ad.l) by dividing the total weight of mesenteric, visceral, epididymal and retroperitoneal adipose tissues by the body weight and multiplied by 100 i.e. (Ad.l = fat weight/body weight x100) as mentioned by Pichon *et al.* (2006).

Biochemical analysis:

Examination of High density lipoprotein cholesterol (HDL-c), Total cholesterol and Triglycerides (TG), were estimated via utilizing enzymatic colorimetric methods (Kostener, 1977; Abell *et al.,* 1952 and Buccolo and David, 1973, respectively). On the other hand, very low density lipoprotein cholesterol (VLDL-c) and low density lipoprotein cholesterol (LDL-c) were calculated mathematically as follows;

VLDL-c = TG/5 while [LDL-C= Total cholesterol –HDL-C – VLDL-C] (Fruchart,1982).

Atherogenic index (LDL-c /HDL-c) was calculated according to Castelli and levitar (1977). Serum homocysteine levels were estimated using the methods of Frontzen *et al.* (1998).

Leptin hormone was estimated by using enzyme-linked immunosorbent assay (ELISA) according to Xiong *et al.* (2005). Adiponectin was determined by using specific diagnostic kits by using the methods of Yokota *et al.* (2000).

Total antioxidants capacity (TAC) were estimated as described by Cao *et al*.(1993), Lipid peroxidation was assessed by measuring the production of malondialdehyde (MDA) as described by Ohkawa *et al*. (1979), superoxide dismutase (SOD) activity was estimated by the method of (Nishikimi *et al.,* 1972) .

Livers were instantly soaked in 50 to 100 ml of ice cold normal saline solution for the determination of liver total lipids , triglycerides, cholesterol and glycogen according to Folch *et al.* (1957), Scheletter and Nussel (1975), Richmond (1973) , and Rerup and Lundquist (1967), respectively.

Statistical analysis

All values obtained from the study had been submitted for statistical analysis by SPSS computer soft war by analyzed divergence ANOVA and follow up test LSD by SPSS ver.11. according to the method qualified by Abo-Allam (2003).

RESULTS AND DISCUSSION

Nutritional value of corn silk:

Moisture, ash, fat, Protein, carbohydrates, fiber , some minerals, some vitamins and some antioxidant of corn silk (CS) were estimated and recorded in Table (1).

It was noticed that fiber, ash, fat, Protein, and carbohydrates contents were 20.1, 6.13, 1.91, 13.57 and 51.35%, respectively in dried CS. The moisture content was 7.04%.

Data in the same Table illustrated some minerals content of corn silk (CS). The values of selenium (Se), zinc (Zn), iron (Fe), copper (cu), magnesium (Mg), and calcium (Ca) were 2.77 (µg/g), 1.96, 1.86, , 47.3, 0.65 and 8.16 (mg/100 g) respectively. The results revealed that total phenols and flavonoids which play an important role as antioxidants were 6918 and 1537 mg/100g.

The results also showed that CS contained vitamin C (9.72 mg/100g), vitamin E (0.215 mg/100g) and vitamin A (266 UI).

Table 1. Nutritional value of corn silk.

Component	Values (on dry weight basis)
Moisture %	7.04
Carbohydrates%	51.35
Proteins %	13.57
Fats %	1.91
Ash%	6.13
Crude Fiber %	20.1
Total phenols (mg/100g)	6918
Total flavonoids (mg/100g)	1537
Vitamin A (IU)	266
Vitamin C (mg/100g)	9.72
Vitamin E (mg/100g)	0.215
Fe (mg/100g)	1.86
Zn (mg/100g)	1.96
Se (µg/g)	0.215
Cu (mg/100g)	47.3
Ca (mg/100g)	8.16
Mg (mg/100g)	0.65

The proximate composition of corn silk powder was determined previously by Aukkanit *et al*. (2015) who found that carbohydrate, protein, crude fiber, moisture, ash and fat contents were 51.37 ,17.94, 16.11, 9.06, 4.60 and 0.91g/100g, respectively. Nurhanan and Rosli (2014) stated that desiccated ripe corn silk had (3.90, 0.66, 8.95, 5.51, 29.74 & 51.24%) for moisture, lipid, protein, ash, carbohydrate and dietary fiber respectively which are differ to a more extent from our findings, this may be attributed to the differences in the crop varieties or the environmental conditions .

