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Effect of Whole Wheat (*Triticuma estivum*) and Oat (*Avena sativa*) Supplements on Body Weight, Insulin Resistance and Circulating Omentin in Obese Women Exhibiting Metabolic Syndrome Criteria

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Abstract: The aim of this study is to investigate the effect of two slimming dietary therapies comprising two oat (*Avena sativa*) supplements mixed with two different wheat (*Triticuma estivum*) grain extract on obese women exhibiting metabolic syndrome criteria. Seventy four obese women divided into two groups; group (A), 42 women and group (B), 32 women. In the first 4 weeks (phase 1), group (A) consumed a hypocaloric diet supplemented by a formula of whole grains of oat and wheat, while group (B) differed only in that the wheat was 72% extract. In the last 4 weeks (phase 2) both supplements were omitted. All participants were subjected to full medical examination, 24-hour dietary recall, anthropometric measurements and estimation of serum adipocytokine omentin and C-peptide among other relevant biochemical parameters mirroring the disorder. Results revealed mid–study decreases in the anthropometric measurements and the levels of fasting blood glucose, C-peptide, insulin resistance and omentin which were significant except for omentin. At the end of (phase 2), group (A) showed a remarkable significant increase in omentin highlighting its close relationship with the weight which was evidenced by being negatively correlated with BMI. In conclusion, using customized dietary therapy containing whole grains of oat and wheat resulted in reducing body weight, increased circulating omentin, decreased C-peptide and insulin resistance which could potentially benefit metabolic syndrome patients.

Key words: Obesity · Metabolic Syndrome · Omentin · C-Peptide · Oat · Wheat

INTRODUCTION

Obesity is a heterogeneous condition with respect to regional distribution of fat tissue; visceral (central) obesity refers to fat accumulation within omental (Om) and mesenteric fat depots, whereas peripheral obesity generally refers to sub-cutaneous (SC) fat accumulation. Many epidemiological studies [1-3] have shown that visceral obesity is associated with a higher risk of obesity-related co-morbidities, such as insulin resistance; type 2 diabetes, cardiovascular disease and dyslipidemia, than is peripheral obesity. However, the underlying mechanism is not well understood. Presumably, distinctive biological properties of visceral fat contribute to the increased pathogenicity of central obesity. For example, an excess of cortisol causes the preferential growth of visceral fat depots [4] and treatment of human immunodeficiency virus patients with protease inhibitors leads to an accumulation of visceral fat but a depletion of sc fat [5,6]. In vitro studies have demonstrated that abdominal visceral fat tissue is relatively resistant to the antilipolytic effect of insulin [7] and more responsive to the stimulatory lipolytic effect of catecholamines [8]. At a molecular level, visceral fat expresses higher levels of interleukin-6 [9], interleukin-8 [10], plasminogen activator inhibitor-1 [11] and angiotensinogen [12] than subcutaneous fat.

Circulating levels of omentin inversely correlate to the number of metabolic risk factors. Individuals with excess of visceral fat accumulation have a high risk of the development of metabolic syndrome [13]. Among various human tissues, visceral adipose tissue produces a large

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amount of omentin and its gene expression in visceral fat depot is reduced in obese subjects [14]. Low levels of circulating omentin are associated with obesity-induced metabolic dysfunction such as insulin resistance and glucose intolerance [14,15]. These observations suggest that reduced levels of omentin may be an indicator of visceral fat accumulation, thereby correlating with the clustering of metabolic disorders.

The primary role of diet is to provide enough nutrients to meet metabolic requirements while giving the consumer a feeling of satisfaction and well-being. Recent knowledge, however, supports the hypothesis that, beyond meeting nutritional needs, diet may modulate various functions in the body and may either play detrimental or beneficial roles in some diseases. Oat (*Avena sativa*) is distinct among the cereals due to its multifunctional characteristics and nutritional profile. Recent advancement in food and nutrition has revealed the importance of its various components. It is a good source of dietary fiber especially beta-glucan, minerals and other nutrients. Oat and oat by products have been proven to be helpful in the treatment of diabetes and cardiovascular disorders. The incorporation of oat grains and oat bran in the food products improves not only the nutrition but also as a therapy against various maladies [16]. Recent study suggests that wholegrain oat-based breakfast cereals may be prebiotics and have the potential to have low glycemic Index [17].

