Effect of watermelon rind powder on lipid profile in obese

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Abstract:

In addition to having various health advantages, watermelons are a good basis of essential nutrients for human consumption. So, the purpose of this research was to examine the impact of watermelon rind powder on the blood lipid profile of male albino rats (Sprague-Dawley strain), weighing about 200–250 g, which were separated arbitrarily into two main groups as follows: The first main group -ve control = 6 rats) was given a basic diet. The second main group (24 rats) was fed a high-fat diet (10% sheep fat) for one month to induce obesity and hypercholesterolemia. Six rats were separated and fed on a high-fat diet only as a control (positive group + ve), then the remaining 18 rats were separated into 3 subgroups (6 rats per group). These subgroups 1, 2, and 3 were fed on a basal diet mixed with watermelon rind powder at 5%, 10%, and 15%, respectively. All rats were killed after 8 weeks of experimentation in order to get their blood. LDL, HDL, VLDL, TG, ALT, AST, TC, and HB were determined. Results: Hypercholesterolemia rats fed on a basal diet mixed with watermelon rind powder showed significantly ($P<0.05$) decreasing liver function enzymes, VLDL, LDL, TC, TG, and VLDL, with significantly ($P<0.05$) increasing hemoglobin and HDL levels when contrasted with the control groups. Conclusion: Feeding on a basal diet mixed with watermelon rind powder could be utilized as a suitable therapy for obese and hypercholesterolemic patients.

Keywords: watermelon rind, microbiome, obesity, rats, liver functions, lipid

تأثير مسحوق قشر البطيخ على ميكروبيوم الأمعاء في الفئران البدينة

المستخلص :

البطيخ هو مصدر جيد للمكونات الغذائية المهمة للاستهلاك البشري وله العديد من الفوائد الطبية. لذا فإن هذه الدراسة تهدف إلى التحقيق في تأثير مسحوق قشرة البطيخ على دهون الدم من الفئران ألبينو الذكور، التي تزن حوالي (٢٠٠- ٢٥٠ جم) تم تقسيمها بشكل عشوائي إلى مجموعتين رئيسيتين على النحو التالي: المجموعة الرئيسية الأولى السلبى (تحكم = ٦ فئران) تم تغذيتها على النظام الغذائي الأساسي. تم تغذية المجموعة الرئيسية الثانية (٢٤ فئران) على نظام غذائي مرتفع – الدهون (١٠ ٪ من دهون الضان لمدة شهر لاحداث السمنة وارتفاع كوليسترول الدم.) ثم تم فصل ٦ فئران من هذه المجموعة وتغذيتها على نظام غذائي عالي الدهون كمجموعة إيجابية للسيطرة ثم تم تقسيم الباقي إلى ٣ مجموعات فرعية (٦ فئران في كل مجموعة). تم تغذية المجموعات الفرعية ١ و٢ و٣ على النظام الغذائي الأساسي المخلوط بمسحوق قشرة البطيخ ٥ ٪ و١٠٪ و١٥ ٪ ، على التوالي.. في نهاية الفترة التجريبية (٨ أسابيع) ، تم ذبح الفئران من أجل جمع الدم .و تم قياس الدهون الثلاثية ,الكوليسترول الكلي , البروتين الدهني منخفض الكثافة , البروتين الدهني عالي الكثافة , الهيموجلوبين ,وظائف الكبد وقد اوضحت النتائج انخفاض في إنزيمات وظائف الكبد ومستوى دهون الدم بشكل ملحوظ P) (≤ 0.05،خاصة كوليسترول البروتين الدهني منخفض الكثافة للغاية.، البروتين الدهني منخفض الكثافة ، الكوليسترول الكلي , دهون الثلاثية , كوليسترول البروتين الدهني منخفض الكثافة للغاية و مؤشر تصلب الشرايين ومستويات كبيرة ($P \leq 0.05$) مع زيادة نسبة الهيموجلوبين و البروتين الدهني عالى الكثافة مقارنة مع مجموعة التحكم. يمكن اقتراح أن اتباع نظام غذائي أساسي ممزوج بمسحوق قشرة البطيخ يمكن استخدامه كعلاج مناسب للمرضى الذين يعانون من السمنة و زيادة دهون الدم.

الكلمات الدالة :قشر البطيخ , السمنة , الفئران , وظائف الكبد , دهون الدم .

INTRODUCTION

The substantial quantities of solid waste that are produced during the production, manufacturing, and ingestion of fruit and vegetables are identified as "agro waste." Along with the loss of important biomass and nutrients, these wastes may lead to disposal problems and problems with the environment. Agro-waste has the potential to be transformed into expensive products or even used as raw material by other organizations. A promising area of research is the use of vegetable and fruit processing wastes as a source of beneficial chemicals. **(Schieber, A., et al., 2001).** Additionally, strict restrictions locally as well as globally have made waste management necessary. The food operations will confront several problems, including how to utilize byproducts, reduce waste from processing activities, and handle and dispose of waste while maintaining sustainable production. Because agro-waste is capable of being used as a resource to create usable products, bioconversion of these materials is gaining more attention. **(Martin, A. *et al*.,1998)** The fruit's rind, peel, and seeds are all edible and have nutritional value. Though normally discarded, the rind is edible and occasionally consumed, despite typically being discarded. According to **(Jayaprakasha et al., 2001), t**he rind, peel, and seed of some fruits contain more essential vitamins, fiber, minerals, and other nutrients than the pulp of the fruit. The part of the watermelon that is most often eaten is its pink or yellow flesh. However, there are alternative ways to consume watermelons, including fried to perfection watermelon, watermelon-flavored bars, and watermelon lemonade **(Wind, 2008).**

