ORIGINAL ARTICLES

Metabolic Syndrome: Potential Benefit From Specific Nutritional Dietary Therapy

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ABSTRACT

The aim was to investigate the effect of a dietary supplement on the different criteria of the metabolic syndrome (Mets). Fifty eight obese Mets women with mean age of 48.8±0.87 years and mean Body Mass Index (BMI) of 38.6± 0.90 kg/m², volunteered for 8 weeks, divided into two equal phases to follow a low caloric balanced diet (1000- 1200 K calories). In phase 1, the diet was supplemented firstly by 30% doum biscuits (Group A= 34 patients), secondly by whole meal wheat flour (WMWF) biscuits (group B= 24 patients). In phase (2) both supplements were omitted. All patients were monitored clinically anthropometrically and biochemically by estimating hemoglobin, fasting blood glucose (FBG), lipid profile and C-peptide concentrations. Chemical, rheological and organoleptic characteristics of the biscuits were determined. While both biscuits contain high percentage of linoleic and linolenic fatty acids, and glutamic acid, the doum biscuit contains in addition higher concentrations of crude fiber and polyphenols. Reduction of all the anthropometric measurements and the blood pressure values were recorded in both groups by the end of both phases. Also hemoglobin and High Density Lipoprotein- Cholesterol (HDL-C) significantly increased, while the other lipid parameters, FBG, C-peptide and Modified HOMA-IR significantly decreased among both groups by the end of phase 1. On the contrary, after omission of the supplements in phase 2, there was a significant decrease in(HDL-C),while the other parameters significantly increased, more so among group (B), thus favouring the choice of the doum biscuit. In conclusion, the combination of hypocaloric diets with specifically chosen supplements, act synergistically directing the metabolism towards normalization especially if adopted as long term policy in the management of the metabolic syndrome.

Key words: Metabolic syndrome, Dietary therapy, C-peptide.

Introduction

The prevalence of metabolic syndrome (MetS) manifestation is rapidly increasing worldwide, and is becoming an important health problem. Actually, MetS includes a combination of clinical complications such as obesity (central adiposity), insulin resistance, glucose intolerance, dyslipidemia, non-alcoholic fatty liver disease and hypertension. All these alterations predispose individuals to type 2 diabetes and cardiovascular disease including earlier mortality rate among people. Investigations were aimed at the establishment of quantitative definition for the criteria. The most widely used definition was established by the World Health Organization (WHO) and the National Cholesterol Education Program Adult Treatment Panel 111 (NCEP ATP111) (Grundy *et al*., 2005). The International Diabetes Federation (IDF) Epidemiology Task Force suggested a new definition for the MetS, focusing on central obesity, (Alberti *et al*., 2005).

The investigation of food components that may deal with the MetS feature is an important field to ameliorate and facilitate MetS dietary –based therapies, (Abete *et al*., 2011). The NCEP ATP111 suggested therapeutic lifestyle changes in order to reduce the prevalence of MetS (Expert Panel, 2001). Among several factors related to lifestyle habits; the beneficial effect of diet has already been highlighted in many clinical and epidemiological studies (Kannel *et al*., 1976, Chrysohoou *et al*., 2004). During the last decades, increasing scientific evidence has emerged that protective health effects can be obtained from diets that are rich in fruits, vegetables, legumes and whole grains, and which include fish, nuts, and low-fat dairy products. Hyphaene thebaica is a desert palm native to Egypt, sub- Saharan Africa and West India. It is known in Egypt as the doum or gingerbread palm which grows to 6-9 m and usually has forked stem with fan-shaped leaves. It listed as one of the most useful plant of the world (Fletcher, 1997). The oblong, yellow-orange apple sized fruit has a red outer skin, a thick, spongy and rather sweet fibrous fruit pulp (mesocarp) that tastes like gingerbread and a large kemel. Previous studies on doum had focused on the fruit because of its nutritional value (Martin, 1999). Research on the fruit pulp showed that it contains nutritional trace minerals, proteins, and fatty acids, in

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particular the nutritional essential linoleic acid (Cook *et al*., 2000). Doum was reported to contain important substances including saponins, tannins, and flavonoids (Dosumu *et al*., 2006). Grains high in insoluble fiber (wheat) moderately lower the blood glucose and blood pressure levels but also have a prebiotic effect. Obesity is inversely related to the whole grain intake, but interventional studies with whole grains have not produced weight loss. Visceral fat, however, may be affected favorably. Grain processing improves palatability and can have varying effects on nutrition. For example the process of milling and grinding flour increases glucose availability and decreases phytochemicals content, whereas thermal processing increases available antioxidants. Understanding how individual grains, in both natural and processed states, affect coronary heart disease (CHD) risk can inform nutrition recommendations and policies and ultimately benefit public health (Harris & Kris-Etherton, 2010).

Biscuits are an important product in human diet and are usually eaten with tea and are also used as weaning food for infants. Michael and Peter (2002) studied the possibility of using whole meal grains (100%) in several products to make use of its bran and germ that contain several healthy and nutrient components, and to maximize the yield of flour and reduce the gap between wheat production and consumption. On the other hand, whole meal flour contains the whole product obtained from the milling of cleaned wheat. Bread can only legally be described as whole meal bread if the flour used in its manufacture is whole meal flour, and no other flour is added.

The aim of this study was to investigate the health effects of dietary supplements in the form of two types of biscuits; the first made from whole wheat, while the second type contained 30% doum flour (Hyphaenethebaica), on the different criteria of the MetS among a group of Egyptian metabolic syndrome women.

Materials, Subjects and methods:

Materials:

Wheat grains (Giza 168) was purchased from Wheat Research Department, Field Research Institute, Agriculture Research Center, Giza, Egypt. Wheat flour (WF) 72% extraction was purchased from the North Cairo Flour Mills Company, Egypt. Dry doum flour was obtained from local herbal shop, Dokki, Egypt. Skimmed milk, sucrose, shortening, corn oil, baking powder, emulsifier, vanilla, bread improver and eggs 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 flour100 % extraction (WMWF) was well blended with doum flour (DF) to produce individual mixtures containing 0, 20, 25 and 30% replacement levels. All samples were stored in airtight containers and kept at 5-7ºC until required.

Rheological properties:

Doum flour blends at 0%, 20%, 25% and 30% levels were prepared by replacing whole meal wheat flour (100% extraction). The effect of DF on the mixing profile of the dough was studied using a faringraph (Model Type No: 81010, Brabender OHG, Duisburg, Germany) according to the standard AACC methods (2000).

Preparation and evaluation of biscuits:

Five biscuits recipes (basic and modified formulas) were prepared by using wheat flour (72%) as acontrol, and by mixingwhole meal wheat flour100 % extraction with doum flour at different levels (0, 20, 25 and 30 %) with other ingredients according to table (1). Then 14.7 ml of dextrose solution (5.93%) and the suitable amount of water were added according to AACC (2000).These formulas were baked in a special oven at 200 °C for about 15 minutes. Organoleptic characteristics of biscuits were evaluated according to Zabik and Hoojjat (1984) by 10 trained panelists. The characteristics tested were the colour (10), flavour (10), taste (10), texture (10), appearance (10), and the overall acceptability (10).