The aim of this study is to investigate the relation between serum omentin concentration in obese patients and the different metabolic syndrome criteria, also to highlight the effect of a dietary therapy composed of a hypocaloric diet and a supplement containing whole oat and wheat, in alleviating these metabolic disorders.

MATERIALS AND METHODS

Materials: Wheat grains (Giza 168) was purchased from Wheat Research Department, Field Research Institute, Agric. Res. Center, Giza, Egypt. Wheat flour (WF) 72% extraction was purchased from the North Cairo Flour Mills Company, Egypt. Oat flour was obtained from local shop, Dokki, Egypt. Skimmed milk, shortening, corn oil, baking powder, emulsifier, vanilla and bread improver were purchased from the local market, Dokki, Egypt.

Preparation of Flour: Wheat grains (Giza 168) were cleaned, tempered (15% moisture) and milled (Quadrumat Junior flour mill) to 100 % extraction flour. Whole meal wheat flour (WMWF) 100 % extraction was well blended with oat flour (OF) to produce individual mixtures containing 0, 25 and 50% replacement levels. All samples were stored in airtight containers and kept at 5-7°C until required.

Table 1: Composition of the two different biscuits (in grams)

Items	Biscuit (1)	Biscuit (2)
WMWF	38.7	-
WF (72%)	-	38.7
OF	38.7	38.7
Corn oil	10.8	10.8
Skimmed milk	10.8	10.8
Baking powder	0.5	0.5
Flavors	0.5	0.5

WMWF: Whole meal wheat flour WF: Wheat flour 72% OF: Oat flour

Preparation and Evaluation of Snacks: Basic and modified formulae were prepared by mixing WMWF extraction (biscuit 1) and wheat flour (72%) (Biscuit 2) with OF at levels 50 %with other ingredients according to Table (1). Then a suitable amount of water was added according to AOAC [18]. These formulas were baked in a special oven at 200°C for about 15 minutes. Weight, volume, specific volume, diameter, thickness and spread ratio of the snacks were recorded.

Analytical Methods: Moisture, ash, fiber, protein and fat of raw materials and different biscuits were determined according to AOAC [18]. Total carbohydrates were calculated by difference. Individual elements (K, Na, Zn and Mg) in the two biscuits were determined according to the method described by Chapman and Pratt [19]. Fatty acids were determined using standard methods [20].

Subjects: Seventy four obese women suffering from metabolic syndrome (MetS), shared as volunteers in this study which lasted for 8 weeks. The study was divided into two phases, phase (1) and phase (2); each one lasted for 4 weeks. Their mean age was 48.8±0.87 years and had a mean BMI of 38.6± 0.90 kg/m^2. The patients were divided into two groups, group (A) and group (B). At phase (1), group (A) followed a low caloric balanced diet (1000- 1200 K calories), supplemented by the 50% OF plus 50% WMWF biscuits, that was consumed before breakfast (2 biscuits) and before dinner (1biscuit), each biscuit weighing 20g, while group (B) consumed the biscuits made from 72% WF(50%) and OF (50%) according to the same protocol. Phase (2) lasted for 4 weeks in which the volunteers were following only the same low caloric balanced diet. All women were subjected to thorough clinical examination. Blood pressure was recorded.

The protocol of the study was approved by the National Research Center Ethics Committee. In addition informed consent was obtained from each participant to be included in the study.

Anthropometric Parameters and Blood Pressure Measurements: Relevant anthropometric measurements were recorded including height, weight and waist circumference using standard methods [21]. BMI was calculated (weight in kg/ height² in meter). Blood pressure for each patient was measured 3 times and the mean was recorded.