Nutrient Content of the Fruit Watermelon and Watermelon Skin:

Two cups of diced watermelon, or 280g, constitute one serving and provide about 80 kcal, 30% of the recommended daily intake of cardiovascular disease (DV) of vitamin A, 25% of the cardiovascular disease of vitamin C, and 8% of the cardiovascular disease (DV) of potassium **Food and Drug Administration, (2006).** Fresh watermelon skin has the following proximal compositions: 92% hydration, 15g/kg protein, 55g/kg total carbs, 30g/kg total fiber, and 15g/kg ash; fat content is negligible. (**Tarazona-Diaz and Aguayo, E., 2013).** In comparison to the flesh, the skin of watermelon contains more than twice as much protein.

eight times as much full fiber and nearly four times as much ash, all of which suggest a higher mineral value. In comparison to the flesh, the rind of watermelon contains more than twice as much protein, eight times as much overall fiber, and nearly four times as much ash, all of which suggest a higher mineral value. In particular, the potassium content of the rind is high—more than three times that of bananas (**Tarazona-Diaz and Aguayo, E., 2013**). Giving l-citrulline might enhance the bioavailability of l-arginine and be better than l-arginine on its own. **(Moinard C,** ***et al.*****, 2008), and Figueroa A,** ***et al.*****, 2017)** Contrary to l-citrulline, dietary l-arginine undergoes partial metabolization via the enzyme arginase in the liver and gastrointestinal tract to l-ornithine besides urea, resulting in inferior plasma l-arginine focuses more than dietary l-citrulline, which does not undergo intestinal or first-pass liver processes. (Citrulus lantus) has been used to cure a variety of diseases and ailments, such as overweight, diabetes, ulcers, and several types of cancer. It has been demonstrated that eating watermelon as a functional food helps people manage their weight. **(Manivannan A.,** ***et al.*****, 2020)** indicated that among obese middle-aged people with hypertension, watermelon consumption improved a healthier ankle and enhanced vascular function. brachial and carotid wave reflections. In a manner comparable to how eating watermelon causes satiety, it also causes a decrease in the mass of the body (BMI) and the ratio of waist to hip in obese people. Compared to traditional refined carbohydrate snacks, watermelon can successfully suppress the appetite and help with weight management, according to **Lum** ***et al. (2019).*** According to **Hong** ***et al. (2018)***, eating watermelon has been associated with better blood lipid profiles in both people and animals due Watermelon skin has over twice as much protein, eight periods as much full whole fiber, and nearly four times as much as compared to the flesh, indicating a higher mineral amount. In particular, the rind contains as much potassium as bananas do—more than three times as much **(Tarazona-Diaz** ***and*** **and Aguayo, E., 2013). (Saikia, S., and Mahanta, C.L**.,**2016)** previously isolated and analyzed fiber from watermelon rind. They discovered that 100g dried samples of rind contain 47.5g of fiber, of which 32.5g are unsolvable and 15g are solvable. They discovered that fiber made from watermelon skin has a greater capacity for retaining water, oil, and bloating than cellulose-based fiber.

Understanding how fiber obtained from watermelon rind will act as a cutting-edge food arrangement and considering its possible applications Cutting-edge novel food crops depend on knowing the fiber's hydration characteristics. Increasing water holding capacity (WHC) can lower the absorption of food through the gut, resulting in an increase in fullness and a contribution to fecal size. Similar to how high oil holding capacity (OHC) determination leads to decreased fat absorption and elevated fat excretion in the gut, which may help lower blood cholesterol and prevent the buildup of cholesterol in the liver and arteries (**Saikia, S., and Mahanta, C.L., 2016).**

Citrulline, an amino acid that is not essential and that, when eaten, transforms into L-arginine, can be found in all parts of the watermelon, involving the rind, flesh, and seeds. 17 An amino acid is a member of the compound citrulline. The original watermelon used to extract citrulline was called citrullus, a Latin word invented by Koga and Odake in 1914, from which its name derives. Wada obtained his final identity in 1930. It is an essential phase in the urea cycle, which is the way mammals release ammonia. Humans need citrulline for the formation of NO in their system, and it can also have antioxidant and vasodilator properties. The amount of citrulline in dry weight (dwt) varied from 3.9 to near 28.5 mg/g. On a thirsty weight basis, the peel contained 24.7 mg/g dwt more citrulline than the flesh had (16.7 mg/g dwt). The findings show that watermelon rind, an overlooked agricultural waste, provides an organic option for obtaining citrullin. **Rahman, B. (2013**) addition to By **FAO (2016),** watermelon (Citrullus lanatus) production has been estimated to amount to over 117 million tonnes worldwide, which makes it a crop of significant economic value. The rind and skin of the watermelon are normally removed before eating, leaving the low-calorie and very nutritious flesh. The rind and peel of fresh-cut watermelons are healthy byproducts, though they aren't typically eaten. They may be put into utilize in the production of dietary fiber and nutrient-dense food supplements. According to a study, this incredibly healthy fruit may help treat metabolic disorders including diabetes and atherosclerosis as well as reduce blood pressure **(Massa, *et al*., 2016)** , **Poduri, *et al*.,(2012), and Hong, *et al*., (2015).**