Analytical Methods:

Moisture, crude fiber, ash, protein and fat of raw material and biscuits were determined according to AOAC (2000). Total carbohydrates were calculated by difference. Individual elements (Ca, P, K, Na, Fe, and Mg) in all samples of biscuits were determined according to the method described by Chapman and Pratt (1978). Fatty

acids, amino acids and polyphenols were determined according to, (AOCS, 1998, Adeyeye&Afolabi, 2004, and AOAC, 1990) respectively.

Table 1: Composition of mixtures used in manufacture of biscuits.

Ingredients	Basic formula	Modified Biscuits			
	1	2	3	4	5
Wheat flour 72% (WF)	100	--	--	--	--
Whole meal wheat flour(WMWF)	--	100	80	75	70
Doum flour (DF)	--		20	25	30
Sucrose	50	--	--	--	--
Corn oil	28	5	5	5	5
Baking powder	1.1	1.1	1.1	1.1	1.1
Salt	1.0	1.0	1.0	1.0	1.0
Emulsifier	--	1.0	1.0	1.0	1.0
Skim milk	--	5	5	5	5
Eggs	20	--	--	--	--

Subjects:

Fifty eight obese women suffering from MetS, shared as volunteers in this study which lasted for 8 weeks.NCEP ATP III identified five components of the metabolic syndrome, (waist circumference ≥ 88 cm (for women), triglyceride ≥ 150mg/dl, HDL-C ≤ 50 mg/dl (for women), blood pressure $\geq 130/85$ and fasting blood glucose ≥ 110 mg/dl.Subjectwho has at least three of the five listed criteria was diagnosed as metabolic syndrome patient (Grundy *et al*.2005). The protocol of the study was approved by the National Research Center Ethics Committee. In addition an informed consent was obtained from each participant to be included in the study. The study was divided into two phases, phase (1) and phase (2) each one lasted for 4 weeks. The mean age of the subjects was 48±.087 years and had a mean BMI of 38.55± 0.90 kg/m². The patients were divided into two groups: 34 patients as group (A), and 24 patients as group (B). At phase (1), group (A) followed a low caloric balanced diet (1000- 1200K calories), accompanied by the 30% doum biscuits, that was consumed before breakfast (2 biscuits) and before dinner (1 biscuit), each biscuit weighs 20g, while group (2) consumed the whole wheat (0% DF) biscuits with the same instructions. 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.

Anthropometric parameters and blood pressure measurements:

Relevant anthropometric measurements were reported including height, weight and minimal waist, abdominal (2), hip and biceps extended circumference using the standard method (Jelliffe, 1966). BMI and waist hip ratio (WHR) were calculated (weight in kg/ height² in meter and waist circumference in cm/ hip circumference in cm respectively). 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. Hemoglobin and fasting blood glucose were determined on fresh samples; other biochemical parameters were performed on fasting sera that were stored at -70 C° until used. Hemoglobin concentration measured by using cyanomethemoglobin method (Van &Zijlstra, 1961).Fasting bloodglucose(FBG) was determined in fresh samples using glucose oxidase method (Barham and Trinder 1972). Serum total cholesterol, HDL-C and triglycerides (TG) were done using; cholesterol proceed No 1010, Stanbio, HDL-C proceed No 0599 StanioLiquicolor, and triglycerides proceed No 2100, (Enzymatic method) respectively. Low density lipoprotein-C (LDL-C) wascalculated according to Friedewald formula: LDL-C = (Total cholesterol) – (HDL-C) – (TG/5), where the very low density lipoprotein-cholesterol (VLDL-C) = TG/5, (Friedewald, 1972).

Serum C peptide was done by ELISA kit. PR. Code=2725-300A. Lot#EIA-27K2G1.Monobind, Inc. Lake Forest, CA (92630) USA.Modified HOMA-IR (M.HOMA-IR) was calculated according to the formula: 1.5+fasting blood glucose x fasting c- peptide/2800 (Li *et al*., 2004).

All the above mentioned parameters were done before the start of the regimen (basal), after 4 weeks and lastly at the end of the study.

Dietary recalls:

Collecting detailed data about nutritional habits and intake through: 24 recall and 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± SE, two tailed Student's t-test was used to compare the two groups. P values <0.05 were considered statistically significant. SPSS window software version 17.0 (SPSS Inc. Chicago, IL, USA, 2008) was used.

Results and Discussion

In general terms, it is difficult for the patients to follow a standard long-term diet/exercise regimen that would improve or alleviate MetS symptoms. Thus, the investigation of food components that may deal with the MetS features is an important field to ameliorate and facilitate MetS dietary-based therapies (Abete *et al*., 2011). The use of some plants as medicinal plants is due to the presence of active and nutritional compounds like the polyphenols, important minerals and fiber in addition to its high content of unsaturated fatty acids. In this context doum fruits are considered as a rich source of such compounds (Dosumu *et al*., 2006).

Chemical composition and mineral content of WF, WMWF, DF and WMWF - DF composite biscuits:

Data presented in Table (2) show the proximate composition of WF 72%, WMWF 100%, DF and the prepared biscuits. The data revealed a low content of fat (0.9%) with high levels of crude fiber and ash contents of DF compared with WF and WMWF. The highest moisture level (11.62%) was found in WF (72% extraction) which decreased with an increase in extraction rate to be (10.50%) in WMWF (100% extraction). The protein, fat, fiber and ash contents increased with an increase in extraction rate. Moisture, crude fiber and ash increased in prepared biscuits with increasing the DF level, whereas protein, fat and total carbohydrates contents decreased in biscuits substituted with DF compared to the control or biscuit prepared from WMWF without DF. This clearly indicates that DF can be an alternative source of dietary fiber in biscuits making. Howarth *et al*. (2001) summarized the effects of dietary fiber on hunger, satiety, and energy intake and body weight. They reported an increase in satiety after meal and a decrease in subsequent hunger with increased dietary fiberconsumption which is more impressive in obese individuals. The results of increased dietary fiber from high fiber food or from supplements on weight regulation were similar. In addition the beneficial effect of dietary fiber on weight regulation was seen for soluble fiber and insoluble dietary fiber. In this context our results showed that both groups lost more weight at the end of phase (1) compared to phase (2).

Table 2: Proximate composition and mineral contents ofWF, WMWF, DF and WMWF - DFF composite biscuits.

