Effects of Dietary Broad Bean and Red Onion Intake on Weight Loss Properties in Obese Rats

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Abstract

Broad bean and red onion are common Egyptian foods that many Egyptians are accustomed to eat them together as a part of daily diet. The aim of this study was to explore the effect of daily intake of broad bean and red onion on weight loss properties in obese rats. Chemical composition, total polyphenols and anthocyanins were determined in both foods. Forty-five Sprague Dawley rats were divided into two groups. Negative control group (n=9) and high fat diet group (n=36). After inducing obesity (4 weeks), they were divided into four equal groups (n=9);high fat diet, high fat diet with 5% broad beans , high fat diet with 5% red onions and high fat diet with 5% broad beans and 5%red onions respectively for another 4 weeks. Anthropometric measurements (body mass index) and biochemical analyses (serum lipids profile and leptin concentrations) were carried out. Results showed that the outer layer of red onion contained significantly higher amount of polyphenols than broad beans and lower layer of red onion. Anthocyanins were detected in red onion but no detected amounts were found in broad bean. Results indicated that the body mass index and serum lipids profile, specifically triacylglycerols were significantly higher in high fat diet fed group .The addition of broad beans or red onions caused significant improvement in all studied parameters but the most favorable effects were observed in broad beans and red onion combination group due to multifactor effect of their components. Further research, including clinical trials to elucidate the mechanisms of action and the influence of different fractions of polyphenols contained broad bean and red onion are recommended.

Keywords: broad beans- red onion -polyphenols- anthocyanins- lipids profile- body mass index- leptin- obesity- rats.

Introduction

The prevalence of obesity has increased at an alarming rate in both developed and underdeveloped countries during the last three decades, and this appears to be more pronounced in women ***(Badran and Laher , 2011)***. Excess weight is the sixth most important risk factor for worldwide disease burden ***(Ezzati et al., 2002)*** and is associated with diabetes mellitus ***(Day and Bailey ,2011)***, cerebral and cardiovascular diseases ***(Ibarra ,2009)*** and various cancers ***(Ceschi et al., 2007).*** The prevalence of obesity in Egypt according to 2010 WHO estimates, 22% of males and 48% of females over the age of 15 were classified as obese, making Egypt the country with the second highest prevalence of obesity in the Arab countries after Kuwait ***(WHO ,2005).***

Polyphenols from various fruits, vegetables, legumes, cereals and herbal plants were reported to protect from liver damage, have immune enhancement potential, anti-infection, anti-stress, anti-cancer effects ***(Valko et al., 2007).*** Recently, the role of polyphenols in controlling body weight is also reviewed. Some flavonoids such as catechins and soy isoflavones can modestly reduce weight ***(Hurt and Wilson ,2012).***

Hughes et al., (2008) found that women with the highest intake of total flavonols/flavones and total catechins experienced a significantly lower increase in BMI of 0.40 and 0.31 respectively. These results suggested that flavonoid intake may contribute to maintaining body weight in the general female population. Animal studies have shown that catechins increase energy expenditure, increase glucose uptake in skeletal muscle, decrease glucose uptake in adipose tissue, and prevent obesity in a dose-response manner ***(Choo , 2003 ,Wolfram et al., 2005)*** . The anti-obesity effect of the major dietary flavonols (quercetin, myricetin, and kaempferol) and the major dietary flavones (luteolin and apigenin) was reported to be happened through mechanisms such as influences on glucose uptake and fatty acid catabolism ***(Strobel et al., 2005 , de Boer et al., 2006).*** Other subclasses of flavonoids were proved have an effect on adipokine secretion and up-regulation of gene expression ***(Prior and Wu, 2006 , Tsuda ,2008).***

Faba beans (*Vicia faba* L.), also commonly known as broad beans and fava, horse, are widely consumed in different parts of the world including Egypt, Sudan, Netherlands, Spain, Saudi Arabia, India and China ***(FAO ,2009).*** In addition to its nutritional importance, broad beans have been shown to have lipid-lowering effects and may also be a good source of antioxidants and and chemopreventive factors including phenolic compounds ***(Madar and Stark, 2002)*** and contain other minor components that have potential impact on human health***(Campos-Vega et al., 2010***).

Onion (*Allium cepa* L.) is a versatile vegetable that is consumed fresh as well as in the form of processed products. Onion is rich in flavonoids such as quercetin, phenolic acids, cepaenes, thiosulfinates and anthocyanins ***(Elhassaneen and Sanad, 2011).*** The major flavonoid found in red and yellow onions was quercetin ***(Abdel-Moemin, 2004)***. Onion contains also sulphur compounds, such as cysteine and allyl propyl disulphide. These compounds possess antidiabetic, antibiotic, hypocholesterolaemic, fibrinolytic, and other various beneficial biological ***effects (Dorant et al., 1995 , Banerjee and Maulik , 2002).***

Some Egyptians are accustomed to eat broad bean and red onion together as a part of their diet. The present study hence aimed to explore the effect of supplementation of high fat diet with 5% broad bean or 5% red onion and their combination on weight loss properties, lipids profile and leptin concentration in obese rats.