<u>Aim of study: </u>this study aimed to estimate the

1. Impact of watermelon rind powder on obesity
2. Impact of watermelon rind powder on blood lipids

MATERIALS AND METHODS:

Animals for the experiments came from the Agricultural Research Center in Dokki, which is located in Giza, Egypt.

The nutritional needs outlined by **AIN (1993)** were taken into consideration while developing the standard diet, and it was designed to make use of high-quality foods.

the in-height fat diet (HFD) remained made with high-quality ingredients per 100g, with the following arrangements: fat (30%), tallow (15%), maize oil (15%), casein (12%), salt mixture (4%), vitamin mixture (1%), fiber (5%), methionine (3%), choline chloride (0.2%), and bile acid (0.2%).

Materials:

Casein, vitamins, minerals, fiber, choline chloride, sodium selenite, and zinc carbonate were found at the Al Gomhoriya Establishment for Medical Preparations, Chemicals, and Medical Equipment in Cairo, Egypt. - A watermelon, scientifically known as Citrullus lanatus, was obtained from the Agricultural Research Center in its fresh case.

The Gama Trade Company for Chemicals in Cairo, Egypt, was contacted in order to make the purchase of blood analysis kits.

Methods:

Preparation of watermelon rind:

After the watermelon fruits had been thoroughly cleaned and rinsed with running water to get rid of any dust that may have been present, the rind was removed from the freshly washed samples, sliced into tiny slices, distributed in trays to dry, and baked in an air oven at a temperature of fifty degrees Celsius for twenty-four hours. Once the rind had been dried, it was then processed in a grinder mill to make rind flour, which was then kept in an airtight container until it was needed. (Amr,2017)

BIOLOGICAL STUDY:

Due to the fact that the metabolism of obese rats is quite similar to that of humans. In the study of atherosclerosis, the use of Albian rats was suggested by Bravo et al. (1994). At the biological studies lab of the Agricultural Investigation Center in Dokki, Giza, Egypt, thirty mature male rats were housed in cages that were well-aerated and kept in hygienic circumstances. During the adaptation process, the rats were fed a basal diet for one week. The foundational diet was constructed using the guidelines provided by Reeves et al. (1993). Food and water were weighed once a week, and the rats were examined each day.

Six rats were maintained on a standard diet (serving as the control group negative, ve).

24 rats were nourished on a high-fat diet for one month before the start of the experiment to reach the desired weight. Chien et al. (2016) then separated into two chief groups:

The primary group (6 rats) was fed a high-fat diet (10% sheep fat) as a controller-positive group.

The second group (18 rats), which was divided into 3 groups, contains 6 rats as follows:

Subgroup (1): were fed a basal diet mixed with 5% watermelon rind powder.

Subgroup (2): were fed a basal diet mixed with 10% watermelon rind powder.

Subgroup (3): were fed a basal diet mixed with watermelon rind powder. 15%

At the conclusion of the experiment, which lasted for eight weeks, all of the rats were required to abstain from food for one full day prior to their sacrifice, after which blood samples were taken from each rat and centrifuged to extract serum. The amount of food consumed as well as the body weight were recorded twice each week. A calculation was made of the food efficiency ratio.

Chemical analysis:

After the completion of the experiment, serum was analyzed at the Agricultural Research Institute to determine the following parameters:

- Aspartate aminotransferase (AST) concentration
- Alanin aminotransferase (ALT) concentration.
- Triglycerides (TG).
- Total cholesterol (TC)
- low-density lipoprotein (LDL)
- High-density lipoprotein (HDL)

Microbiome analysis:

Collection and processing of samples of the microbiome: Samples of gastrointestinal content and feces were inoculated in peptone water and incubated at 37 °C for 24 hours. The samples were cultured on a different set of specialized culture media to identify the bacteria. Chow *et al.* (2006) and Islam *et al. (2014)*.

Statistical Analysis: -

SPSS statistical software (version 13; SPSS Inc., Chicago, USA) was used to do the analysis on the findings that were collected. The findings were summarized using the mean value. As stated by Armitage and Berry (1987), significance was determined by utilizing a one-way analysis of variance (often known as "ANOVA"). The significance of the differences between the means was investigated using the least significant difference test (LSD) at a significance level of $p< 0.05$.