Constituents (%)				Biscuits				
	WF	WMWF	DF	Control	0% DF	20%DF	25% DF	30% DF
Moisture	11.62±0.73	10.50±0.29	9.5±0.22	3.60±0.03	3.82±0.22	4.25±0.19	4.50±0.17	4.80±0.12
Protein	9.80±0.02	12.05±0.22	6.41±0.23	9.50 ±0.36	13.5±0.18	12.30±0.36	12.00±0.35	11.75±0.34
Fat	1.13 ±0.43	2.65 ±0.15	0.9±0.19	28.5±0.65	7.25±0.35	7.00±0.09	6.65±0.26	6.50±0.15
Fiber fiber	0.51±0.01	1.80±0.17	12.24±0.35	1.2±0.01	1.85±0.02	4.85±0.14	5.11±0.11	5.60±0.40
Total Ash	0.45±0.00	3.25 ± 0.36	6.42±0.08	1.66±0.06	1.78±0.12	3.00±0.16	3.35±0.09	3.70±0.25
T.C	88.11±0.96	80.25±0.21	74.03±0.30	59.14±0.85	75.62±0.77	72.85±0.72	72.89±0.85	72.45±0.69
Minerals (mg/100gm)								
Phosphorus	180.5± 0.11	188± 0.18	490± 0.28	180± 0.16	187± 0.12	248± 0.15	275± 0.17	305± 0.11
Potassium	96± 0.06	115± 0.13	650± 0.19	98± 0.05	115± 0.09	220± 0.22	250± 0.35	290± 0.21
Calcium	35± 0.03	40± 0.05	95± 0.09	35± 0.01	40± 0.03	55± 0.05	62± 0.05	70± 0.01
Magnesium	110± 0.09	115± 0.11	2.50± 0.00	110± 0.03	115± 0.08	95.15± 0.01	90± 0.09	84± 0.03
Sodium	630± 0.16	650± 0.31	15± 0.01	630± 0.23	650± 0.11	520± 0.31	480± 0.18	420± 0.13
Iron	2.50± 0.01	3.5± 0.03	3.0± 0.02	2.0± 0.02	3.5± 0.03	3.2± 0.01	3.0± 0.07	2.8± 0.01

Values are means of three determinations ± standard error.
*T.C: Total Carbohydrate

Mineral content of the WF, WMWF, DF and the prepared biscuits were evaluated and presented in Table (2). Results indicated that DF was characterized by the highest content of phosphorus, potassium and calcium (490, 650 and 95mg/100 g, respectively), while WMWF was characterized by the highest value in sodium, magnesium and iron (650, 115 and 3.5 mg/100gm, respectively). Addition of DF to WMWF caused changes in

mineral content (P, K, Ca, Mn, Na and Fe) of biscuits samples supplemented with DF. The obtained results agreed with those reported by many previous studies (Izydorczyk *et al.*, 2001, Hussein *et al.*, 2006, AL-Mussali *et al.*, 2007 and Hussein *et al.*, 2011).

Rheological properties of doughs:

Data presented in Table (3) show the effect of flour extraction rate and the effect of adding DF at three levels to WMWF on the rheological properties of dough as evaluated by a faringraph. The water absorption was found to be 58.5% in WF, while it increased in WMWF (64%) with an increase in flour extraction rate, which may be due to the higher protein and complex carbohydrate contents contributed from bran (Venkateswara *et al.*, 1985). Similar results were reported by (Azizi *et al.*, 2006), who reported water absorption of different extraction rate flours in the range of 56 to 66%. Water absorption increased as DF level increased in blends, which might be due to the high fiber content of DF. Fiber is characterized by its high water holding capacity as reported by Holloway & Grieg (1984). The same trend was also observed in the arrival time and dough development time. Increased dough development time may be due to the presence of increased amount of bran particles in high extraction rate flours, which may interfere in the quick development of gluten and hydration of endosperm (Vetrimani *et al.*, 2005 and Mueen-ud-Din *et al.*, 2010). General incorporation of high fiber materials (DF) in dough altered dough development, consequently dough development time increased as DF level increased. Similar findings were reported by Chen *et al.* (1988). Dough stability decreased from 6 to 4 minutes as DF level increased, while weakening increased from 80 to 140 BU and mixing tolerance index increased from 30 to 70 BU which is due to dilution of gluten protein from wheat flour with the increase fiber content from DF. This may also be due to the interaction between fibrous materials and gluten, which affects the dough mixing properties as reported by Peymanpour *et al.* (2012).

Table 3: Faringraph parameters of dough prepared from different formulas.

Samples	Water absorption (%)	Arrival time(min)	Dough development time(min)	Stability time (min)	Weakening (BU)	Mixing tolerance index(BU)
Control	58.5	1.5	2.5	10.0	100	40
0% DF	64	2.5	3.5	8.0	80	30
20%DF	70	3.5	5	6.0	120	60
25% DF	73	4.0	5.5	5.0	130	65
30% DF	77	4.0	6.0	4.0	140	70

Sensory evaluation of biscuits:

Table (4) represents the mean values and their statistical parameters, respectively for color, texture, odor, taste, appearance and overall acceptability. As shown from this table, all biscuit samples were rated lower than the control sample. No significant differences at $p < 0.05$ were noted within all biscuit and between the controls for odor. Significant differences at ($P < 0.05$) were observed within all replaced biscuit samples and with the control. Biscuit prepared with DF at 30% levels showed significantly higher sensory scores than those prepared with DF at 20% or 25% levels. No significant differences at $p < 0.05$ were noted with biscuit contained 30% DF and between the controls for all sensory characteristics.

Table 4: Sensory properties of biscuits prepared from different formulae.

Samples	Color (10)	Texture (10)	Odor (10)	Taste (10)	Appearance (10)	Overall acceptability (10)
Control	8.5a±0.85	7.85a±1.28	8.5 ±0.92	8.2a ± 1.03	8.6ab±0.89	8.5a±0.89
WMWH	7.8ab±0.79	6.5b±1.35	8.2 ± 0.42	6.8b ± 1.23	7.6c±0.84	7.3b±0.92
20%DF	7.1b±1.37	6.9ab±0.87	8.1 ±0.57	6.2b ± 1.75	7.6c±0.52	7.4b±0.67
25% DF	7.7ab±0.79	6.9ab±1.85	8.2±0.63	7.05b ±1.01	8.0bc±0.47	7.5b±0.71
30% DF	8.4a±1.38	8.1a±1.97	8.9±0.74	8.9a ± 0.88	9.1a±0.99	9.1a±0.57
LSD at 0.05	0.97	1.03	Ns	1.11	0.71	0.75

Fatty acid profiles in WMWF and 30%DF biscuits:

Figure (1&2) showed the relative area% of fatty acids profile in the WMWF and 30% DF biscuits, which showed the high percent of linoleic (33% in both types) and linolenic acids (45.8% in WMWF &42.7% in DF) in both types, followed by palmeto-oleic (9.9&12.4%), and oleic acid (7.7& 8.0%). A recent multicenter study, KANWU (Vessby *et al*, 2001) has shown that shifting from a diet rich in saturated fatty acids to one rich in mono-unsaturated fat improves insulin sensitivity in healthy people, while a moderate n-3 fatty acids