Blood Sampling and Biochemical Analysis: Fasting blood samples (after 12 hour fasting) were drawn from the patients. Fasting blood glucose was determined on fresh samples; other biochemical parameters were performed on fasting sera that were stored at -70°C until used. Fasting blood glucose (FBG) was determined in fresh samples using glucose oxidase method [22]. Serum total cholesterol, HDL-C and triglycerides were done using; cholesterol proceed No 1010, Stanbio Liquicolor [23], HDL-C proceed No 0599 Stanio Liquicolor [24] and triglycerides proceed No 2100, (Enzymatic method) [25] respectively. LDL-C was calculated according to Friedewald equation [26]. Serum C peptide was done by ELISA kit. PR. Code=2725-300A. Lot#EIA-27K2G1. Monobind, Inc. Lake Forest, CA (92630) USA [27]. Modified homeostatic model assessment of insulin resistance (M.HOMA-IR) was calculated, where M.HOMA-IR=1.5+fasting blood glucose x fasting c-peptide/2800 [28], in which insulin was replaced by C-peptide so as to be applied on diabetic patients using exogenous insulin. Ometin determination was done by human omentin -1 ELISA kit RD191100200R, Lot no E 12-108 Bio Vendor – Laboratomimedicinaa.s Czech Republic [29].

Dietary Recalls: Collecting detailed data about nutritional habits and intake through: 24 recall Diet history. Analysis of food items using World Food Dietary Assessment System, (WFDAS), 1995, USA, University of California.

Statistical Analysis: All values were expressed as mean value ±SE. Two tailed student t-test was used to compare between different phases in the same group. Correlation between the different parameters was tested by Pearson test. P values <0.05 were considered statistically significant. SPSS window software version 17.0 (SPSS Inc. Chicago, IL, USA, 2008) was used.

RESULTS

Tables (2 & 3) summarized the average of moisture, protein, fat, crude fiber and ash of the WMWF 100% extraction, WF 72% extraction, OF and biscuits produced from them, in addition to some mineral contents of the two products.

Figures (1& 2,) showed the relative area% of fatty acids profile in the WMWF and 50% OF biscuit, WF and 50% OF biscuits respectively, which showed the high percent of linoleic and linolenic acids in both types.

Table (4) showed a comparison between the different macronutrients and micronutrients intakes of the whole sample before starting the regimen and of the two regimens phases. The data showed the balanced and healthy distribution of the macronutrients in the two regimens compared to the habitual diet of the patients.

Table (5) showed the mean± SE of age, anthropometric, blood pressure measurements of group (A) and group (B) at the start of the study and at the end of the two phases of regimen. All the anthropometric measurements of the two groups decreased significantly at p<0.05-0.01 at the end of phase (1). Significant reduction of all the anthropometric measurements reported in group (A) at the end of phase (2), blood pressure values decreased numerically. Patients of group (B) showed significant increase in the anthropometric measurement by the end of the second phase. Group (B) showed significant decrease in SBP and DBP by the end of the phase 1, while significant decrease in SBP only was detected by the end of phase 2.

Table (6) showed the results of the studied biochemical parameters of the two groups before and at the end of the two phases. At the end of phase (1) the FBG and the lipid profile levels decreased significantly at p< 0.01, the percent decrease was high in group (A) in case of TC, LDL-C and non HDL-C concentration, while equal significant increase was found in the level of HDL-C between the two groups. The De Ritis ratio improved significantly in group (A). Significant decrease in the C-peptide concentration and M.HOMA-IR level were detected. Omentin concentration showed numerical decrease in the two groups. At the end of phase (2) most of the aforementioned parameters significantly increased in the two groups, with significant decrease in the HDL-C at <0.05-0.01. De Ritis ratio and omentin concentration increased significantly in group (A). C-peptide numerically increased in both groups.

Table 2: Chemical composition of raw materials and biscuits (mean ± SE)