Former study indicated that total flavonoids and total phenolic involved the largest fraction of phytochemicals in CS (Liu *et al.,* 2011). They stated that total phenolic and total flavonoid contents in CS were ranging from 80.8 to 117.1 µg GAE/g and 30.1 to 88.8 µg RE/g respectively ; this variation due to Corn varieties difference (Sarepoua *et* a*l.* ,2013). However, these results were in agreement with that of Haslina *et al.* (2017).

Effect of corn silk powder, its extracts and vitamin D on body weight and fat content of the experimental rats:

From Table 2, it has been observed that administration of corn silk powder (CSP) 10%, corn silk tea (CST), corn silk ethanolic extract (CSEE) ,Vitamin D (VD), CSP plus VD, CST plus VD and CSEE plus VD, for 6 weeks to the high fat diet (HFD) fed-animals significantly lowered the markers of obesity as compared to HFD control group.

Table 2. Effect of corn silk powder, its extracts and vitamin D on body weight and fat content of the experimental rats.

Treatments	Initial body weight (g)	Final weight (g)	Body weight gain %	Fat (g)	Adiposity index %
Negative control	173.14 ±5.42 [b]	206.93±5.62 [e]	20.82±4.30 [b]	4.60±0.06 [i]	2.22±0.05 [f]
Positive control	257.00 ±2.00 [a]	354.33±4.04 [a]	37.87±0.54 [a]	18.24±0.24 [a]	5.15±0.2 [a]
Corn silk powder	258.13 ±4.37 [a]	312.33±2.52 [b]	21.01±1.16 [b]	12.36±0.08 [b]	3.96±0.06 [b]
Corn silk tea	256.60±1.98 [a]	274.61±2.62 [d]	7.02±0.34 [d]	8.11±0.09 [d]	2.95±0.03 [c]
Corn silk extract	255.00±4.00 [a]	273.65±2.63 [d]	7.32±1.07 [d]	7.71±0.26 [e]	2.82±0.12 [d]
Vitamin D	255.33±4.73 [a]	270.33±7.02 [d]	5.87±0.95 [d]	7.13±0.32 [f]	2.64±0.06 [e]
Corn silk powder+ vit. D	254.67 ±3.51 [a]	286.81±2.11 [c]	12.64±2.04 [c]	8.75±0.20 [c]	3.05±0.09 [c]
Corn silk tea+ vit.D	257.15 ±3.75 [a]	274.80±2.24 [d]	6.87±0.78 [d]	5.71±0.14 [g]	2.08±0.04 [g]
Corn silk extract +vit. D	255.08 ±3.91 [a]	272.16±1.99 [d]	6.71±0.86 [d]	5.14±0.095 [h]	1.89±0.02 [h]

Data were expressed as (Means ± SD), values with the same letters in each column are not significant at P < 0.05.

The Findings revealed that the rats fed on the high fat diet had significant ($P < 0.05$) increases in initial body weight (IBW) as compared to negative control group. On the other hand, the finial body weight (FBW) of all the treated groups decreased significantly at ($P<0.05$) in comparing with positive control group. The results also showed that the percentages of body weight gain (BWG%) were (21.01, 7.02, 7.32, 5.87, 12.64, 6.87&6.71) in the groups given CSP 10%, CST, CSEE, VD ,VD plus CSP, VD plus CST, and VD plus CSEE respectively. The results revealed that fat weight and adiposity index of positive control group were significantly increased compared to negative control rats, while the treated groups showed significant decreases in fat weight and adiposity index in comparing with positive control . Corn silk extract group exhibited a weight-reducing effect by decreasing fat accumulation in the body. Min *et al.* (2011) and Lee *et al.* (2011) found that high maysin corn silk extract restrains expression of genes implicated in adipocyte recognition, fat piling up, and fat compilation beside enhances expression of genes embroiled in lipolysis and fat oxidation.