Materials and Methods

Reagents and Chemicals:

Casein, vitamins, minerals, cellulose, choline chloride were purchased from El-Gomhoreya Company, Cairo, Egypt. Folin-Ciocalteu reagent (FCR), lanthanum (III) chloride heptahydrate, $FeCl_3.6H_2O$, $CuCl_2.2H_2O$, 2,9-dimethyl-1,10-phenanthroline (neocuproine), and cholesterol of analytical grade were purchased from Sigma Chemical Co.,(Nasr City, Cairo) Egypt. Kits for lipid profile and leptin radioimmunoassay (RIA) kit (Linco Research, St. Charles, MO, USA) were obtained from Egyptian American Company for Laboratory Service, Egypt.

Preparation of Broad Bean and Red Onion Samples

Raw broad bean (*Vicia faba* L) 5–10 mm diameter and raw red onion (*Allium caepa* L) medium size bulbs weighing 120g with 3 inches in diameter were purchased in September 2011 from the local market, Giza, Egypt. Both foods were identified as Giza 2 for broad bean and Beheri for onion by Field Crops Research Institute, Agricultural Research Centre, Giza, Egypt.

Broad Beans were washed under running water, soaked at room temperature (25°C) for 48 hours, 3 water: 1 bean proportion in a glass container with changing water 3 times a day. Broad beans were weighed, frozen in liquid nitrogen, lyophilized for 2 days, milled to fine powders and kept frozen at -20°C until required to be mixed with the diet.

The bulbs of red onions were peeled, cleaned and washed. The top six layers were removed from onion and weighed, chopped with a plastic knife, and liquid nitrogen was added to dry up the tissues. A weighed portion was then lyophilized for 72 h (Virtis model 10-324), and the dry weight was determined. The samples were ground and stored at -20°C until analysis.

Determination of Chemical Composition of Broad Beans and Red Onion:

Total solids were determined following the methods described by the Association of Official Analytical Chemists ***(AOAC, 2000).*** Nitrogen content was determined by using ***Kjeldahl, (1883)*** method and multiplied by a factor of 6.25 to determine the crude protein content. The moisture content was determined by drying the samples, at 105°C, to a constant weight. Crude fat was determined by Soxhlet method. Dietary fiber content of the defatted samples was determined by decomposing the starches with acids and the proteins with base and then filtered ***(Nielsen, 1998).*** Total carbohydrate content was obtained by difference. To measure total solids, the samples were put in a microwave oven with 200 Watt motor for 20 min until constant weight, and results were expressed as gram of total solids per gram dry weight (g / g DW).

Determination of Total Phenolic Content :

Phenolic compounds were extracted by adding one gram of lyophilized broad bean or red onion to 100 ml of methanol/water (1:1) and kept at room temperature in dark place for 24 h.The amount of total phenolics content was determined using Folin-Ciocalteu reagent ***(Singleton and Rossi ,1965).*** One hundred microlitres of extract was diluted with the same amount of methanol. One hundred microlitres Folin–Ciocalteu reagent and 500 mls 20% Na_2Co_3 were added to it. The tubes were mixed and 200 mls 20% Na_2Co_3 were also added. The tubes were centrifuged for 3 min at 3000 rpm and allowed to stand for 20 min in a dark place at room temperature. The absorbance was measured at 735 nm in a spectrophotometer. The standard curve was plotted using gallic acid. The amount of total phenolics was calculated as gallic acid equivalents (GAE) in milligrams per gram dry weight (mg GAE/g DW).

Determination of Total Anthocyanins:

The total amount of anthocyanins content was determined as described by ***Fuleki and Francis (1968)*** measured by a spectrophotometer at 535 nm. The absorbance of the samples (A) was calculated as follows:

Anthocyanin pigment content (mg/liter) = (A x MW x DF x 1000)/ (ε x 1).

Where A= [(Absorbance λ vis-max-210) pH 1.0] - [(Absorbance λ vis-max-A750) pH 4.5] , Molecular weight of anthocyanin (cyd- 3-glu) = 449

Extraction coefficient (ε) =29.600 , DF=Diluted factor

Rats, Diets and Experimental Design:

Forty-five adult male Sprague Dawley rats weighing (200-210 g) were obtained from the laboratory animal colony, Ministry of Health and Population, Helwan, Cairo, Egypt. Rats were housed individually in stainless steel cages in an environmentally controlled animal laboratory conditions and given food and distilled water *ad libitum* during the experimental period. Rats were adapted for one week on an AIN-93M basal diet ***(Reeves et al., 1993)*** before being assigned to dietary groups. After the adaptation period, the rats were divided into two main groups. The first group (9 rats) continued on basal diet and was kept as negative control group (NC). The second group (36 rats) was fed on high fat diet (HF) that contain 19% saturated fat and 1% soybean oil for 4 weeks in order to induce obesity.