Biological indices calculation:

Every day of the trial period, the subjects' diets and weekly body weights were recorded. According to Chapman et al. (1959), the following formulas were used to determine the body weight increase percentage and the feed efficiency ratio: Lean Body Mass

(LBM) = Last Weight (g) - Starting Weight (g) 100/Starting Weight (g) FER = weight growth (in grams)/feed consumed (in grams). Evaluation of Serum Biochemistry: Allain (1974), Lopez (1977), and Fossati and Prencipe (1982) were used to calculate total cholesterol (TC), triglycerides (TG), and high-density lipoprotein (HDL). Lipoproteins of low and extremely low density were measured using a protocol based on that developed by Lee and Nieman (1996). LDL = Total Cholesterol - [(VLDL-C) + (HDL-C)]. VLDL = Triglycerides /5. The atherogenic index (AI) was determined using the formula proposed by Nakabayashi et al. (1995). AI = LDL + VLDL + HDL; AI is a measure of atherogenicity. Young (2001) was used to measure glucose levels in the serum.

The concentration of AI was estimated according to Kikachi et al.(1998).

sample collection:

Over the course of the 8-week investigation, participants' total body weight was tracked. Animals were starved overnight before being put to sleep (under ether) at the conclusion of the feeding period. Serum was extracted from around 2 ml of blood using the retro orbital technique and then centrifuged into sterile, dry plastic tubes. Serum and plasma were separated using heparized microtubes. Serum was extracted from centrifuged blood samples and frozen at -20º degrees Celsius. This analysis cannot be completed until.

The serum was tested for a number of different lipid and cholesterol levels, as well as triglycerides, HDL-c, LDL-c, risk rate, and liver function enzymes (GOT, GPT). Moreover, liver, heart, kidney, and stomach were excised, rinsed, blotted, weighed, and kept in formalin solution (10%) and stool samples were collected to take a swab for examinations carried out.

Results and Discussion:

table 1: A Effect of Watermelon Rind Powder on Body Weight Gain%, Feed feed Ratio, Food Intake, Heart, Liver, Kidney, and Stomach Relative Weight in Rats

Variables / Groups	BWG%	FER	FI (g/d)
Basal diet (negative control)	-4.56±1.8 bc	-0.23±0.09bc	17.00
High-fat diet (positive control)	6.9±0.5a	0.35±0.02a	15.00
diet +5%W.M.	-4.05±1.29bc	-0.2±0.06b	17.00
diet +10%W.M.	-6.2±1.91c	-0.31±0.1c	20.00
diet +15%W.M.	-5.1±0.46bc	-0.25±0.02bc	18.00

Exhibit the mean values of body weight gain (BWG), food intake (FI), and feed utilization (Fer) in obese mice fed a diet containing varying amounts of watermelon rind powder. The findings showed that the BWG and FER of the positive control group were higher than those of the negative control and obese groups treated with watermelon rind powder at varying concentrations ($P \leq 0.05$). The findings corroborated those of Mohammed (2016) and Hosny (2017), who had previously determined that BWG and FER mice consume a diet much higher in fat than that of the control group (-).

Mice fed a baseline meal with varying concentrations of watermelon rind powder lost weight and had lower Fer and BWG compared to the control group. There was no difference in Fi between the watermelon rind powder and the negative control group, which was fed the same amount of watermelon rind powder as the slow mice on a basal diet (5%). There was a correlation between our findings and those of (Ware, *et al*., 2015), who found that watermelon consumption lowered the probability of being overweight or underweight.

Also, show Aderiye et al. (2020) that watermelon can be effective for weight loss. Moreover, Manivannan et al. (2020) found that eating watermelon has been used to treat obesity and manage weight. In the same table,

The top FI in the obese mice that feed on the basal diet with watermelon powder is 10%. This is due to According to Hashim (1997), the influence of B-carotene on food intake may be ascribed to a decrease in the palatability of the diet. This could explain why animals given watermelon mixes consume significantly less food per day than control rats. Saikia et al. (2016), who previously isolated and analyzed fiber from watermelon rind, They discovered that 100g of dried rind samples contain 47.5g of fiber, of which 32.5g are insoluble and 15g are soluble. They found that the fiber created from the rind of the watermelon had a greater water holding capacity (WHC), oil holding capacity (OHC), and swelling capacity than the control, which was made from cellulose.

Similar to low OHC, high OHC will lead to decreased absorption and higher excretion. According to Saikia et al. (2016), increased WHC will decrease food transit in the gut, resulting in a rise in satiety and assistance with regard to fecal bulk. Similar to high OHC, high-fat excretion and decreased absorption in the intestine may help lower serum cholesterol and prevent the buildup of cholesterol in the liver and arteries.