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supplementation does not affect insulin sensitivity. On the other hand there are also other features of the metabolic syndrome that are influenced by different types of fat, particularly blood pressure and plasma lipid levels. Most studies showed thatn-3 fatty acids reduce blood pressure in hypertensive but not in normotensive subjects, while shifting from saturated to monounsaturated fat intake reduces diastolic blood pressure. In relation to lipid abnormalities n-3 fatty acids reduce plasma triglyceride levels but in parallel, increase LDL cholesterol. However other reported that substitution of unsaturated fat for saturated fat not only reduces LDL cholesterol but contributes also to reduction in plasma triglycerides in insulin resistant individuals. There is evidence available in humans indicating that dietary fat quality influences insulin sensitivity and associated metabolic abnormalities (Riccardi *et al.*, 2004).
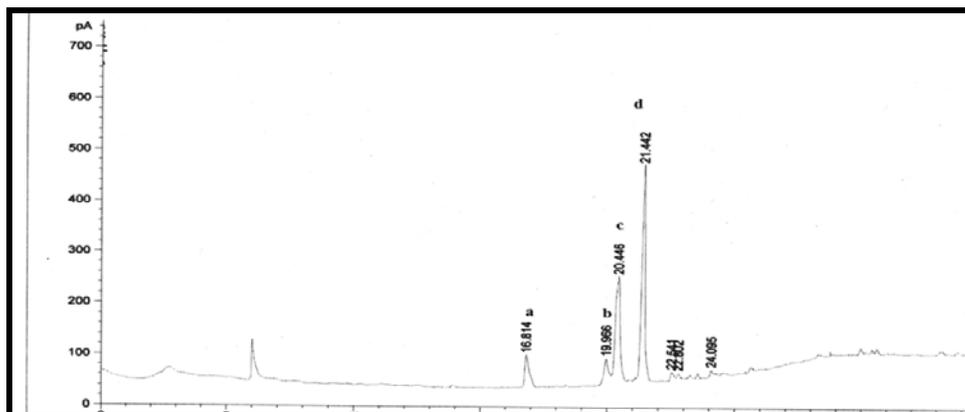

Fig. 1: Relative area percentages of fatty acids contents of (**WMWF) biscuits**, a: Palmeto-oleic acid (C16:1), 9 %, b: Oleic acid(C18:1) n-9, 7%, c: Linoleic acid (C18:2) n-6, 33% and d: Linolenic acid (C18:3) n-3, 45%.
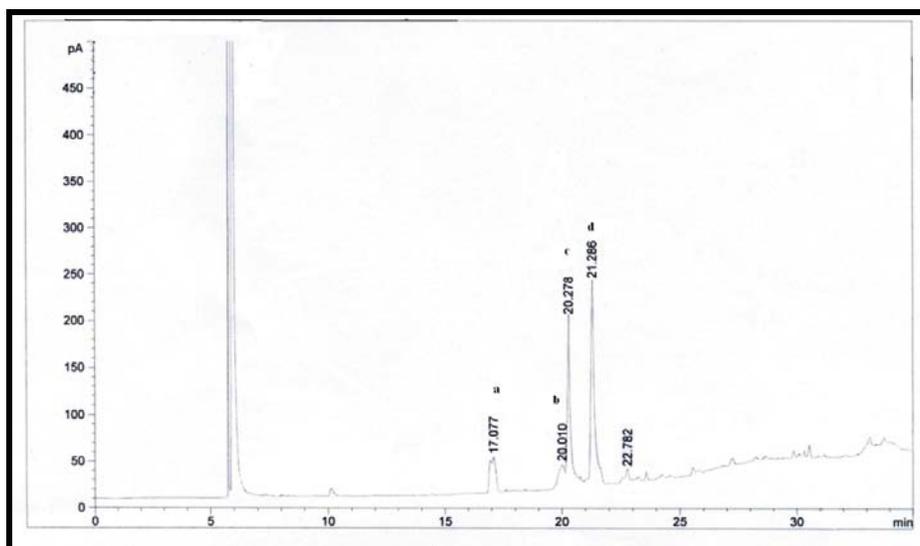

Fig. 2: Relative area percentages of fatty acid profiles of **30% DF biscuits**, a: Palmeto-oleic acid (C16:1) 12.4 %, b: Oleic acid(C18:1) n-9, 8%, c: Linoleic acid (C18:2) n-6, 33% and d: Linolenic acid (C18:3) n-3, 42 %.

Phenolic compounds:

Table (5) showed the polyphenols content of both type of biscuits. The result showed that WMWF biscuit contain 110 mg/100g, while 30% DF contain 164.3 mg/100.Polyphenols are present in a variety of plants utilized as important components of both human and animal diets such as grains, legumes, fruits and vegetables.(Bravo, 1998, Chung *et al.*, 1998 and Crozier*et al.*, 2000). Polyphenols exhibit a wide range of biological effects as a consequence of their antioxidant properties, they inhibit LDL oxidation in vitro (Frankel

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et al., 1993) and in vivo (Halliwell, 1999), so provide protection against atherosclerosis and CHD. Atherogenesis is a process markedly dependent on lipid oxidation products that are recognized by specific receptors (Moriel, 2000 and Rigotti, 2000). Nitric oxide, a free radical itself, participates in the atherogenic process (Rubbo *et al*., 2000) through membrane lipid and lipoprotein oxidation events (Boveris *et al*., 2000). The tested biscuits contain 110.0 mg/g &164.3 mg/g polyphenols for WMWW and that supplemented with 30% DF. So in addition to the effect of the fiber, the unsaturated fatty acids and potassium contents of the supplement on the blood pressure and the lipid profile, the antioxidant polyphenol could be considered a part of the network that can play an important role in the protection and management of the cardiovascular disease that the patients of the MetS are prone to develop.

Table 5: Polyphenols (mg/100g) contents in WMWH and 30% DF biscuits.

Sample	Polyphenols mg/100g
WMWF	110.0
30%DF	164.3

Amino acids:

Figure 3&4 showed the amino acids content of both biscuits. Both WMWF and 30% DF biscuits contain 13.50 and 11.75g protein per 100g respectively, the highest amino acid that was found in both biscuits was glutamic acid. This was followed in the WMWF biscuits by proline, leucine and phenylalanine, while the 30% DF biscuits has high leucine followed by phenylalanine and proline. Sulfur-containing amino acids, namely cysteine and methionineare particularly sensitive to oxidation. It has been suggested that oxidation of surface-exposed methionine residues to methionine sulfoxide may represent an endogenous antioxidant defense that protects protein from extensive and irreversible oxidative modification. Methionine amino acid content was 111.2 and 174 mg per 100g of WMWF and 30% DF biscuits respectively. Although other amino acid residues are likely to be involved in anti-/pro-oxidant properties of human serum, it has been proposed that cysteine chiefly works as a free radical scavenger whereas methionine mainly acts as a metal chelator (Bourdon *et al*., 2005).
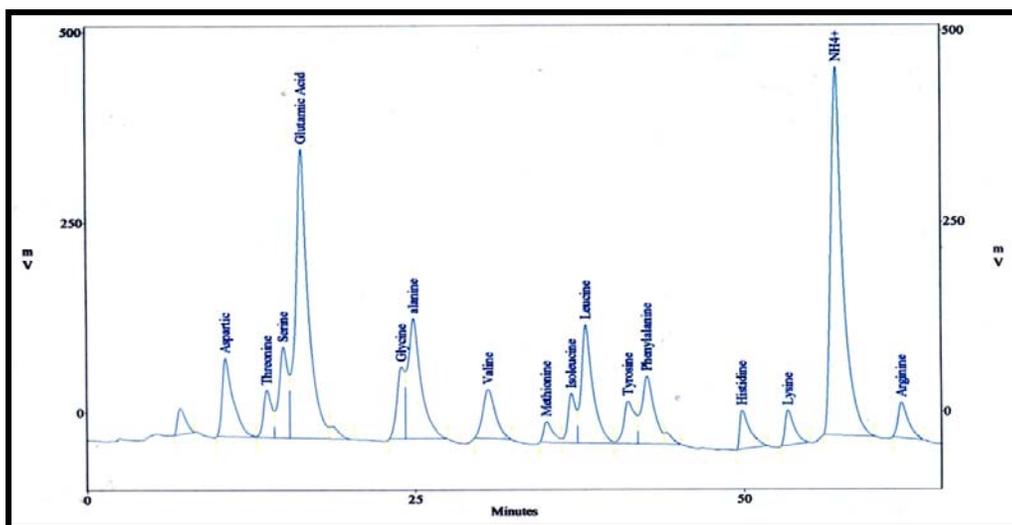

Fig. 3: Amino acid profiles (mg/100 g diet) of (**WMWF) biscuits**: Aspartic(343.5) , Thereonine(134.9), Serine (226.8), Glutamic(1804.3), Glycine(73.7), Alanine (404.6), Valine (178.7), Methionin(111.2), Isoleucine (166.3), Leucine(615.6), Tyrosine(314.4), Phenyl alanine (503.5), Histidine (292.6), Lysine(164.8), Arginine (319.6) and Proline (630.7).
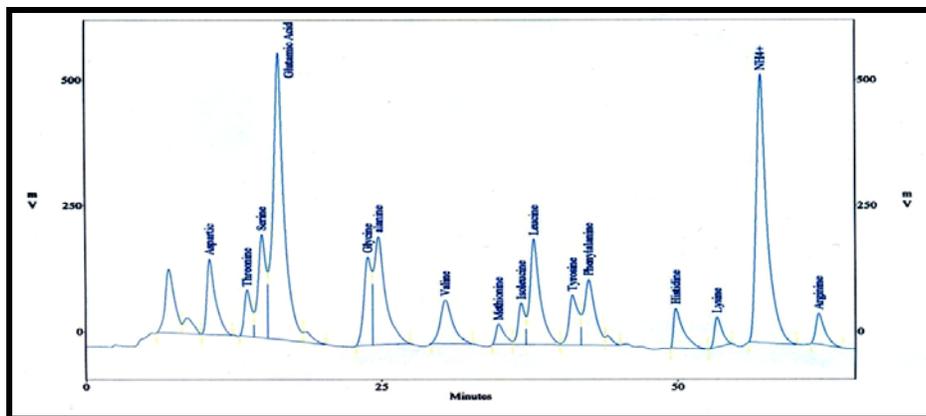
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Fig. 4: Amino acid profiles(mg/100 g diet) of **30% DF biscuits**: Aspartic(436.3) , Thereonine(185.3), Serine (384.5), Glutamic(2977), Glycine(151.1), Alanine (536.1), Valine (259.4), Methionin(173.8), Isoleucine (206.1), Leucine(834.1), Tyrosine(526.4), Phenyl Alanine (718.0), Histidine (494.0), Lysine(197.4), Arginine (411.5) and Proline (597.1).

Nutrients and Total Calories:

Table (6&7) showed a comparison between the different macronutrients and micronutrients and the percent caloric distribution of the habitual diet of the whole sample before starting the regimen and of the two regimen 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 6: Mean±SE of daily nutrients intake basal and at the different phases of the study.

Nutrients	*Habitual diet*	*Regimen withWMWF Biscuits*	Regimen with 30% DF Biscuits
Energy (kcal)	2230.02±9.18	1143.39±4.16	1127.18±7.21
Protein (g)	89.74±4.59	58.02±2.33	56.97±3.43
Carbohydrate (g)	265.90±12.88	144.0±6.28	142.33±6.22
Fat g	87.19±4.81	34.87±1.64	34.421±2.14
Fiber (g)	33.04±1.98		
Calcium (mg)	765.37±6.20	519.21±3.25	537.21±5.22
Iron (mg)	16.69±0.97	13.24±0.12	12.82±1.42
Sodium (mg)	3919.55±2.35	2123.46±3.47	1985.40±3.50
Potassium (mg)	2871.25±5.56	2842.14±3.18	2947.14±3.43

Table 7: Percent caloric intake from the three main macronutrients of thehabitualdiet and the two different regimens.

Nutrients	Habitual diet	Regimen with WMWH biscuit	Regimen with30% DF biscuits
Total Calories	2230.0	1143.4	1127.2
% Calories from protein	16.1	20.3	20.2
% Calories from carbohydrate	47.7	50.4	50.4
% Calories from total fat	35.2	27.4	27.5

Anthropometric measurements:

Table (8) showed the mean± SE of age, anthropometric and 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 and the blood pressure values of the two groups decreased significantly at $p \leq 0.01\text{-}0.001$ at the end of phase (1). Significant reduction of all the anthropometric measurements in group (A) were noticed at the end of phase (2), blood pressure values decreased numerically, while patients of group (B) showed only numerical reduction in the weight, BMI and SBP, but significant decrease in the other parameters.

The data in this study revealed that patients who consumed biscuits made from the WMWF and biscuit with 30% DF showed significant decrease in all the anthropometric parameters. The results of this study revealed that adding 30% DF to the WMWH biscuits increased the fiber and the polyphenols content of the biscuits. The influence of these components was especially observed on the BMI and minimal waist parameter which showed the higher percent decrease among all the anthropometric parameters in the two groups, yet group (A) who consumed 30% DF biscuits showed the higher decrease when compared to group (B). Visceral obesity may represent a clinical intermediate phenotype reflecting the relative inability of subcutaneous adipose tissue to act as a protective metabolic sink for the clearance and storage of the extra energy derived from dietary triglycerides, leading to ectopic fat deposition in visceral adipose depots (Després *et al.*, 2008).

Table 8: Mean±SE of the anthropometric & blood pressure measurements of the two groups, basel and at the end of the two phases of the study.