The initial determination of obesity in this study was conducted after two weeks from feeding high fat diets to rats. Initial blood sample analysis was taken from each rat groups to test lipid profile in order to carry on feeding high fat diet solely or shift to the treatments (broad beans, red onion or their combination), specifically total cholesterol and triacylglycerol. The cut off point was 90mg/dl and 95mg/dl for total cholesterol and triacylglycerol respectively ***(Lim et al., 2009).***

Obese animals in the HF diet group were randomly divided into four sub-groups that were fed for another 4 weeks on the following diet scheme:
HF group: fed on high fat diet and kept as positive control group.
HFB group: fed on high fat diet supplemented with 5% dried broad beans.
HFO group: fed on high fat diet supplemented with 5% dried red onions.
HFBO group: fed on high fat diet supplemented with both dried broad beans and dried red onions at 5% level.

Biological Evaluation and Body Mass Index of Rats

The biological evaluation for different groups was carried out by determination of feed intake and body weight gain percent. The amount of feed consumed and rats' body weight were recorded twice a week using digital balance. Rats' body weight and body length were used to calculate body mass index [BMI = body weight (g)/length^2 (cm)] of each rat after feeding high fat diet for 4 weeks and at the end of the experimental period. The rats' body length (nose-to-anus or nose–anus length) was done in anaesthetized rats ***(Novelli et al., 2007 , Altunkaynak and Ozbek , 2009)*** using non-stretch tape.

Biochemical Analysis

At the end of the feeding period, rats were sacrificed following an overnight fast. Animals were lightly anesthetized with diethyl ether. Blood samples were taken from the orbital venous plexus by means of fine capillary glass tubes. Blood samples were centrifuged for 10 minutes at 3000 rpm to separate the serum. Serum was carefully separated into clean dry Wassermann tubes by using a Pasteur pipette and kept frozen at -20°C until analysis.

Collected sera were used for the determination of total cholesterol (TC) ***(Allain et al ., 1974)*** ,triacylglycerol (TAG) ***(Bucolo and David , 1973),***high density lipoprotein cholesterol (HDL-C) ***(Lopes-Virellaet et al., 1977).*** Low density lipoprotein cholesterol (LDL-C) and very low-density lipoprotein cholesterol (VLDL-C) were calculated using Friedewald and modified Friedewald formula ***(Friedewald et al., 1972 , Francisco et al., 2008)*** respectively which assumes that the suggested formula (VLDL-C & LDL-C) values should be given instead of separate LDL-C and VLDL-C ones.

Modified Friedewald formula (MFF): LDL-C (mg/dl) = Non-HDL-C × 90% - TG × 10%.

Serum leptin concentration was measured according to ***(Ahren et al., 1997)*** and the detection limit was 0.5 ng/ml . All measurements were conducted in triplicates

Statistical Analysis:

The statistical analysis was performed using SPSS software programme version 16 for windows; SPSS, Inc .Results were expressed as mean ± standard deviation (SD). The difference among groups was evaluated by a one way ANOVA . Duncan's test was used as a post-hoc test to compare the significance among the groups. The probability value used for statistical significance was $p \leq 0.05$ ***(Steel and Torrie, 1980).***

Results

Chemical composition of broad beans and red onion were presented in Table (1). The broad bean contain 22.5% protein (nitrogen content X 6.25), 1.5% fat, 55.5% carbohydrate, 6.5% fiber, 10.4% moisture and 3.6% ash while the protein, fat, carbohydrate, dietary fiber , ash and moisture contents in red onion were 1.1%, 0.1%, 8.1%, 1.8%, 88.5% and 0.4% respectively .

Results in Table 2 showed the content of total polyphenols and anthocyanins in broad beans and red onion. Polyphenols were higher in outer layer than in lower layers of red onion representing 24.9±0.8 vs. 12.9±0.3 mg GAE/g DW respectively. The anthocyanins content in outer and lower onion was comparable. No detectible amount of anthocyanins was found in broad bean while it contain 18.08± 2.3 mg GAE/g DW polyphenols.

Rats in all experimental groups were apparently healthy, showing no pathological signs or abnormalities during the entire experimental period. The body length, initial body weight, final body weight, final body mass index and feed intake of experimental groups were shown in Table (3). All experimental groups had similar body weights at the beginning of the study. Although feeding HF caused significant weight gain compared with animals fed basal diet (NC), the groups fed HF diet containing 5 % broad bean, 5% red onion or their combination. Feed intake was significantly higher in HF group than NC group (29.0 ± 1.7 g/ day vs. 18.2 ± 3.4 g/ day respectively The BMI results were summarized in Table (3). As expected, the mean of BMI was 0.67±0.02 g/cm^2 in the NC group and 0.98±0.07 g/cm^2 in the HF group. The difference between the BMI values of the two groups was statistically significant ($p<0.05$). The present study showed that the BMI in rats fed HFB, HFO and HFBO were significantly lower than that in rats fed the HF diet. The more pronounced reduction in BMI was observed in HFBO group which was approach from NC group. The administration of 5% broad bean or its combination with red onion caused significant reduction in feed intake compared to HF group.