Effect of corn silk powder, its extracts and vitamin D on serum lipid profile in experimental rats

From Table (3) the results exhibited that all the treated rats groups had significant reductions in the levels of serum cholesterol, triglyceride, LDL-$_C$, VDL-$_C$ and cholesterol/HDL-c ratio, while the level of serum HDL-$_C$ elevated significantly as compared to positive control. No significant differences were observed in the determined parameters among the treated groups with CST plus VD and CSEE plus VD compared to negative control.

The reduction in the serum levels of TC, TAG and LDL-C coupled with an increase in HDLC and the improvement from cardiovascular risk was obvious in the rats groups which consumed corn silk (powder or extract or tea). These findings agree with that obtained by Saheed *et al.* (2015) who reported that CS extract had an antilipidemic effect. In the current study, because of the consumption of VD, levels of serum TG, LDL, VLDL and TC were reduced, and the level of HDL improved. VD decreases weight of various adipose tissues. So, it has been observed that VD plays a vital role in the treatment of obesity. This is consistent with what has been studied by Verma *et al*. (2016).

Table 3. Effect of corn silk powder, its extracts and vitamin D on serum lipid profile of normal and obese male rats.

Treatments	TC mg/dl	TG mg/dl	HDL mg/dl	LDL mg/dl	VLDL mg/dl	AI
Negative control	71.47±3.60 e	84.68±3.78 g	40.36±0.78 a	14.18±3.15 f	16.94±0.76 g	0.35±0.081 e
Positive control	216.33±5.51 a	154.33±4.04 a	19.91±1.79 e	165.56±5.62 a	30.87±0.81 a	8.37±0.10 a
Corn silk powder	161.47±2.25 b	145.67±3.06 b	20.80±1.63 e	111.53±3.31 b	29.13±0.61 b	5.39±0.57 b
Corn silk tea	126.60±1.98 c	129.61±7.41 c	27.89±1.88 d	72.79±4.02 c	25.92±1.48 c	2.62±0.27 c
Corn silk extract	72.86±3.08 e	90.60±4.65 efg	38.40±2.24 ab	16.34±5.17 f	18.12±0.93 efg	0.43±0.16 e
Vitamin D	108.33±3.06 d	103.65±2.63 d	31.64±1.19 c	55.96±4.25 d	20.73±0.53 d	1.77±0.18 d
Corn silk powder+vit.D	104.67±3.51 d	97.14±2.62 de	37.27±1.59 b	47.97±4.60 e	19.43±0.52 de	1.29±0.17 d
Corn silk tea+ vit. D	74.48±5.46 e	92.80±2.79 ef	39.48±0.56 ab	16.44±5.65 f	18.56±0.56 ef	0.42±0.14 e
Corn silk extract +vit. D	71.75 ±3.44 e	86.56±3.19 fg	38.86±1.16 ab	15.58±3.46 f	17.31±0.64 fg	0.40±0.09 e

Data were expressed as (Means ± SD),values with the same letters in each column are not significant at P < 0.05.

Effect of corn silk powder, its extracts and vitamin D on glycogen and lipids of liver in experimental rats.

The results recorded in Table (4) stated that glycogen and triglycerides contents in the liver were significantly lower, while the cholesterol and total lipids contents were significantly higher in the positive control group than in the negative control. The treated groups expressed significant amelioration as compared to the high fat group control (Table 4). The best extract in amelioration of liver biomarkers was CSEE +VD followed by CST+ V D. The rats that received the CSEE +VD had liver glycogen, cholesterol, total lipids and triglyceride levels that are similar to that of negative control group. The improvement occurred in the results may be attributed to the corn silk contents of antioxidants agents such as phenolic compound, vitamins and minerals.