Patient's characteristics	Age	Height(cm)	Weight(kg)	BMI(Kg/m²)	Waist(cm)	Abd 2(cm)	Hip(cm)	WHR (cm/cm)	Biceps ext.(cm)	SBP (mmHg)	DBP (mmHg)
Basal											
Group (A)	50.3±0.81	157.9±1.01	96.8± 3.21	38.8± 1.24	101.9± 2.12	122.1± 2.34	123.6± 2.12	0.83± 0.01	34.5± 0.92	137.7± 1.91	91.3± 1.42
Group (B)	46.9±0.87	158±1.22	96.5± 3.69	38.2± 1.33	96.1± 2.05	120.1± 2,48	122.1± 2.33	0.79± 0.01	35.1± 1.01	138.2± 3.27	89.0± 1.75
Phase 1											
Group (A)			93.8± 3.23**[a]	37.6± 1.23**[a]	97.0± 2.09**[a]	118.8± 2.08**[a]	120.0± 1.98**[a]	0.81± 0.01**[a]	32.6± 0.82**[a]	131.9± 2.40*[a]	86.4±1.17**[a]
Group (B)			93.8± 3.47**[c]	37.1± 1.22**[c]	92.1± 1.99**[c]	116.6± 2.29**[c]	118.8± 2.27**[c]	0.78± 0.01**[c]	33.2± 0.97**[c]	125.8± 3.04**[c]	84.6± 1.44**[c]
Phase 2											
Group (A)			90.9± 3.73**[b]	36.6± 1.44**[b]	92.9± 2,55**[b]	116.5± 2.49**[b]	118.2± 2.45**[b]	0.78± 0.01**[b]	31.9± 0.97*[b]	128.4± 2.85	83.9± 1.04
Group (B)			93.1± 3.61	36.8± 1.27	90.7± 1.88**[d]	115.5± 2.34*[d]	116.9± 2.21**[d]	0.78± 0.01	32.7± 1.01*[d]	123.6± 2.51	82.3± 1.64*[d]
% Decrease											
Group (A)											
Basal vs Ph1			-3.1	-3.9	-4.8	-2.7	-2.9	-2.4	-5.5	-4.2	-5.4
Ph 1 vsPh 2			-3.1	-2.7	-4.2	-1.9	-1.5	-3.7	-2.2	-2.7	-2.9
Group (B)											
Basal vsPh 1			-2.8	-2.9	-4.2	-2.9	-2.7	-1.3	-5.4	-9.0	-4.9
Ph 1 vsPh 2			-0.8	-0.8	-1.5	-0.9	-1.6	0	-1.5	-1.8	-2.7

a& c : Basal vs Phase 1   b & d : Phase1 vs Phase 2
*p≤0.01   **p≤0.001

Lipid profile:

Table (9) showed the mean±SE of the biochemical parameters of the two groups at the three visits. At phase (1) the results showed significant increase in the mean levels of the haemoglobin and HDL-C at p≤0.01-0.001 among both groups. However the percent increase was higher among group (A). Significant reduction in the mean concentrations of the FBG, other lipid parameters, C-peptide and M.HOMA-IR were observedin both groups, which was higher among group (A), except fortriglyceride and VLDL-C. At phase (2), the level of HDL-C decreased significantly compared to phase (1) between both groups, the percent decrease was more among group (B), while the other parameters showed significant increase which was higher among group (B) compared to group (A) except for FBG, risk factor (Total cholesterol/HDL-C) and C-peptide, yet M.HOMA-IR showed no difference between the two groups.

Table 9: Mean± SE of the biochemical parameters of the two groups basal and at the end of the two phases of the study.

Biochemical parameter	Haemoglobin (g/dl)	FBS (mg/dl)	Triglyceride (mg/dl)	VLDL-C (mg/dl)	T.cholest. (mg/dl)	LDL-C (mg/dl)	HDL-C (mg/dl)	Non-HDL-C(mg/dl)	Risk factor	C-peptide	Modified HOMA
Basal											
Group (A)	11.3±0.18	128.9±7.14	188.5±13.68	37.7±2.74	224.7±6.0	139.9±4.87	47.1±1.06	177.6±6.26	4.9±0.17	2.76±0.22	1.64±0.02
Group (B)	11.9±0.19	106.3±7.13	136.0±8.64	27.2±1.73	209±9.21	137.8±8.94	43.9±2.01	165.0±9.37	4.9±0.27	2.73±0.22	1.61±0.01
Phase (1)											
Group (A)	11.9±0.17**[a]	106.9±6.06**[a]	149.0±11.68**[a]	30.0±2.34**[a]	195.3±7.49**[a]	105.7±5.97**[a]	59.6±1.44**[a]	135.7±7.56**[a]	3.3±0.16**[a]	2.21±0.22**[a]	1.59±0.01
Group (B)	12.5±0.16**[c]	89.5±3.10*[c]	107.1±6.71**[c]	21.4±1.34**[c]	181.8±6.64**[c]	106.2±6.07**[c]	54.2±2.05**[c]	127.6±6,70**[c]	3.4±0.18**[c]	2.43±0.20**[c]	1.58±0.01
Phase (2)											
Group (A)	12.1±0.18	111.3±5.67	156.2±13.88	31.2±2.78	211.0±6.32*[b]	124.3±5.62*[b]	55.5±2.45*[b]	155.5±7.90*[b]	4.1±0.25**[b]	2.27±0.19	1.59±0.01
Group (B)	12.7±0.16	92.7±2.16	122.6±8.51*[d]	24.5±1.70*[d]	204.9±10.03* *[d]	130.9±9.44**[d]	49.5±1.82*[d]	155.4±9.72**[d]	4.2±0.23**[d]	2.47±0.22	1.58±0.01
% Decrease											
Gr(A):											
B vsPh 1	5.3	-17.1	-20.5	-20.4	-13.1	-24.5	26.5	-23.6	-32.7	-19.9	-3.1
Ph1vsPh 2	1.7	4.1	4.2	4	8.0	17.6	-6.9	14.6	24.2	2.7	0
Group (B)											
B vsPh 1	5.0	-15.8	-21.3	21.3	13.0	-22.9	23.5	-22.7	30.6	-11.0	-1.9
Ph1vsPh 2	1.6	3.6	14.5	15.9	12.7	23.3	-8.7	21.8	23.5	1.7	0

a&c : Basal vs Phase (1)   b&d :Phase (1) vs Phase (2)
*p≤0.01   **p≤0.001
Risk factor: Total cholesterol/ HDL-C

The lipid profile of the patients at the beginning of the study showed a clear picture of dyslipidemia. Data of the study revealed that consumption of the dietary regimen caused a reduction of the T.cholesterol, LDL-C, non-HDL-C and triglyceride concentrations, at the same time increase in HDL-C level was detected (the two latter parameters are main items of the MetS). The link between dietary fat, saturated fatty acids (SFAs), serum cholesterol and CHDhas been referred to as the diet-heart or lipid hypothesis, and since the hypothesis was not universally accepted the term" cholesterol controversy" was adopted (Steinberg, 2006). Public health organizations worldwide have proposed dietary guidelines to help reducing the risk of CHD. The National Cholesterol Education Program (NCEP) Step-One diet, Expert Panel, 1988, (Emst *et al.*1988) is typical and recommends, in part, that total fat should not exceed 30% of total calories, intake of SFAs is less than 10% of calories and a dietary cholesterol intake is less than 300 mg per day. Our data in this study revealed that the habitual diet of the patients provided of 35.2% SFAs from the total fat intake and 353.3 mg cholesterol/ day. After using both dietary therapies for group (A) and group (B), the percent of calories supplied from fat content in both diets was 27.4 and 27.5% of the total calories respectively beside the high content of n-3 fatty acids in the supplements. Comparing the results obtained between the two groups, group (A) showed the higher percent decrease in the levels of FBG, LDL-C, non- LDL-C, and the risk factor, beside higher percent increase in the HDL-C concentration at the end of phase (1). However after stopping the supplements and the participants followed only the low caloric regimen, all the parameters started to increase by different percentages, but it is interesting to note that the increase was higher among group (B), which is in favour with the prolonged healthy effect of the DF and so to encourage its use as healthy food among MetS patients.