Cont. Table (1)

Groups	*liver%*	*heart%*	*kidney%*	*stomach%*
Basal diet	2.29±0.34 ab	0.33±0.02 ab	0.61±0.06 ab	0.68±0.05 a
high-fat diet	3.04±0.12 a	0.39±0.04 a	0.75±0.04 a	0.92±0.08 a
diet+5%W.M.	2.23±0.31 ab	0.26±0.02 b	0.46±0.05 b	0.82±0.07 a
diet+10%W.M.	1.89±0.38 b	0.25±0.05 b	0.45±0.1 b	0.74±0.11 a
diet+15%W.M.	2.28±0.24 ab	0.31±0.04 ab	0.59±0.05 ab	0.76±0.06 a

- Values are expressed as mean ± SD - Significant at $p<0.05$

-Values that have different letters in each column differ significantly, while similar or partially are not significant

Cont. Table 1 illustrates the impact of a basal diet with watermelon rind powder on the liver, heart, kidney, and stomach relative weight of obese rats. Results revealed that liver, heart, kidney, and stomach relative weight were significantly elevated in the positive control group as a result of hypercholesterolemic induction, with mean values of 3.04±0.12, 0.39±0.04, 0.75±0.04, and 0.92±0.08, respectively, compared with the normal control group fed a basal diet of 2.29±0.34, 0.33±0.02, 0.61±0.06, and 0.68±0.05, respectively. While the effect of the basal diet with watermelon rind powder 5% on liver, heart, kidney, and stomach relative weight in obese rats with mean values of 2.23±0.31, 0.26±0.02, 0.46±0.05, and 0.82±0.07, respectively, contrasted with the normal control group fed a basal diet of 2.29±0.34, 0.33±0.02, 0.61±0.06, and 0.68±0.05, respectively. While the effect of the basal diet with watermelon rind powder 10% on liver, heart, kidney, and stomach relative weight in obese rats with mean values of 1.89±0.38, 0.25±0.05,0.45±0.1, and 0.74±0.11 respectively. While the effect of the basal diet with watermelon rind powder 15% on liver, heart, kidney, and stomach relative weight in obese rats with the mean values of 2.28±0.24, 0.31±0.04, 0.59±0.05, and 0.76±0.06 were significantly decreased compared with the positive control group fed on a high-fat diet as a result of hypercholesterolemic induction with mean values of 3.04±0.12, 0.39±0.04, 0.75±0.04, and 0.92±0.08 that refer to In rats fed a high-cholesterol diet as compared to the control group, Ali (2016) found that the liver-to-body weight ratio was considerably higher. According to Ali (2016), the liver's cholesterol buildup may have contributed to this rise. This is due to In rats fed a high-cholesterol diet, as contrasted with the control group, the liver-to-body weight ratio was considerably higher. According to Ali (2016), the liver's cholesterol buildup may have contributed to this rise.

In addition, the root cause of this flaw is Many metabolic dysfunctions may be traced back to their origins in oxidative stress. Excessive reactive oxygen species (ROS) generation is attributed to uncontrolled oxidation (Butt et al., 2009). Reduced free radical formation and endothelium-dependent vasodilatation may occur from NO inactivation. Traditional metabolic pathways maintain their steady ROS production. Food, smoking, the environment, and exercise have all been linked to increased ROS accumulation (Espn et al., 2007 and Weisburger, 2002). Dietary treatment is characterized in terms of lycopene's role in LDL oxidation, short-term growth, and lowering lymphocyte oxidative damage (Alshatwi et al., 2010). The production of reactive oxygen species (ROS) also permanently upsets the oxidative equilibrium and the production of double-allylic hydrogen atoms in lipids. The citrulline (an amino acid) found in watermelon rind powder is put to good use in the creation of arginine. Citrulline has superior bioavailability than arginine and has been studied extensively for its benefits to cardiovascular health, immunological function, wound healing, and sickle cell anemia (Mandel et al., 2005). Watermelon may also have considerable amounts of carotenoids such as carotene, phytofluene, phytoene, lutein, and neurosporene, as has been hypothesized. Due to the special composition of watermelon, it may be useful in the therapy of several illnesses and conditions, including diabetes, nephropathy, macular degeneration, rheumatoid arthritis, neurological disorders, liver disease, and several types of cancer. Additionally, watermelon and waste have high amounts of antioxidant activity that can help fight metabolic problems and lower levels of oxidative stress.

Hypercholesterolemia is significantly associated with atherosclerosis and coronary heart disease, and this association has been well-established in the medical literature. Adipose tissue is a potential contributor to the development of chronic diseases because of its high endocrine and metabolic activity. The development of chronic disease may be influenced by the active endocrine and metabolic locations that adipose tissue represents. It is crucial to look at how hypercholesterolemia affects typical adipose function, as cholesterol is mostly metabolized in a person's adipose tissue. and it has been demonstrated that hypercholesterolemia causes adipocyte cholesterol excess. According to research on preadipocytes, adipocyte differentiation and maturation can be hampered by cholesterol accumulation by influencing several transcription factors. In animal experiments, hypercholesterolemia has been found to increase adipocyte size, inflame adipose tissue, and cause disruptions in the normal operation of the endocrine system. Additionally, clinical research has also shown that these benefits can be seen in illnesses unrelated to obesity. Hypercholesterolemia affects human metabolism, according to a report by Aguilar and Fernandez, M.. (2014).

Table (2): Effect of Watermelon Rind Powder on Serum Lipid Profile in obese rats.