Kusunoki *et al.* (2002) studied the connection between liver lipid content, liver glycogen, and insulin resistance in high fat-fed rats. They found that the triglyceride and cholesterol contents in liver were higher in the high-fat-fed rats than in normal rats. On the other hand, they found that their liver glycogen contents were lower than in normal rats. There was a reverse relationship between liver triglyceride content and liver glycogen content, this relationship might be due to insulin resistance in high-fat fed rats. One study suggested that fatty diet was the major reason of hepatocellular necrosis forming on liver as a result of free radicals and oxidative damage which led to inflammation and fibrosis outcomes (Altunkaynak , 2005) , this suggestions emphasizes the results obtained in this study.

Table 4. Effect of corn silk powder, its extracts and vitamin D on glycogen and lipids of liver in experimental rats.

Treatments	Glycogen (mg/100g)	Cholesterol (mg/100g)	Total lipid (mg/100g)	Triglycerides (pg/g)
Negative control	7.95±0.24 a	4.53±0.38 f	40.15±0.23 f	3.62±0.19 a
Positive control	3.52±0.43 c	8.66±0.30 a	58.27±0.46 a	2.11±0.12 e
Corn silk powder	5.66±0.70 b	6.73±0.38 b	53.21±2.67 b	2.37±0.18 e
Corn silk tea	5.40±0.70 b	6.35±0.30 b	51.83±2.02 bc	2.66±0.16 d
Corn silk extract	5.02±1.05 b	5.50±0.38 cd	46.21±2.31 d	2.81±0.20 d
Vitamin D	5.58±0.58 b	5.74±0.26 c	48.56±2.33 cd	2.95±0.07 cd
Corn silk powder + vit.D	5.50±0.94 b	5.25±0.19 cde	42.58±2.57 ef	3.24±0.16 bc
Corn silk tea+ vit. D	6.03±0.07 b	5.00±0.11 def	46.03±2.91 de	3.49±0.30 ab
Corn silk extract +vit. D	7.39±0.52 a	4.85±0.24 ef	39.62±1.2 f	3.66±0.29 a

Data were expressed as (Means ± SD),values with the same letters in each column are not significant at P < 0.05.

Antioxidant activity of corn silk in vivo.

The results in Table (5) showed that the positive control group rats, which fed on high fat diet, had significant decreases in total antioxidant capacity (TAC) and superoxide dismutase (SOD) levels and a significant increase in malondialdehyde (MDA) level in comparing with negative control group. On the other hand, all the treated groups showed significant increases in serum levels of TAC and SOD and decrease in MDA as compared to the positive control group. From these results, it was observed that the antioxidant biomarkers in group which treated with CSEE+ VD group was similar to that of the negative control group to a more extent .

Table 5. Effect of corn silk powder, its extracts and vitamin D on malondialdehyde (MDA), total antioxidant capacity (TAC) and superoxide dismutase (SOD) in the experimental rats.

Treatments	MAD µmol/l	TAC mmol/l	SOD U/ml
Negative control	1.37±0.070 f	3.11±0.100 b	29.71±0.354 a
Positive control	3.80±0.100 a	1.19±0.015 f	19.02±0.030 f
Corn silk powder	2.47±0.272 c	2.03±0.064 de	23.35±0.306 e
Corn silk tea	2.07±0.055 d	1.87±0.133 e	22.63±0.136 e
Corn silk extract	2.17±0.151 d	2.92±0.068 b	28.33±1.528 b
Vitamin D	3.07±0.070 b	2.16±0.157 d	24.73±0.346 d
Corn silk powder+ vit. D	1.78±0.210 e	2.59±0.066 c	27.39±0.271 c
Corn silk tea+ vit. D	1.65±0.244 ef	2.56±0.092 c	25.53±0.284 d
Corn silk extract +vit. D	1.29±0.131 f	3.43±0.286 a	28.77±0.215 ab

Data were expressed as (Means ± SD), values with the same letters in each column are not significant at P < 0.05.