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C-peptide and M.HOMA-IR:

The association of C-peptide levels with the components of MetS has already been reported in the literature, (Inukai *et al*., 1999; Bo *et al*., 2000). Erdmann *et al*. (2008) demonstrated that insulin resistance already develops during weight gain. Plasma C-peptide concentration provide an indirect measure of the insulin secretory reserve (Polonsky, 1995). Our data in this study (Table, 9) proved higher level of the serum C-peptide and the M.HOMA-IR among the Mets patients at the basal examination in both groups which is in agreement with the previous studies that reported the increase in the C-peptide level with increase body weight. After the participants consumed the dietary therapies, the two groups showed significant decreases in both parameters. However higher percent decrease was observed in group (A) compared to group (B), 19.9&11.0% for C-peptide and 3.1&1.9 for the M.HOMA-IR respectively. In spite of the continuous decrease in anthropometric parameters in the patients in phase (2), yet the C-peptide level showed slight increase but not the M.HOMA, This result could be explained by the accompanied increase in the level of FBG.

Conclusion:

The data obtained in this study showed the healthy effect of both supplements, however adding the doum flour to the whole wheat supplement showed more favourable results due to its higher content of fiber, polyphenols, potassium and in part sulpher methionine amino acid, as both supplements have similar amounts of the polyunsaturated fatty acids. Our data highlighted the importance of the combination of the use of the hypocaloricdiets with supplements that exert specific effects that direct the metabolism towards normalization especially if adopted as long term policy in the management of the metabolic syndrome.

References

AACC, 2000. Approved Methods. 10th Ed. American Association of Cereal Chemists, St. Paul.

Abete, I., E. Goyenechea, M.A. Zulet, J.A. Martinez, 2011. Obesity and metabolic syndrome: potential benefit from specific nutritional components. Nutr Metab Cardiovasc Dis., 21(2): B1-15.

ACC/SCN, 1987. First Report on the World Nutrition Situation.Food and Policy Division, FAO, Rome.

Adeyeye, E.I. and E.O. Afolabi, 2004. Amino acid composition of three different types of land snails consumed in Nigeria. Food Chem., 85: 535-539.

Alberti, K.G., P. Zimmet, J. Shaw, 2005. IDF Epidemiology Task Force Consensus Group.The metabolic syndrome – a new world wide definition. Lancen, 366: 1059-1062.

AL-Mussali, M.S., F. Basunbel, H. Khamees, 2007. Bread from Composite Flour of Wheat and Millet. Yemen Journal of Agricultural Research and Studies, 16: 5-18.

AOAC. Official Methods of Analysis of the Association of Official Analytical Chemists, "17thed, Association of Official Analytical Chemists, Arlington, Vitginia, USA, 2000.

Association of Official Analytical Chemists (AOAC), 1990. Official methods of analysis (15thed.) Washington, D.C.

AOCS, 1998. Official Methods and RecommendedPractices of the American Oil chemist's Society (5thEdn.). AOCS press, Champaign, Washington.

Azizi, M.H., S.M. Sayeddin, S.H. Payghambardoost, 2006. Effect of flour extraction rate on flour composition dough characteristics and quality of flat bread. J. Agric. Sci. Technol., 8: 323-330.

Barham, D. and P. Trinder, 1972. An improved colour reagent for determination of blood glucose by oxidase system. Analyst, 97: 142-145.

Bo, S., P. Cavallo-Perin, L. Gentile, *et al*., 2000. Relationship ofresidual beta-cell function, metabolic control and chronic complications in type 2 diabetes mellitus. Acta Diabetol., 37: 125-129.

Bourdon, E., N. Loreau, L. Lagrost, D. Blache, 2005. Differential effects of cysteine and methionine residues in the antioxidant activity of human serum albumin.FreeRadic Res., 39(1): 15-20.

Boveris, A.D., A. Galatro, S. Puntarulo, 2000. Effect of nitric oxide and plant antioxidants on microsomal content of lipid radicals. Biol Res., 33: 159-165.

Bravo, L., 1998. Polyphenols: Chemistry, dietary sources, metabolism, and nutritional significance. Nutr Rev., 56: 317-333.

Chapman, H.D. and P.F. Prtt, 1978. Methods of analysis for soil plants and water.Univ of California, Div. Agric. SCi. Priced Publication, 4034: 50.

Chen, H., G.L. Rubenthaler, E.G. Schanus, 1988. Effect of apple fibre and cellulose on the physical properties of wheat flour. J. Food Sci., 53: 304-305.

Chrysohoou, C., D.B. Panagiotakos, C. Pitsavos, U.N. DAS, C. Stefanadis, 2004. Adherence to the Mediterranean diet attenuates inflammation and coagulation process, in healthy adult: the ATTICA study. J Am Col Cardiol., 44: 152-158.

1950

J. Appl. Sci. Res., 9(3): 1940-1951, 2013

Chung, K.T., T.Y. Wong, C.I. Wei, Y.W. Huang, Y. Lin, 1998. Tannins and human health: a review. Crit Rev. Food Sci. Nutr., 38: 421-464.

Cook, J.A., D.J. Vander Jagt, A. Pastuszyn, G. Mounkaila, R.S. Glew, M. Millison, *et al.*, 2000. Nutritional and chemical composition of 13 wild plant foods of Niger.Journal of Food Composition and Analysis,13: 83-92.

Crozier, A., J. Burns, A.A. Aziz, A.J. Stewart, H.S. Rabiasz, G.I. Jenkins, C.A. Edwards, M.E.J. Lean, 2000. Antioxidant flavonols from fruits, vegetables and beverages: measurements and bioavailability. Biol Res., 33: 79-88.

Després, J.P., I. Lemieux, J. Bergeron, P. Pibarot, P. Mathieu, E. Larose, J. Rodés-Cabau, O.F. Bertrand, P Poirier, 2008, Abdominal obesity and the metabolic syndrome: contribution to global cardiovascular risk. Arterioscler Thromb Vasc Biol., 28: 1039-1049.

Dosumu, O.O., F.O. Nwosu, C.D. Nwogu, 2006. Antimicrobial studies and phytochemical screening of extracts of Hyphaenethebaica (Linn) Mart fruits. Intl J Trop Med., 1: 186-189.