Parameters / Groups	CHLO (mg/dl)	T.G(mg/dl)	HDL (mg/dl)	LDL (mg/dl)	LDL-c(mg/dl)	VLDL (mg/dl)	AI
Basal diet (-)	68.17±0.78^{b}	58.2±2.3^{b}	43.57±0.61^{c}	56.27±1.15^{b}	12.96±1.45 b	11.64±0.46	0.57±0.04 b
High-fat diet (+)	88.77±3.47^{a}	67.3±0.81^{a}	37.97±0.69^{d}	62.1±1.66^{a}	37.34±3.15a	13.46±0.16	1.34±0.07 a
Diet+5%W.M.	66.4±1.1b^{c}	52.6±1.12^{c}	49.13±0.69a	53.43±0.9b^{c}	11.21±0.54 b c	10.52±0.22	0.49±0.02 b
Diet+10%W.M.	60.23±1.65^{c}	40.27±1.84^{e}	44.67±1.43bc	47.83±0.8^{d}	3.05±2.1^{d}	8.05±0.37	0.23±0.05 c
Diet+15%W.M.	63.33±2.24b^{c}	46.63±1.25^{d}	47.1±1.32a^{b}	52±0.97^{c}	6.91±0.93 ^{d} c	9.33±0.25	0.34±0.01 c

Control (-) = Normal rats fed basal diet.

HDL = High-Density Lipoprotein Cholesterol.

LDL = Low-Density Lipoprotein Cholesterol.

VLDL =Very Low-Density Lipoprotein Cholesterol.

TG =Triglyceride

(AI)= Atherogenic Index

Table 2 illustrate the impact of the basal diet with watermelon rind powder on the serum lipid profile of obese rats. findings shown that serum CHLO, T.G., LDL, LDL-c, VLDL, and AI concentration were significantly increased as a result of hypercholesterolemic induction with the mean values of 88.77±3.47mg/dl, 67.3±0.81mg/dl, 62.1±1.66 mg/dl mg/dl, 37.34±3.15 mg/dl, 1.34±0.07mg/dl, and 13.46±0.16 respectively contrasted with the normal control group fed basal diet 68.17±0.78mg/dl,58.2±2.3mg/dl, 12.96±1.45mg/dl, 0.57±0.04mgdl, and 11.64±0.46 mg/dl, respectively.

While serum HDL concentrations were reduced as a result of hypercholesterolemic induction, the mean value of 37.97±0.69 mg/dl contrasted with the normal control group of 43.57±0.61 mg/dl. The levels of HDL significantly increased ($p \leq 0.05$) when adding watermelon rind powder to groups fed a basal diet with 5, 10, and 15% levels of intake, compared with the positive control group. These values were 44.67±1.43 mg/dl, 49.13±0.69 mg/dl, and 7.1±1.32 mg/dl, respectively. The highest improvement for HDL was detected in the group that fed on 10% of watermelon rind powder, while the group that consumed 5% watermelon rind powder had the lowest mean value when compared to the group that did not consume the powder (the negative control group).

While the levels of CHOL, LDL, TG, AI, LDL-C, and VLDL significantly reduced ($p \leq 0.05$) when obesity groups fed on basal diets with watermelon rind powder at 5, 10, and 15% levels of intake contrasted with the positive control group with the mean values of 66.4±1.1 mg/dl, 60.23±1.65 mg/dl, and 63. 33±2.24 mg/dl, respectively for CHOL, 53.43±0.9 mg/dl, 47.83±0.8 mg/dl and 52±0.97 mg/dl , respectively for LDL , 52.6±1.12 mg/dl, 40.27±1.84mmg/dl and 46.63±1.25 mg/dl, respectively for TG, 0.49±0.02, 0.23±0.05 and 0.34±0.01, respectively for AI, 11.21±0.54 mg/dl, 3.05±2 mg/dl and 6.91±0.93 mg/dl, respectively for LDL-c.

The most pronounced improvement in LDL, TG, AI, LDL-C, HDL, and GHOL concentrations was detected in the groups of obesity rats fed the basal diet with 10% watermelon rind powder, followed by group 15 and then 5% compared with the basal diet control group. Also, it was detected that there were no significant variances in serum for level CHOL for this group compared with the negative control group. But as a result of other values, LDL, TG, LDL-c, HDL, VLDL, and AI were observed to be significant differences in the groups of obesity rats fed the basal diet with 5, 10, and 15% watermelon rind powder contrasted with the basal diet control group. Concentration findings displayed that the best improvement was detected in the group of obese rats fed the diet with 10% watermelon rind powder contrasted with the normal control group. The greatest development in lipid profile was observed in the group fed on 10% watermelon rind powder.