Table (4) showed serum TC Serum total cholesterol, triacylglycerol and lipoprotein fractions for all experimental groups. The concentrations of TC, LDL-C, VLDL-C and TAG were significantly higher in the HF group compared to NC group. Total cholesterol values were significantly lower among groups fed broad beans and red onion based diets compared to HF group. Serum triacylglycerol concentrations were significantly decreased in all groups of rats supplemented with broad beans. The most notable improvement was observed in HFBO group. Regarding lipoprotein fractions, serum HDL-C concentration was significantly elevated, while LDL-C and VLDL-C were significantly decreased in HFO, HFB and HFBO groups compared with the HF group

Serum leptin concentrations of NC, HF and treated groups were presented in Table (5). HF group was significantly higher as compared with the NC group. The administration of broad bean, red onion or their combination caused significant improvement in leptin concentrations. Broad bean administration together with red onion significantly reduced the leptin levels to a point comparable to that of the negative control group.

Discussion

Administration of broad bean, red onion and their combination apparently lowered weight gain and BMI in rats fed a high-fat diet compared to positive control group (HF). Similar result was reported that hypercholestrolemic rats fed on vicia faba diets showed significantly lower body weights and energy intakes than rats fed on casein diets***(Macarulla et al., 2001)***.The combined effects of plant components included in these supplements could be responsible for the observed lower body weight gain and reduced BMI in the HFB,HFO and HFBO groups.

It was reported that phytochemicals such as quercetin in broad bean are potential agents to inhibit differentiation of preadipocytes, stimulate lipolysis, and induce apoptosis of existing adipocytes, thereby reducing the amount of adipose tissue ***(Andersen et al., 2010)*** which in turn reduce body weight gain. In addition, other studies showed that anthocyanins have a significant potency of anti-obesity and ameliorate adipocyte function in in vitro and in vivo systems ***(Tsuda , 2008 , Abdel-Moemin , 2011).*** Reducing feed intake in broad bean, red onion and their combination groups may imply also suppression of appetite and feeling of satiety probably through regulation of leptin secretion as discussed below. Leptin plays important role as satiety signal and acts as a marker of adipose tissue mass .

Other components in broad bean such as fiber, protein , phytic acid and slowly digestible and resistant starch were implicated also in providing satiety and delay the return of hunger. Pulses are high in fiber of this, approximately one-third to three-quarters is insoluble fiber and the remaining is soluble fiber. Insoluble fiber is associated with fecal bulking through its water-holding capacity, whereas soluble fiber ferments, positively affecting colon health through production of short chain fatty acids, lowered pH, and potential microbiota changes. Viscous soluble fiber may also increase gastric distention and help to slow gastric emptying rate ***(Howarth et al., 2001)***. Moreover, the protein in pulses ***(Pai et al., 2005)*** has been implicated in providing satiety. Phytate has been shown to reduce the in vitro rate of starch digestion and delay postprandial glucose absorption in humans ***(Thompson et al., 1987)***, which could contribute to satiety . On the other hand, a number of reports infer a slowly digestible or resistant character of the starch in pulses ***(Guillon and Champ ,2002)***, so both types of starch have effect on satiety.

The high-fat diet induced dyslipidemia in rats which was ameliorated by supplemented diets with the studied foods. These rats showed significant decrease in total cholesterol, triacylglycerol, LDL-C and VLDL-C concentrations. This was associated with an increase in high density lipoprotein cholesterol. All treatments, however, preserved these parameters at a different degree. The content of photochemicals in these foods would have biological activities that improve certain metabolic parameters associated with high fat diets. This hypothesis is supported by several published reports that the consumption of dehydrated onion product had significant cholesterol lowering and antioxidant effects ***(Vidyavati et al., 2010)***, serum HDL-C was higher in rabbits fed on black rice rich in anthocyanins compared with rabbits fed on white rice ***(Abdel-Moemin , 2011)***, triglyceride levels of mice fed on HF diet were improved after feeding with quercetin ***(Kobori et al., 2011)***, anthocyanins from black soybean extract reduced plasma total cholesterol and TAG levels in rats ***(Park et al., 2007)*** and polyphenols derived from adzuki beans improved lipid metabolism in mice fed high-fat diets ***(Nishi et al., 2008)*** . They suggested that polyphenols has an inhibitory effect on the activity of acetyl-CoA carboxylase; an enzyme that leads to the production of malonyl-CoA for the biosynthesis of fatty acids. In addition, ***(Zang et al., 2006)*** revealed that polyphenols can lower hyperlipidemia in diabetes by activating the 5' adenosine monophosphate-activated protein kinase .