These results were attributed to the nutritional compositions and the antioxidant ability of the corn silk (CS) due its content from antioxidant substances such as phenols, vitamins (A, C, E) and minerals (Zn, Cu, Se). Ren *et al.* (2013) found that corn silk contains many phenols such as flavones glycosides, which have achieved high antioxidant activity in a lecithin liposome system, beside a potent scavenging activity against radicals like superoxide, hydroxyl radicals and 1,1-diphenyl-2-picrylhydrazyl (DPPH).

Effect of corn silk powder, its extracts and vitamin D on leptin, adiponectin hormones and homocysteine in the experimental rats.

Table (6) revealed that the positive group had significant increases ($p< 0.05$) in the values of serum leptin hormone and homocysteine but a significant decrease in adiponectin in comparing with negative control at $p< 0.05$. All the treated groups showed improvement in leptin hormone, homocysteine and adiponectin levels where significant decreases in leptin and homocystein and a significant increase in adiponectin were observed in comparing with positive control. Rats treated with CSEE+VD showed non-significant differences in the values of serum leptin hormone, homocysteine and adiponectin as compared to negative control. This means that the ethanolic extract of corn silk was the best treatment for treatment of obesity and its complications.

An augmentation of adipose tissue is related to an elevated level of leptin there for, the level of leptin decreased with the weight loss (Friedman and Halaas ,1998). In addition, Menendez *et al.* (2011) proved that 1,25 (OH)2D (active form of vit.D) acts as a potent inhibitor of leptin secretion in a culture of human adipocytes.

Fonseca *et al.* (2000) confirmed that experimental obesity produced by high fat and high sucrose feeding resulted in almost 50% rising of plasma homocysteine in rats.

Table 6. Effect of corn silk powder, its extracts and vitamin D on Leptin, Adiponectin hormones and Homocysteine in the experimental rats.

Treatments	Leptin ng/ml	Adiponectin ng/ml	Homocysteine (µg /ml)
Negative control	2.89±0.06 ^{g}	8.85±0.33 ^{a}	8.20±0.17 ^{g}
Positive control	6.12±0.10 ^{a}	4.66±0.57 ^{f}	26.32±0.25 ^{a}
Corn silk powder	4.21±0.06 ^{d}	6.34±0.56 ^{de}	13.23±0.54 ^{b}
Corn silk tea	4.87±0.15 ^{b}	5.82±0.14 ^{e}	11.29±0.17 ^{c}
Corn silk extract	4.52±0.05 ^{c}	6.67±0.40 ^{cd}	10.28±0.11 ^{d}
Vitamin D	4.27±0.08 ^{d}	6.90±0.1 ^{cd}	8.62±0.24 ^{f}
Corn silk powder+ vit. D	3.97±0.03 ^{e}	7.04±0.08 ^{c}	9.25±0.09 ^{e}
Corn silk tea+ vit. D	3.48±0.04 ^{f}	7.93±0.24 ^{b}	9.08±0.05 ^{e}
Corn silk extract +vit.D	2.90±0.2 ^{g}	8.81±0.33 ^{a}	8.33±0.07 ^{fg}

Data were expressed as (Means ± SD),values with the same letters in each column are not significant at P < 0.05.

Obesity leads to hyperleptinemia, which may affect the pathogenesis of obesity-related complications. Leptin resistance, which is the end of dysregulation of leptin action, is related to processes that produce diabetes and other associated diseases in humans, like impaired insulin secretion and reduced whole-body glucose profiteering, lipotoxicity, fat deposition, mutate hepatic metabolism (Schmidt *et al.,* 2006; Ahmed, 2012).

In conclusion, the powder or extracts of corn silk as a tea or as an ethanolic extract and vitamin D whether taken individually or mixed with vitamin D, caused a weight reduction in the experimental rats and improved the levels of both serum and liver lipid profile of the rats. So the current study recommends by using the corn silk, which is a waste product of maize, in producing products or extracts which could be tried on obese, hyperlipidemic and diabetic patients.