A disorder known as blood cholesterol is one in which the amount of fat in the blood, particularly cholesterol and low-density lipoplastics (LDL), leads to an increased risk of developing atherosclerosis. The watermelon rind crust cortex has high antioxidant activity, which is responsible for its benefits when consumed. (Cauza *et al*., 2004) This transformation to l-citrulline and therefore dietary l-arginine is partly metabolized by the enzyme arginase in the gastrointestinal tract and the liver to l-carnitine and urea, which results in lower plasma l-arginine concentrations than dietary l-citrulline that bypasses intestinal and first-pass liver processes. The watermelon rind powder contains citrulline. (Citrulus Lantus) has been used to treat a broad variety of ailments, such as cardiovascular problems and illnesses connected to aging, and research has shown that increasing an individual's consumption of l-citrulline significantly improves the adult's cardiovascular health results. (Moinard, *et al*., 2008) and Figueroa, *et al*., 2017), the watermelon rind powder riched with carotenoids, vitamin K and Mg, p, zn,fe citrulline, carotenoids, and flavonoids, and fat and cholesterol-free, is therefore taken into account as a low-calorie fruit. (Leskovar *et al*., 2004; Bruton *et al*., 2009). Additionally, according to the findings, the peel is where the fruit's antioxidant activity is strongest, has the highest antimicrobial effect, and has the highest content of total phenol. It has been observed that there is a strong connection between the contents of the total phenol and biological activity, and thus watermelon rind powder protects the body from oxide lipid oxidation, while (Collins *et al*., 2007)

Table (3): Effect of Watermelon Rind Powder on Serum Liver Function in obese rats.

Parameters / Groups	GOT(u/l) (AST)	GPT(u/l) (ALT)
Basal diet (negative control)	24.67±1.2[b]	26.67±0.33[b]
High-fat diet (positive control)	43±3.61[a]	31.67±0.88[a]
diet+5%W.M.	25.67±4.18[b]	26.67±1.2[b]
diet+10%W.M.	20±1.53[b]	23.33±1.2[c]
ditet+15%W.M.	22.67±1.45[b]	26±0.58b[c]

Mean values are expressed as means ± SD. Means with different superscript letters in the column are significantly different at P≤ 0.05.

Control (-) = Normal rats fed basal diet.

Control (+) =obese rate with a high-fat diet.

GOT (AST) =Aspartate aminotransferase concentration.

GPT (ALT) =Alanine aminotransferase concentration

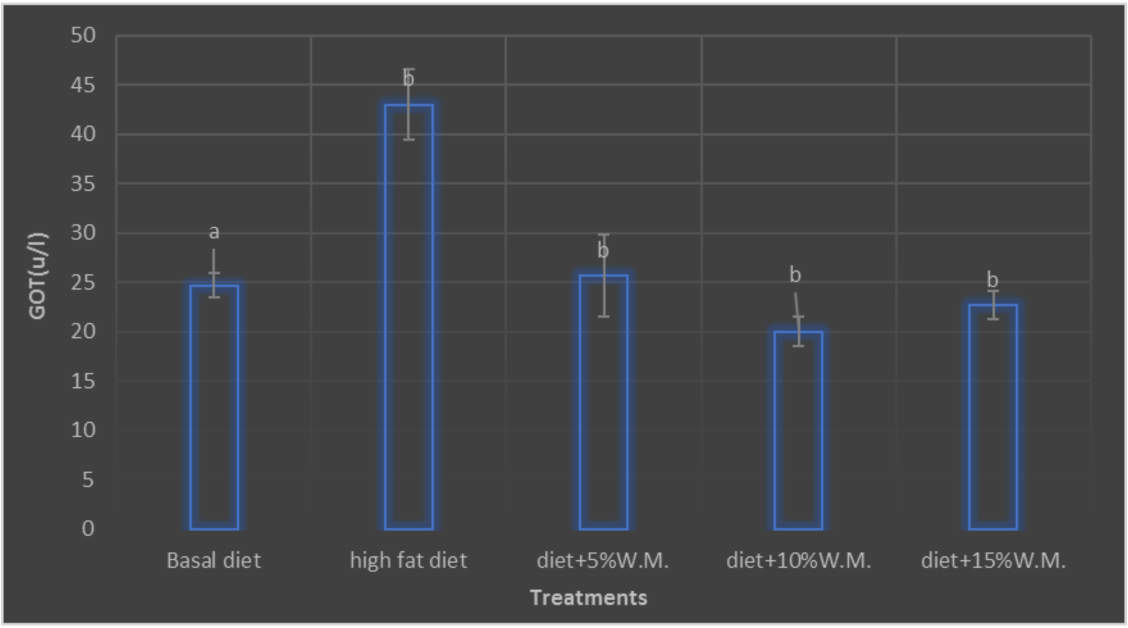

Fig (1) Effect of Watermelon Rind Powder on Serum Liver Function (GOT) in obese rats.