The observed improvements in lipid profile in broad bean supplemented groups may be attributed to its content of fiber. In this context, it has been described previously that fiber can reduce the absorption of dietary fat ***(Lairon , 1996, Macarulla et al., 2001)***

The HF diet induced an increase in the plasma leptin level as compared with the NC diet. The occurrence of obesogenic parameters such as hyperleptinemia, hypercholesterolemia and hypertriglyceridemia lends support for the label of an obese status. In the light of this, leptin and insulin insensitivity can ensue, with the loss of hormonal satiety signals in obese animals ***(Strader and Woods, 2005).*** Moreover, it was worthy noted that each dietary supplement irrespective of its composition, significantly reduced the plasma leptin levels even when rats were on the HF diet. Therefore, polyphenols and anthocyanins exerted also a modulating effect on leptin secretion. It is possible that controlling body weight gain partly contributes to the decrease in plasma leptin because leptin is typically present in the circulation at levels proportional to fat mass ***(Maffei et al., 1995).***

In conclusion, the supplementation of broad bean and red onion together is more favorable than the broad bean diet or onion diet alone in controlling body mass index, improving lipid profile and leptin levels which can be explained by the multifactor effect of their components. Overall, the anti-obesity effects of these foods demonstrated a potentially important dietary supplement for the prevention and attenuation of obesity and related disorders. However, further research, including clinical trials to elucidate the mechanisms of action and the relative influence of different fractions of polyphenols contained broad bean and red onion is required.

Table (1) :
Chemical composition of broad beans and red onion.

Basic Components	Broad beans %	Red onion%
Protein	22.5	1.1
Fat – Total	1.5	0.1
Carbohydrates	55.5	8.1
Dietary Fiber	6.5	1.8
Moisture	10.4	88.5
Ash	3.6	0.4

Table (2):
Total polyphenols and anthocyanins in broad beans and red onion.

Food Items	Polyphenols (mg GAE/g DW)	Anthocyanins (mg CGE /g DW)
Broad beans	18.08± 2.3 ^{a}	ND
Upper layer red onion	24.9±0.8 ^{b}	14.4±2.7 ^{a}
Lower layer red onion	12.9±0.3 ^{c}	13.2±4.9 ^{a}

Values are mean ±SD of three measurements. GAE: gallic acid equivalent, DW: dry weight, CGE :cyanidine-3-glucoside equivalent , ND : not detected.
Mean values which have unlike superscript letters within a column were significantly different (p<0.05).

Table(3):
Body length, initial body weight, final body weight, final body mass index and feed intake of experimental groups.

Groups	Body length (cm)	Initial body weight (g)	Final body weight (g)	Final BMI (g/cm^2)	Feed Intake (g/ day)
NC	20.2±0.3^{a}	201±3.3^{a}	273.4±2.7^{a}	0.67±0.02^{a}	18.2 ± 3.4^{a}
HF	19.9±0.1^{a}	202±5.1^{a}	388.1±3.8^{b}	0.98±0.07^{c}	29.0 ± 1.7^{b}
HFB	20.5±0.6^{a}	205±4.5^{a}	302.6±4.1^{c}	0.72±0.02^{b}	18.6 ± 4.5^{a}
HFO	20.0±0.7^{a}	200±2.6^{a}	280.9±1.5^{ac}	0.70±0.05^{b}	15.2 ± 2.5^{a}
HFBO	20.9±0.4^{a}	207±3.2^{a}	279.6±1.9^{a}	0.64±0.08^{a}	17.4 ± 3.6^{a}

Values are means ± SD. BMI: body mass index, NC: negative control group, HF: high fat diet group, HFB: HF with 5% broad beans, HFO: HF with 5% red onions, HFBO: HF fed on a combined broad beans and red onions at 5%. Mean values which have unlike superscript letters within a column were significantly different (p<0.05).

Table(4):
Serum total cholesterol, triacylglecrol and lipoprotein fractions of experimental groups.

groups	TC (mg/dl)	TAG (mg/dl)	HDL-C (mg/dl)	LDL-C (mg/dl)	VLDL-C (mg/dl)
NC	65.0±1.3^{a}	50.0± 1.3^{a}	39.0± 2.4^{c}	16.0± 0.37^{a}	10.0± 0.71^{a}
HF	101.0± 2.7^{d}	108.6± 1.7^{c}	29.1± 1.7^{a}	31.4± 0.37^{c}	40.6± 0.93^{c}
HFB	85.0± 3.3^{c}	99.4± 1.5^{b}	33.5±1.0^{b}	21.50± 0.37^{b}	30.0± 1.2^{b}
HFO	80.0± 2.5^{c}	76.1± 0.97^{ab}	38.6± 1.5^{c}	18.9± 0.37^{ab}	22.5± 1.7^{ab}
HFBO	72.5± 1.7^{ab}	59.0± 0.65^{a}	40.0± 1.3^{c}	17.3± 0.37^{a}	15.2± 0.6^{ab}

Values are means ± SD. NC :negative control group, HF: high fat diet group, HFB: HF with 5% broad beans, HFO: HF with 5% red onions, HFBO: HF fed on a combined broad beans and red onions at 5%,
TC: Total cholesterol, TAG: Triacylglecrol, HDL-C: High density lipoprotein cholesterol, LDL-C: low density lipoprotein cholesterol and VLDL-C: Very low density lipoprotein cholesterol. Mean values which have unlike superscript letters within a column were significantly different (p<0.05).