Samples	Moisture (%)	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	T.C. (%)
WMWF 100% extraction	13.00a±0.15	13.5g±0.10	2.5^{h}±0.01	1.75^{f}±0.001	1.65^{e}±0.002	80.60^{b}±0.85
WF 72% extraction	11.5b±0.11	12.50i±0.12	1.65^{i}±0.03	0.91^{h}±0.003	0.71^{g}±0.003	84.23^{a}±0.81
Oat flour (OF)	7.12c±0.13	16.8a±0.17	5.0^{g}±0.05	4.82^{a}±0.002	1.85^{d}±0.001	71.53^{f}±0.72
Biscuits from						
WMWF (Control)	5.32^{g}±0.17	13.80^{e}±0.11	8.05^{e}±0.07	1.71^{g}±0.001	1.67^{e}±0.001	74.73^{e}±0.65
50% WMWF+50% OF	7.18^{c}±0.09	16.32^{b}±0.12	12.15^{a}±0.06	3.50^{b}±0.007	2.65^{a}±0.002	65.38^{h}±0.60
WF (Control)	5.02^{h}±0.07	12.72^{h}±0.13	7.22^{f}±0.02	0.92^{h}±0.009	0.72^{g}±0.001	78.42^{c}±0.45
50% WF+50% OF	6.85^{d}±0.11	14.65^{d}±0.15	9.82^{c}±0.04	3.12^{c}±0.003	2.00^{c}±0.003	70.41^{g}±0.55
LSD at 0.05	0.082	0.092	0.087	0.175	0.059	1.52

Table 3: Minerals content of two biscuits (mg/ 100g dry weight)

Samples	K %	Zn%	Na %	Mg %
Biscuit 1 (50% WMWF+50%OF)	320.96	5.34	302.34	29.82
Biscuit 2 [50% WF (72%)+50%OF]	364.78	11.28	369.51	56.75

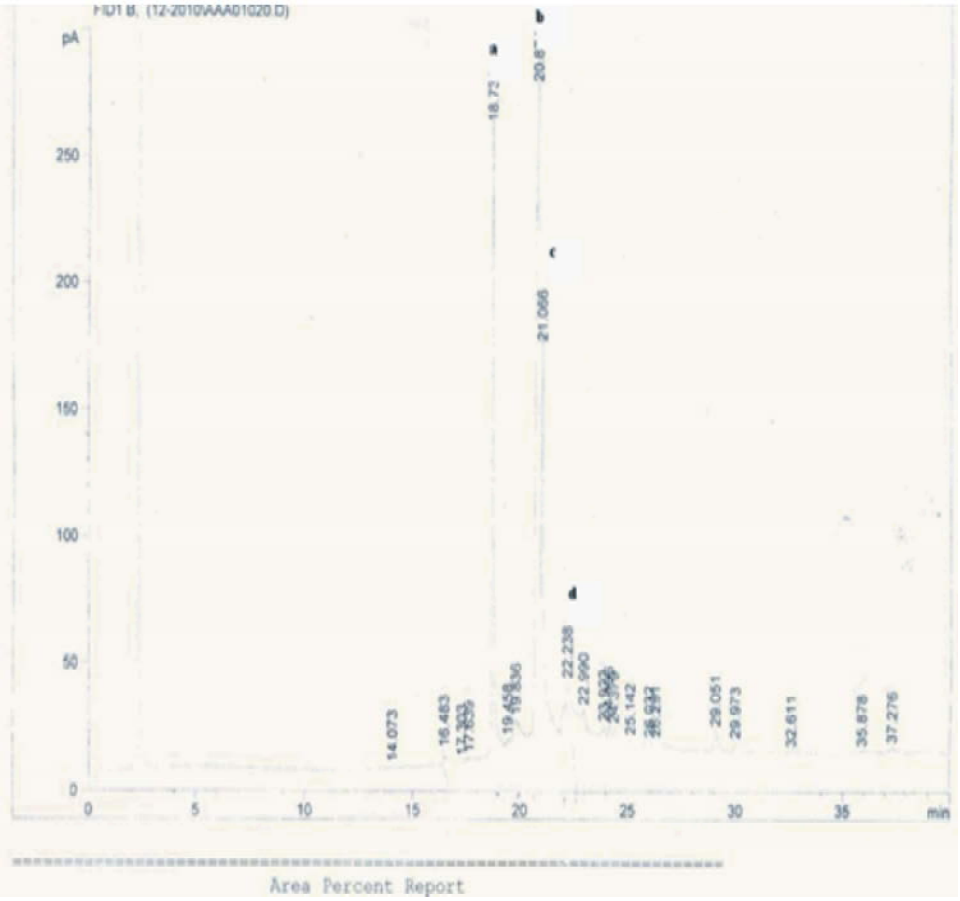

Fig. 1: Relative area percentages of fatty acids contents of Biscuit 1[OF/WMWF (50%+50%)], a: Palmeto-oleic acid (C16:1), 13 %, b: Oleic acid (C18:1) n-9, 5%, c: Linoleic acid (C18:2) n-6, 33% and d: Linolenic acid (C18:3) n-3, 13.5%