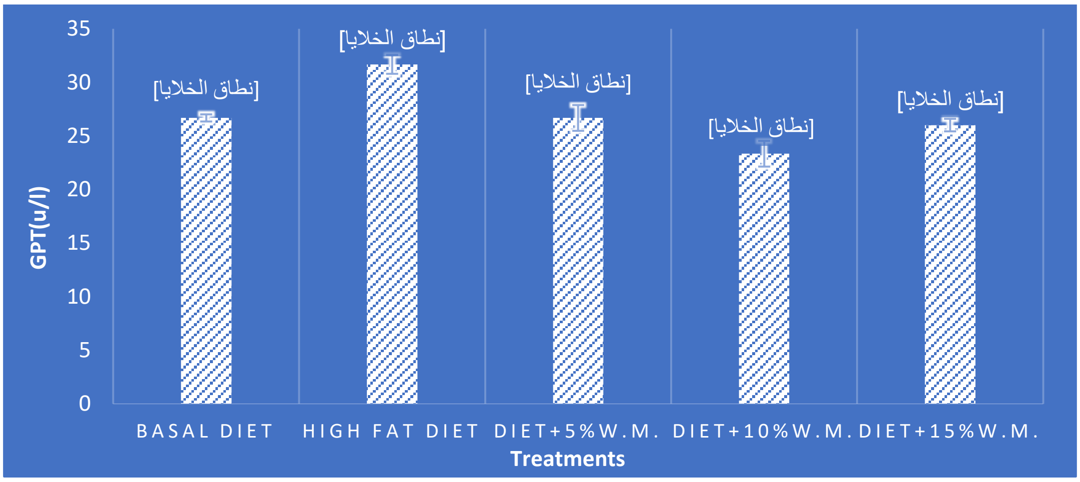

Fig (2) Effect of Watermelon Rind Powder on Serum Liver Function (GPT) in obese rats.

Table (3) and figures (1 and 2) showed that the Liver enzyme concentrations of obese rats fed at a different level of watermelon rind powder there was a high significant rise in the serum of GOT and GPT positive control group contrasted with the negative control group which represented 43±3.61 u/l vs 24.67±1.2u/l for GOT concentration and 31.67±0.88 u/l vs 26.67±0.33 u/l for GPT level. The concentration of GOT significantly reduced ($p \leq 0.05$) in the obesity groups that were fed on basal diet with watermelon rind powder 5%,10%, and 15% levels of intake contrasted with the positive control 25.67±4.18, 20±1.53 and 22.67±1.45 respectively. The groups fed on a basal diet mixed with watermelon rind powder (5, 10, and 15% of watermelon rind powder produced a decrease in serum GPT concentration compared with the negative control group) with a mean value of 26.67±1.2, 23.33±1.2, and 26±0.58, respectively. which was the group that was fed on a basal diet mixed with watermelon rind powder. 10% shows the best results on liver enzymes of the group that was fed on a basal diet mixed with watermelon rind powder. 10% showed the best results, followed by the group fed on a basal diet mixed with watermelon rind powder (15% and then the group fed on a basal diet mixed with watermelon rind powder (5% which showed nonsignificant differences compared with the negative control, but this group showed significant differences compared with the positive control in levels. Alkaloids are therapeutically significant natural plant products due to their analgesic, antispasmodic, and antibacterial activities (Adeolu and Enesi, 2013). Watermelon contains alkaloids, particularly at low concentrations. Saponins have a bitter taste that may be related to pharmacologic potentials such as hemolytic activities (Sodipo *et al*., 2000) and favorable effects on blood cholesterol levels, bone health, cancer, and the stimulation of the immune system. Saponins may also be associated with the ability of plants to inhibit the growth of cancer cells. Particularly, tannins showed that they might have astringent and antimicrobial properties (Adeolu and Enesi, 2013) and that they might be used to treat a variety of illnesses, such as inflammation, liver damage, kidney problems, arteriosclerosis, hypertension, stomach problems, and the inhibition of reactive oxygen species (Zhu et al., 199). In addition, tannins propose that they could possibly have astringent and antimicrobial properties. These GOT results in Table 1 concur with those of Harrison et al. (1966), who observed that an increase in GOT and GPT is typically closely connected to liver disorders.

Conclusion

The significance of the study's findings lends credence to the utilization of watermelon by-products as a means of warding off the beginning of metabolic syndrome. According to the findings of this study, watermelon's high citrulline content, putative anti-inflammatory chemicals, and high fiber content may all contribute to the potential mechanisms of action that are influenced by these characteristics. It would be prudent to conduct more in-depth research into these potential modes of action. Future research that studies the meals' citrulline content and the mice's endogenous nitric oxide generation could shed light on whether or not this mechanism has given way to the experiential development of glucose absorption. Lipid profile and content of different types of microbiomes, as well as obesity, when watermelon powder rind was consumed.

For human consumption, watermelons are an exceptionally rich source of a variety of vitally needed nutritional components. In addition to this, it possesses a variety of medicinally valuable components, making it a more potent tool for the administration of healthcare. It is advised that watermelon rinds be utilized for the treatment of obesity and overweight individuals, as well as for the improvement of the blood lipid profile and glucose.

The best results were shown in the group that was fed the basic diet mixed with watermelon rind powder at a concentration of 10%; this concentration is the best, according to the preceding results that are mentioned in "the results and discussion.".

Recommendations

1. Watermelon rind powder could be utilized as a suitable fortification therapy for hypercholesterolemia cases.

2- Hypercholesterolemia cases should be aware of the health benefits of watermelon rind.

3-Increasing the dietary consumption of watermelon rind powder has beneficial effects in lowering lipid profile.

4- Watermelon rind powder could be used as a suitable supplementation for reducing body weight.

5- Further studies are required focusing on the anti-obese

effect of this powder for a longer duration.

6- More research on the relationship between watermelon rind powder and microbiome in humans must be done.

5 - Watermelon rind powder could be used as a suitable supplementation for reducing the count of bacteria (microbiome)

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