Table(5):
Serum leptin concentrations of experimental groups.

groups	Leptin (ng/ml)
NC	2.19± 2.3^{a}
HF	24.8± 1.6^{c}
HFB	10.8± 1.4^{b}
HFO	9.8± 2.6^{b}
HFBO	6.8± 2.5^{ab}

Values are means ± SD. NC :negative control group, HF: high fat diet group, HFB: HF with 5% broad beans, HFO: HF with 5% red onions, HFBO: HF fed on a combined broad beans and red onions at 5% .Mean values which have unlike superscript letters within a column were significantly different (p<0.05).

References

A.O.A.C. (2000):
Official Methods of Analysis no 985.26 (17th ed) Washington, DC: Association of Official Analytical Chemists.

Abdel-Moemin A.R. (2004):
To investigate the antioxidant properties of dietary flavonoids in human metabolism [dissertation]. Belfast: The Queen's University.

Abdel-Moemin A. R. (20١١):
Switching to black rice diets modulate LDL oxidation and lipid measurements in rabbits. The American Journal of the Medical Sciences , 341: 318-324 doi: 10.1097/MAJ.0b013e3182019f62

Ahren B., Månsson S., Gingerich R.L.and Havel P.J.(1997):
Regulation of plasma leptin in mice: influence of age, high-fat diet, and fasting. Am J Physiol Regul Integr Comp Physiol 273: R113–R120.

Allain C.C., Poon L.S., Chan C.S., Richmond W. and Fu P.C.(1974):
Enzymatic determination of total serum cholesterol. Clin. Chem., 20(4): 470-475.

Altunkaynak B.Z. and Ozbek E. (2009):
Overweight and structural alterations of the liver in female rats fed a high-fat diet: A stereological and histological study *Turk J Gastroenterol , 20 (2): 93-103.*

Andersen C., Rayalam S., Della-Fera M.A., and Baile C.A. (2010):
Phytochemicals and adipogenesis , 36(6):415-422.

Badran M. and Laher I. (2011):
Obesity in arabic-speaking countries .Journal of Obesity ,Vol. 2011, Article ID 686430.

Banerjee S.K. and Maulik S.K.(2002):
Effects of garlic on cardiovascular disorders: a review. *Nutritional Journal.* ,1(4):1–14.

Bucolo G. and David H.(1973):
Quantitative determination of serum triglycerides by the use of enzymes. Clin Chem ,19:476–482.

Campos-Vega R., Loarca-Pin˜a G. and Oomah B.D. (2010):
Minor components of pulses and their potential impact on human health. Food Res Int 43, 461–482.

Ceschi M. , Gutzwiller M. F., Moch H., Eichholzer M., and Probst-Hensch N.M.(2007) :
Epidemiology and pathophysiology of obesity as a cause of cancer. *Swiss Medical Weekly*, 137(3-4): 50–56.

Choo J.J. (2003) :
Green tea reduces body fat accretion caused by high-fat diet in rats through beta-adrenoceptor activation of thermogenesis in brown adipose tissue. J Nutr Biochem ,14:671–676.

Day C. and Bailey C.J.(2011):
Obesity in the pathogenesis of type 2 diabetes. *Br J Diabetes Vasc Dis* ,11:55–61.

de Boer V.C., van Schothorst E.M., Dihal A.A., *et al,*.(2006):
Chronic quercetin exposure affects fatty acid catabolism in rat lung. Cell Mol Life Sci , 63:2847–2858.

Dorant E., van den B., Dorant P.A., Goldbohm R.A. (1995):
Allium vegetable consumption, garlic supplement intake, and female breast carcinoma incidence. .*Breast Cancer Res Treatment* , 33:163–170.

Elhassaneen Y.A. and Sanad M.I. (2011) :
Phenolics, selenium, vitamin C, amino acids and pungency Levels and antioxidant activities of two Egyptian onion varieties. Am. J. Food Tech.

Ezzati M. , Lopez A. D., Rodgers A., Vander Hoorn S. and Murray C. (2002):
Selected major risk factors and global and regional burden of disease, *The Lancet*, 360(9343) 1347–1360.

FAO (2009):
Food and Agriculture Organization, Rome, FAOSTAT data; from: http://faostat.fao.org.

Francisco J., Muniz S. and Bastida S.(2008):
Do not use the Friedewald formula to calculate LDL-cholesterol in hypercholesterolemic rats. Eur J Lipid Sci Technol ,110:295–301.

Friedewald W.T. , Levy R.I. and Frederickson D.S. (1972):
Estimation of the concentration of low-density lipoprotein cholesterol in plasma without use of the preparative ultracentrifuge. Clin Chem ,18:499 –502.