Table (7) showed the correlation coefficient between omentin, C-peptide levels and the MetS criteria, De Ritis ratio, M.HOMA-IR at the start of the study. Significant negative correlation was found between the circulating omentin and BMI and significant positive correlation with the De Ritis ratio and SBP. C-peptide showed significant positive correlation with the MWC, FBG, ALT and M. HOMA; and negative correlation with HDL-C.

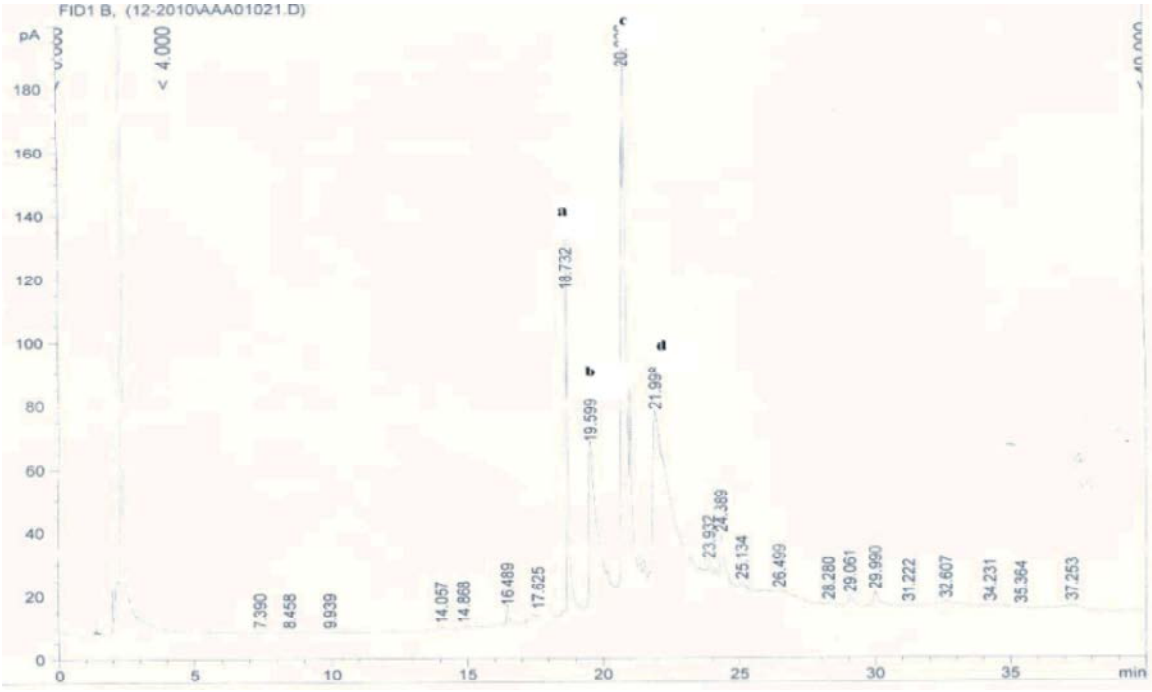

Fig. 2: Relative area percentages of fatty acid profiles of Biscuit 2 [OF/WF72 %(50%+50%)], a: Palmeto-oleic acid (C16:1) 5.3%, b: Oleic acid (C18:1) n-9, 8.8%, c: Linoleic acid (C18:2) n-6, 18.2% and d: Linolenic acid (C18:3) n-3, 21.1 %

Table 4: Mean values and % of the recommended dietary allowance of nutrient intake of different types of diet among the obese women