Erdmann, J., U. Kallabis, O. Oppel, S. Sypcheenko, S. Wagenpfell, V. Schusdziarra, 2008. Development of hyperinsulinemia and insulin resistance during the early stage of weight gain. Am J Physio Indocrinol Metab., 294: E568-E575.

Emst, N.D., J. Cleeman, R. Mullis, J. Sooter-Bochenek, L. Van Horn, 1988. The National Cholesterol Education Program; Implication for dietetic practitioner from Adult Treatment Panel Recommendation. J Am Diet Ass., 88: 1401-8, 1411.

Expert Panel on Detection.Evaluation and Treatment of High Blood Cholesterol in Adults.Executive summary of the third report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panei 111) JAMA. 2001; 285: 2486-2497.

Fletcher, R.F., 1997. Listing of useful plants of the world.Australian New Crops http//www.newcrops.uq.edu.au/listing/hyphaenethebaica.htm.

Frankel, E.N., J. Kanner, J.B. German, E. Parks, J.E. Kinsella, 1993. Inhibition of oxidation of human low-density lipoprotein by phenolic substances in red wine. Lancet, 341: 454-457.

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

Grundy, S.M., J.L. Cleeman, S.R. Daniels, K.A. Donato, R.H. Eckel, B.A. Franklin, D.J. Gordon, R.M. Karauss, P.J. Savage, S.C. Jr Smith, J.A. Spertus, F. Costa, 2005. Diagnosis and Management of the Metabolic Syndrome. An American Heart Association/National Heart, Lung, and Blood Institute Science Statement, Circulation, 112: 2735-2752.

Halliwell, B., 1999. Establishing the significance and optimal intake of dietary antioxidants: The biomarker concept. Nutr Rev., 57: 104-113.

Harris, K.A., P.M. Kris-Etherton, 2010. Effects of whole grains on coronary heart disease risk CurrAtheroscler Rep., 12(6): 368-76.

Howarth, N.C., F. Saltzinan, S.B. Roberts, 2001. Dietary and weight regulation. Nutr Rev., 59: 129-139.

Holloway, W.D. and R. Grieg, 1984. Water holding capacity of hemicelluloses from fruits, vegetables and wheat bran. Food Sci., 49: 1632-1633.

Hussein, A.M.S., I.M.F. Helmy, B.E. Mustafa, 2006. Effect of barley flour and some of their functional ingredients on quality of pan bread. Minufiya J. Agric. Res., 31: 877-897.

Hussein, A.M.S., A. Naglaa, Shedeed, H. Hanan, M. Abdel-Kalek, Shams, H.A. El-Din, 2011. Antioxidative, antibacterial and antifungal activities of tea infusions from berry leaves, carob and doum.Pol. J. Food Nutr. Sci., 61: 201-209.

Inukai, T., R. Matsutoma, K. Tayama, *et al.*, 1999. Relation between the serum level of C-peptide and risk factors for coronary heart disease and diabetic macroangiopathy in patients with type 2 diabetes mellitus. Exp Clin Endocrinol Diabetes, 107: 40-45.

Izydorczyk, M.S., A. Hussain, A.W. Mac Gregor, 2001. Effect of barley and barley components on rheological properties of wheat dough. J. Cereal Sci., 34: 251-260.

Jelliffe, D.B., 1966. The assessment of the nutritional status of the community. World Health Organization, Geneva Monograph, 35: 63-69.

Kannel, W.B., D.L. Mc Gee, T. Gordon, 1976. A general cardiovascular risk profile: The Framingham Study. Am J Cardiol., 38: 46-51.

Li, X., Z.G. Hou, H.Y. Qi, 2004. Replacement of insulin by fasting C- peptide in modified homeostasis model assessment to evaluate insulin resistance and islet beta cell function. Zhonghua Yi Xue Yi Chuan Xue Za Zhi (Chinese), 29: 419-23.

Martin, F.W., 1999. Palm for stable foods in: Multipurpose Palms You Can Grow. Metabolism and Nutritional Significance (ed.C.Elevitch). Nutr. Rev., 56: 317-333.

Michael, C. and S. Peter, 2002. Important aroma compounds in freshly ground whole meal and white wheat flour - Identification and quantitative changes during sour dough fermentation. J. Agric. And Food Chem., 50: 6835-6840.

Moriel, P., F.L. Plavnik, M.T. Zanella, M.C. Bertolami, D.S.P. Abdalla, 2000. Lipid peroxidation and antioxidants in hyperlipidemia and hypertension. Biol Res., 33: 105-112.

Mueen-ud-Din, G., Salim-ur-Rehman, F.M. Anjum, H. Nawaz, M.A. Murtaza, 2010. Effect of Wheat Flour Extraction Rates on Flour Composition, Farinographic Characteristics and Sensory Perception of Sourdough Naans. World Academy of Science, Engeneering and Technology, 68: 807-813.

Peymanpour Gh., K. Rezaei, B. Sorkhilalehloo, B. Pirayeshfar and G. Najafian, 2012. Changes in Rheology and Sensory Properties of Wheat Bread with the Addition of Oat Flour. J. Agr. Sci. Tech., 14: 339-348.

Polonsky, K.S., 1995. The B-cell in diabetes: from molecular genetic to clinical research. Diabetes, 44: 705-717.

Riccardi, G., R Giacco, A.A. Rivellese, 2004. Dietary fat, insulin sensitivity and the metabolic syndrome. Clin Nutr. Aug., 23: 447-56.

Rigotti, A., 2000. Scavenger receptors and atherosclerosis. Biol Res., 33: 97-103.

Rubbo, H., C. Batthyany, R. Radi, 2000. Nitric oxide-oxygen radical interactions in atherosclerosis. Biol Res., 33: 167-175.

Steinberg, D., 2006. An interpretive history of the cholesterol controversy, part V: the discovery of status and the end of the controversy. J Lip Res., 47: 1339-1351.

Van Kampen, E.J. and W.G. Zijlstra, 1961. Standarization of hemoglobinometry, and the hemoglobin cyanide method. Clin. Acta, 6: 538-543.

Venkateswara, R., G.D. Indrani and S.R. Shupalekar, 1985. Effect of milling methods and extraction rate on the chemical, rheological and bread making characteristics of wheat flours. J. Food. Sci. Technol., 22: 38-42.

Vessby, B., M. Uusitupa, K. Hermansen, G. Riccardi, A.A. Rivellese, L.C. Tapsell, C. Nälsén, L. Berglund, A. Louheranta, B.M. Rasmussen, G.D. Calvert, A. Maffetone, E. Pedersen, I.B. Gustafsson, L.H. Storlien, KANWU Study. 2001. Substituting dietary saturated for monounsaturated fat impairs insulin sensitivity in healthy men and women: The KANWU Study.Diabetologia, 44: 312-319.

Vetrimani, R., M.L. Sudha and P.H. Rao, 2005. Effect of extraction rate of wheat flour on the quality of vermicelli. Food Res. Int., 38: 411-416.

Zabik, M.E., P. Hoojjat, 1984. Sugar-shap cookies prepared with wheat-navybean sesame seed flour blends. Cereal Chem., 61: 41-44.