Fuleki T. and Francis F.J.(1968):
Quantitative methods for anthocyanins. 1. Extraction and determination of total anthocyanin in cranberries. J Food Sci. ,33:72–77.

Guillon F. and Champ M.M.(2002):
Carbohydrate fractions of legumes: uses in human nutrition and potential for health. Br J Nutr. 88 (3): S293–S306.

Howarth N.C., Saltzman E. and Roberts S.B. (2001) :
Dietary fiber and weight regulation. Nutr Rev. ,59:129–139.

Hughes L.A., Arts I.C., Ambergen T., Brants H.A., Dagnelie P.C., Goldbohm R.A., van den Brandt P.A. and Weijenberg M.P.(2008) :
Higher dietary flavone, flavonol, and catechin intakes are associated with less of an increase in BMI over time in women: a longitudinal analysis from the Netherlands Cohort Study. Am J Clin Nutr , 88(5):1341-1352.

Hurt R.T. and Wilson T. (2012):
Geriatric obesity: evaluating the evidence for the use of flavonoids to promote weight loss. J Nutr Gerontol Geriatr. 31(3):269-89 .

Ibarra J. **(2009):**
Obesity and cardiovascular disease . *JLGH* ,4(4) : 130-133.

Kjeldahl J. (1883):
Determination of protein nitrogen food products. In : Encyclopedia of Food Science, 439–441.

Kobori M., Masumoto S., Akimoto Y. and Oike H. (2011):
Chronic dietary intake of quercetin alleviates hepatic fat accumulation associated with consumption of a Westem-style diet in C57/BL6J mice. Molecular Nutrition and Food Research , 55(4) 530–540.

Lairon D. (1996) :
Dietary fibers: effects on lipid metabolism and mechanisms of action. Euro. J Clin Nutr ,50, 125-133.

Lim S., Son K.R., Song I.C., Park H.S., Jin C.J., Jang H.C., Park K.S., Kim Y.B., Lee H.K. (2009) :
Fat in liver/muscle correlates more strongly with insulin sensitivity in rats than abdominal fat. Obesity (Silver Spring).17(1):188-95.

Lopes-Virella, M.F., Stone S., Ellis S. and Collwell J.A.(1977):
Cholesterol determination in high density lipoproteins separated by three different methods. Clin. Chem., 23(5): 882-886.

Macarulla M.T., Medina C., De Diego M.A., Chávarri M., Zulet M.A., Martínez J.A., Nöel-Suberville C., Higueret P.and Portillo M.P. (2001):
Effects of the whole seed and a protein isolate of faba bean (Vicia faba) on the cholesterol metabolism of hypercholesterolaemic rats British Journal of Nutrition , 85, 607-614.

Madar Z. and Stark A.H.(2002):
New legume sources as therapeutic agents. Br J Nutr, 88:287-292.

Maffei M., Halaas J., Ravussin E., Pratley R.E., Lee G.H., Zhang Y., Fei H., Kim S., Lallone R. and Ranganathan S. (1995):
Leptin levels in human and rodent: measurement of plasma leptin and ob RNA in obese and weight-reduced subjects. Nat Med;1:1155–1161.

Nielsen S.S. (1998):
Food analysis ,2nd ed., Gaithersburg: Aspen Publication.

Nishi S., Saito Y., Souma C., Kato J., Koaze H., Hironaka K. and Kojima M.(2008):
Suppression of serum cholesterol levels in mice by adzuki bean polyphenols. Food Sci Technol Res, 14 (2): 217 –220 .

Novelli E.L., Diniz Y.S., Galhardi C.M., Ebaid G.M., Rodrigues HG, Mani F., Fernandes A.A., Cicogna A.C., Novelli Filho J.L.(2007):
Anthropometrical parameters and markers of obesity in rats. Lab Anim. ,41(1):111-119.

Pai S., Ghugre P.S. and Udipi S.A. (2005) :
Satiety from rice-based, wheat-based and rice-pulse combination preparations. Appetite, 44:263–271.

Park K.Y., Kwon S.H., Ahn, I.S., Kim S.O., Kong C.S., Chung H.Y. and Do M.S. (2007):
Weight reduction and lipid lowering effects of black soybean anthocyanins in 480 rats fed high fat diet. The FASEB J. 21:842-846 .

Prior R.L., Wu X.(2006):
Anthocyanins structural characteristics that result in unique metabolic patterns and biological activities. Free Radic Res ,40: 1014–1028.

Reeves P.G., Nielsen F.H., Fahey G.C. and Ain J.R.(1993):
Purified diets for laboratory rodents: final report of the American Institute of Nutrition ad hoc writing committee on the reformulation of the AIN-76A rodent diet. J Nutr., 123,1939–1951.

Singleton V.L. and Rossi J.A.(1965):
Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. Am. J. Enol. Vitic. ,16:144–158.

Steel R.G. and Torrie J. H. (1980):
Principles and Procedures of Statistics: aBiometrical Approach. 2nd ed ,New York: McGraw-Hill.

Strader A.D. and Woods S.C. (2005):
Gastrointestinal hormones and food intake. Gastroenterology 128:175–191.