	Habitual diet	Baladi Bread	Biscuit 1	Biscuit 2	
Nutrient intake	Mean value %RDAS	Mean value %RDAS	Mean value %RDAS	Mean value %RDAS	RDA
Energy (kcal)	2802.61	966.42	921.36	926.43	2200
	127.38	43.93	41.88	42.10	
Protein (g)	98.05	51.49	57.47	56.60	50
	169.10	102.98	114.94	113.2	
Fat (g)	127.43	30.89	29.31	28.83	
Carbohydrate(g)	311.06	116.42	102.45	105.62	
Dietary fiber (g)	30.48	16.71	18.65	17.38	
Vitamin A (µg)	567.24	765.24	774.21	773.57	800
	70.91	95.66	96.78	96.69	
Vitamin D (µg)	1.97	3.21	3.23	3.20	5
	39.40	64.20	64.60	64.00	
Sodium (mg)	700.72	280.01	245.10	249.23	500
	140.14	56.01	49.02	49.85	
Potassium (mg)	929.93	1633.51	1669.95	1658.35	2000
	46.49	81.68	83.49	82.92	
Calcium (mg)	731.63	891.46	920.32	918.92	1000
	73.16	89.15	92.03	91.89	
Iron (mg)	6.35	11.12	11.83	11.80	15
	42.33	74.13	78.87	78.67	
Zinc (mg)	6.27	10.45	10.98	10.78	
	52.25	87.08	91.50	89.83	12
Sat. FA (g)	42.91	9.62	10.68	10.61	
MUFA (g)	40.09	10.72	11.04	10.99	
PUFA (g)	34.95	8.30	5.66	5.44	
Cholesterol (mg)	437.93	88.41	85.64	85.79	

MUFA: monounsaturated fatty acids, PUFA: polyunsaturated fatty acids

Table 5: Mean± SE of anthropometric parameters and blood pressure of obese women at the baseline and at the end of the two phases of the dietary therapy

	Group (A) (no.=42)			Group (B) (no.=32)		
Parameters	Baseline (1st visit)	Mid (2nd visit)	Last (3rd visit)	Baseline (1st visit)	Mid (2nd visit)	Last (3rd visit)
Age (year)	48.24± 1.17			48.63±1.28		
Height (cm)	154.75±0.84			154.88±0.95		
Weight (Kg)	92.12± 1.59	89.01±1.49**a	85.49±1.71**b	93.13±2.05	90.04±1.79**a	90.37±2.48**b
BMI (Kg/m^2)	38.53± 0.69	37.25±0.67**a	35.73±0.78**b	39.11±1.01	37.80±0.89**a	38.19±1.19**b
Body fat (%))	47.83±0.65	46.37±0.73**a	44.73±1.09**b	48.83±0.84	46.94±0.84**a	48.31±1.01
Waist (cm)	97.12± 1.06	92.33±0.99**a	89.53±1.25**b	98.03±1.52	92.90±1.57**a	93.50±1.71
Hip (cm)	121.21± 1.44	117.27±1.19**a	114.17±1.62**b	122.48±1.92	116.13±1.76**a	116.30±2.31**b
WHR (cm/cm)	0.80±0.01	0.79±0.01**a	0.79±0.01	0.80±0.01	0.80±0.01	0.81±0.01
SBP (mmHg)	120.24±2.80	116.43±1.79	114.64±2.80	130.86±3.28	125.36±2.73*a,	114.44±3.26**b
DBP (mmHg)	79.05±1.55	76.67±1.43	71.07±1.59	81.43±2.17	76.43±1.56*a	74.44±2.39

BMI: body mass index, WHR: waist hip ratio, SBP: systolic blood pressure, DBP: diastolic blood pressure
*P<0.05 **P<0.01 a: Base vs. Mid b: Mid vs. Last of the same group

Table 6: Mean± SE of fasting blood glucose, lipid profile, liver enzymes C-peptide, M.HOMA-IR and omentin of obese women at the baseline and at the end of the two phases of the dietary therapy