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تقييم فاعلية شوشة الذرة وفيتامين (د) على ارتفاع دهون الدم والسمنة لدى فئران التجارب

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السمنة من المشاكل الصحية التي تحمل تبعات خطيرة وخصوصاً أنها تحولت من مجرد حالات فردية إلى ظاهرة تعاني منها مجتمعات بأكملها، مما نتج عنه زيادة نسبة انتشار الأمراض الناتجة عن السمنة وقد أجريت الدراسة الحالية لتقييم الدور العلاجي لمسحوق أو مستخلص (مائي أو كحولي) لشوشة الذرة سواء بمفردها أو بالإضافة الى فيتامين (د)على ارتفاع دهون الدم والسمنة لدى فئران التجارب وكذلك تقييم القيمة الغذائية لشوشة الذرة . وقد أجريت الدراسة البيولوجية على أربعة وخمسين من ذكور فئران التجارب ،التي تزن (١٥٠±١٠) جم قسمت الى مجموعتين رئيسيتين هما المجموعة الضابطة السليمة (٦ فئران تم تغذيتهم على الغذاء القياسي طول مدة التجربة) و المجموعة المصابة بالسمنة وهي عبارة عن ٤٨ فأر تم تغذيتهم على وجبة عالية الدهون لمدة ستة أسابيع لإحداث السمنة. وقد تم تقسيم الفئران المصابة بالسمنة بشكل عشوائي إلى ثمانية مجموعات (٦ فئران لكل منها) إحداها مجموعة ضابطة موجبة والمجموعات الأخرى تناولت وجبة عالية الدهون إثنين منها تم تدعيمهم بمسحوق شوشة الذرة ، ومسحوق شوشة الذرة مع فيتامين د. أما المجموعات الخمسة المتبقية تم معاملاتها بواسطة شاي شوشة الذرة (مستخلص مائي) ، مستخلص الإيثانول ، فيتامين د ، شاي شوشة الذرة مع فيتامين د ، والمستخلص الإيثانولي مع فيتامين د لمدة ستة أسابيع. اظهرت النتائج وجود نقص معنوي في الوزن النهائي، والنسبة المئوية للزيادة في الوزن ودهون الجسم ، مؤشر الدهون بالجسم adiposity index ، والكوليسترول في الدم ، الدهون الثلاثية و الليبوبروتينات منخفضة الكثافة و الليبوبروتينات منخفضة الكثافة جدا ومؤشر تصلب الشرايين والمالونداياالدهيد وهرمون اللبتين و الهيموسستين ، من ناحية أخرى أظهرت النتائج زيادة كبيرة في مستوى الليبوبروتينات عالية الكثافة. كذلك أظهرت مجموعات الفئران المعالجة تحسنا معنويا ملحوظا في دهون الكبد وتحسن للإنزيمات المضادة للأكسدة وذلك بالزيادة المعنوية في مستويات السعة الكلية لمضادات الاكسدة وإنزيم سوبر أكسيد ديسميوتاز وأيضا زيادة الأديبونيكتين مقارنة بالمجموعة الضابطة الموجبة . وقد خلصت الدراسة إلى أن افضل النتائج المتحصل عليها كانت للمجموعات التي تم الدمج فيها بين شوشة الذرة سواء مسحوق او مستخلص مع فيتامين (د). ولذا توصي الدراسة باستهلاك مستخلص شوشة الذرة سواء المائي أو الكحولي مع فيتامين د على صورة شراب أو عن طريق استخدامها في تدعيم بعض المنتجات الغذائية للأشخاص المصابين بالسمنة أو بارتفاع مستوى دهون الدم .

الكلمات المفتاحية: السمنة – ارتفاع دهون الدم - شوشة الذرة – فيتامين د -اديبونيكتين - اللبتين - الهيموسستين – مضادات الأكسدة.