Strobel P., Allard C., Perez-Acle T., Calderon R., Aldunate R., Leighton F. (2005):
Myricetin, quercetin and catechin-gallate inhibit glucose uptake in isolated rat adipocytes. Biochem J., 386(Pt 3):471-478.

Thompson L.U., Button C.L.and Jenkins D.J.(1987):
Phytic acid and calcium affect the in vitro rate of navy bean starch digestion and blood glucose response in humans. Am J Clin Nutr. 46:467–473.

Tsuda T.(2008):
Regulation of adipocyte function by anthocyanins; possibility of preventing the metabolic syndrome. J Agric Food Chem ,56:642–646.

Valko M., Leibfritz D., Moncol J., Cronin M.T., Mazur M. and Telser J. (2007):
Free radicals and antioxidants in normal physiological functions and human disease. Int. J. Biochem. Cell Biol., 39: 44-84.

Vidyavati H.G., Manjunatha H., Hemavathy J. and Srinivasan K. (2010):
Hypolipidemic and antioxidant efficacy of dehydrated onion in experimental rats. Journal of Food Science and Technology ,47 (1) 55-60.

WHO (2005):
World health organization global comparable estimates, 2010, from: https://apps.who.int/infobase/Comparisons.aspx.

Wolfram S., Raederstorff D., Wang Y., Teixeira S.R., Elste V. and Weber P. (2005):
TEAVIGO (epigallocatechin gallate) supplementation prevents obesity in rodents by reducing adipose tissue mass. Ann Nutr Metab,49(1):54–63.

Zang M., Xu S., Maitland-Toolan K.A., Zuccollo A., Hou X., Jiang B., Wierzbicki M., Verbeuren T.J. and Cohen R.A.(2006):
Polyphenols stimulate AMP-activated protein kinase, lower lipids, and inhibit accelerated atherosclerosis in diabetic LDL receptor-deficient mice. Diabetes.,55(8):2180-21

تأثير تناول الفول البلدي و البصل الأحمر على خصائص فقدان الوزن في الفئران المصابة بالبدانة

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الملخص العربى

يعتبرالفول البلدى والبصل الأحمر من الأطعمة التي يعتاد بعض المصريين على تناولها معا كجزء من وجباتهم الغذائية. تهدف هذه الدراسة إلى إستكشاف تأثير الإستهلاك اليومي من الفول والبصل الأحمر على خصائص فقدان الوزن في الفئران المصابة بالبدانة. تم تحليل المحتوى الكميائي ، الفينولات العديدة الكلية والأنثوسيانين فى كلا من الفول و البصل الأحمر. تم تقسيم خـمسة وأربعين فأر إلى مجموعتين. المجموعة الضابطة السالبة (العدد = ٩) و التى غذت على غذاء أساسى خلال فترة التجربة و مجموعة غذت على غذاء عالي فى الدهون (العدد=٣٦). بعد إحداث البدانة (٤ أسابيع) قسمت هذة المجموعة إلى أربعة مجموعات متساوية (ن = ٩) غذت بغذاء مرتفع الدهون ، غذاء مرتفع الدهون+٥% فول ، غذاء مرتفع الدهون+٥% بصل أحمر، غذاء مرتفع الدهون+ (٥% فول و ٥% بصل أحمر) على التوالى لمدة ٤ أسابيع اخرى. تم حساب مؤشر كتلة الجسم و إجراء التحليلات الكيميائية الحيوية (صورة دهون مصل الدم وتركيزات هرمون اللبتين) . أظهرت النتــائج أن محتوى الفينولات العديدة فى الطبقة الخارجية من البصل الأحمر كان اعلى بدرجة ملموسة عن محتوى الفول البلدى او الطبقة الداخلية للبصل الأحمر، أما بالنسبة للأنثوسيانين فلم يتم تقدير اى كميات منه فى الفول البلدى. أظهرت النتائج أن مؤشر كــتلة الجسم و صورة دهون مصل الــدم خــاصة الجلسريدات الثلاثية كــانت أعلى بشكل ملموس في المجموعة التى تغذت على غذاء عالي فى الدهون. إضـــافة الفول والبصل الأحـــمر أحدثت تحســنا كبيرا في جميع الــقــياسات التى تم دراستها ولكن أفضل تأثير تم ملاحظــتة كان فى المجموعة التى تــناولت خـــليط الفول والبصل الأحمر و ذلك بسبــب التأثـــيرالمتداخل لمكوناتها المختلفة معا . توصى الدراســة بضرورة إجـراء مــزيد من البـحوث بما في ذلك التجــارب السريرية لتوضــيح آليات عمل وتــأثير الأنواع المختلفة من الفينولات العــديدة الموجودة بالفول والبصل الأحمر.

الكلمات المفتاحية : الفول البلدى - البصل الأحمر- الفينولات العديدة- الأنثوسيانين، مؤشر كتلة الجسم اللبتين – البدانة -الفئران.