	Group (A) (no.=42)			Group (B) (no.=32)		
Parameters	Base (1st visit)	Mid (2nd visit)	Last (3rd visit)	Base (1st visit)	Mid (2nd visit)	Last (3rd visit)
FBG (mg/dl)	95.42±2.84	79.87±1.72**a	88.34±2.99**b	90.72±1.84	85.52±1.53**a	83.13±2.01
T. cholesterol(mg/dl)	230.08±8.15	183.58±5.64**a	186.70±6.90*b	208.76±6.66	184.54±4.99**a	205.68±7.24**b
LDL-C (mg/dl)	148.52±8.25	97.98±6.29**a	125.82±8.52**b	130.39±7.34	101.47±5.00**a	125.85±8.88**b
HDL-C (mg/dl)	50.03±1.57	61.41±1.94**a	57.04±1.70**b	49.23±1.61	60.61±2.24**a	53.39±2.61**b
Non HDL-C(mg/dl)	180.05±8.85	122.18±6.72**a	148.97±9.64**b	159.52±7.59	123.93±4.91**a	152.28±8.62**b
Risk factor (T.cholesterol/ HDL-C)	4.87±0.29	3.17±0.17**a	3.82±0.26**b	4.43±0.23	3.13±0.11**a	4.05±0.27**b
Triglycerides (TG) (mg/dl)	157.63±7.64	120.95±4.96**a	115.76±8.41	145.68±6.71	112.29±5.61**a	132.16±10.40
AST (IU/L)	32.17±1.27	28.51±1.19**a	30.0±1.50**b	29.55±1.32	25.65±1.19**a	25.64±1.19
ALT (IU/L)	50.29±1.21	38.74±1.18**a	43.54±1.45*b	49.87±0.98	40.42±1.18**a	43.14±1.93*b
DeRitis ratio (AST/ALT)	0.64±0.02	0.75±0.03	0.78±0.04	0.59±0.03	0.65±0.04	0.64±0.05
C-peptide (ng/ml)	4.73±0.64	2.53±0.45**a	3.02±0.43	5.08±0.56	2.13±0.28**a	2.65±0.42
M.HOMA-IR	1.66±0.03	1.58±0.02**a	1.60±0.02**b	1.67±0.18	1.57±0.01**a	1.58±0.01
Omentin (ng/ml)	687.71±57.82	669.80±54.30	700.0±45.78**b	790±64.18	724.0±73.52	650.90±70.48

FBG: fasting blood glucose, AST: aspartate transaminase, ALT: alanine transaminase, M.HOMA-IR: modified homeostatic model assessment of insulin resistance. *P<0.05 **P<0.01 a: Baseline vs. Mid b: Mid vs. Last of the same group

Table 7: Correlation coefficient between omentin, C-peptide and metabolic syndrome criteria, liver enzymes, C-peptide, M.HOMA-IR

Parameters	Omentin (ng/ml)	C-peptide (ng/ml)
Weight (kg)	-0.069	0.800
BMI (kg/m^2)	-0.017*	0.234
MWC (cm)	0.218	0.002**
SBP (mmHg)	0.005**	0.356
DBP (mmHg)	0.051	0.251
FBG (mg/dl)	0.365	0.003**
TG (mg/dl)	0.840	0.000**
HDL-C (mg/dl)	0.070	-0.000**
AST (IU/L)	0.063	0.098
ALT (IU/L)	-0.697	0.001**
De- Ritis ratio (AST/ALT)	0.038*	0.763
C-peptide (ng/ml)	0.942	1
M.HOMA-IR	0.629	0.000**

MWC: minimal waist circumference
Numbers presented in this table are the value of r =correlation coefficient
*Correlation is significant at the 0.05 level; **Correlation is significant at the 0.01 level

DISCUSSION

The baseline data of this study showed that the patients of the two groups had high levels of all the anthropometric measurements above the recorded standards values. In addition, the biochemical parameters showed high concentrations of the TC and non-HDL-C that denoted a metabolic lipid profile disorder. Serum C-peptide concentrations as an indication of functional β-cell mass showed mild C-peptidemea (>3.75ng/ml). C-peptide plays a role in early atherogenesis in patients with diabetes mellitus and may be a marker for cardiovascular morbidity and mortality in patients without diabetes [30]. The means of the DeRitis ratio (AST/ALT) of the two groups were <1 which predicted the development of nonalcoholic fatty liver disease (NAFLD). Metabolic syndrome is not only associated with higher

risk of precipitating type 2 diabetes mellitus and cardiovascular events, but also impacts on liver in different ways. Nonalcoholic fatty liver disease is considered to be the hepatic manifestation of MetS and it is characterized by triglyceride accumulation and a variable degree of hepatic injury, inflammation and repair [31].

At the end of phase (1) both groups showed significant decreases of the anthropometric parameters and blood pressure, in addition to the improvement in the FBG, serum lipid profile, De Ritis ratio, C-peptide and M.HOMA-IR. In this context we could suggest that the consumption of oat and wheat which contains healthy bioactive ingredients resulted in reduced obesity and abdominal fat, also improved lipid profiles, insulin resistance and liver functions. Taken as a daily supplement, oat and wheat mixtures could act as an adjuvant therapy for metabolic disorders.

At the end of phase (2) in which the supplements were omitted the extended effect of the supplements on liver functions was more prominent in group (A) as the level of the De Ritis ratio value was still improving, in spite of the levels of the other parameters in both groups increased towards the baseline values. The relative tendency to increase in the LDL-C and non HDL-C concentrations at the end of this phase could be explained by the absence of the effect of the oat beta glucan on the serum lipids after stopping both supplements.

Adipocytokines have been found to control insulin sensitivity, inflammatory activity, neuroendocrine activity, cardiovascular function, food and water intake, breeding and bone metabolism. Few of these adipokines play a positive role in the metabolism promoting good health, while few of them pose adverse effects. Omentin is a recently identified adipocytokine that is falls under the category of being a good adipokine. Plasma omentin-1 levels are significantly decreased in patients with obesity, insulin resistance and diabetes all of which contribute to the major components of the metabolic syndrome and other disease conditions like atherosclerosis and autoimmune disorders [32]. A previous study showed that omentin stimulates glucose uptake in response to insulin in cultured adipocyte, suggesting that omentin exerts beneficial actions on insulin sensitivity [33].

It had been reported that omentin mRNA is highly expressed in omental adipose tissue. The omentin mRNA expression level decrease in over weight/obese individuals and decrease further when overweight / obesity is combined with type 2 diabetes. Omentin mRNA is positively correlated to serum omentin level, obesity indexes, insulin resistance and lipid metabolism parameters. Decrease omentin gene expression may contribute to the underlying pathophysiology insulin resistance syndrome [34].

Omentin is produced by visceral fat and its local concentration in visceral fat may far exceed that in the circulation or in SC fat. Thus, on a local level, within the omentum adipose depot, omentin may act as a paracrine factor to enhance insulin sensitivity and glucose metabolism and thereby modulate the distribution of body fat between visceral and subcutaneous fat depots. On the other hand, because omentin circulates in blood, it may also act at distant sites, e.g., muscle, liver and sc fat, to enhance insulin sensitivity and glucose metabolism and thus may play a wider role in nutrient storage and partitioning. Subcutaneous fat comprises more than 80% of the adipose tissue in the human body. Hence, the fact that omentin circulates systemically and potentiates insulin action in subcutaneous fat may be of physiological and perhaps pathophysiological importance [35]. In accordance with the above literature were the results recorded by omentin in group (A) where the net increase in its level was accompanied by a -7.10% decrease in body weight together with a -7.82% decrease in the MWC, thus pointing to a parallel reduction in abdominal visceral obesity.

Due to the pivotal importance of omentin, the results of group (A) in which the supplement was composed of the whole grains of both oat and wheat caused the increase of omentin level by 4.51% after 8 weeks, while in group (B) in which the wheat in the supplement was 72% extracted, caused a decrease of -10.10% in its level after the same period of time which was the end of the study. This highlights the advantage of whole grains in benefiting the metabolism with important parameters.

CONCLUSION

In conclusion, based on the results of this study, determination of C-peptide and liver enzymes in metabolic syndrome obese subjects could predict the early development of cardiovascular and liver complications. The circulating adipocytokine omentin was associated with body adiposity and was increased with adequate weight control. In addition, using a dietary therapy composed of a hypocaloric balanced regimen and a supplement formula of whole grains of oat and wheat results in increased omentin and decreased C-peptide and insulin resistance, a benefit which could potentially support metabolic syndrome obese patients.

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