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MONITORING OBESITY DURING DIETARY THERAPIES USING HYPOCALORIC DIET AND VEGETABLE SOUP SUPPLEMENT

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This study was aimed at determining the effects of a radish-root-based mixed dried vegetable soup supplement as an adjunct to a balanced hypocaloric diet therapy in the management of obesity. Sixteen healthy obese middle aged women, divided into two equal groups, followed a hypocaloric (1000 Kcal/day) diet for four weeks. The first group consumed an additional portion of the soup twice daily, *i.e.* before lunch and before dinner. The second group served as control. Relevant anthropometric and biochemical parameters were measured before, after two and after four weeks. Both, the soup and control dieters lost 4.18% and 4.71% of their weights, respectively. The soup dieters showed a significant decrease in blood pressure and triglycerides. Total cholesterol levels showed slight variations in both groups. LDL-Cholesterol was significantly decreased in the control dieters, whereas superoxide dismutase (SOD) was significantly increased in the soup, but not in the control dieters. The negligible increase in the c-reactive protein (CRP) in the soup dieters contrasted with the highly significant rise of the control. Calcium was decreased to subnormal concentrations in both groups, while copper, zinc and magnesium showed variable but beneficial increases. We emphasize during and post-diet monitoring of serum TG, CRP and calcium for a more efficient obesity control. Regular consumption of the soup by virtue of its antioxidant and anti-inflammatory properties will help to blunt and/or delay weight cycling and other complications of obesity.

INTRODUCTION

It is now accepted that obesity is a chronic multifactorial disease that is much more than excessive fat in a human body. There has also been a growing recognition that, as well as their functions as fuel and/or co-factors, macro-and micronutrients can be potent dietary signals detected by the cellular sensor systems that can influence the metabolic programming of cells and have an important role in the control of the homeostasis [Francis *et al*., 2002]. Owing to the complexity and variability of nutrition, the body has to process a huge number of different nutrients and other food components which can reach high concentrations without becoming toxic, and at the same time each nutrient can also bind to numerous targets with different affinities and specificities [Müller & Kersten, 2003]. It has been reported that smoking, diabetes, and obesity are independently associated with increased oxidative stress in men and women in large community-base cohort [Keaney *et al*., 2003]. While much of cardiovascular risk attributable to obesity may be mediated through effects on blood pressure, lipids, and glucose tolerance, some of these risk factors may be mediated by inflammatory pathways [Rexrode *et al*., 2003]. Adipocytes secrete interleukin-6 (IL-6) [Kern *et al*., 2001], one of the main determinants of hepatic C-reactive protein (CRP) production [Papanicolau *et al*., 1998]. In this context, moderate weight loss has been found to result in decreased circulating levels of tumor necrosis factor α (TNF-α), IL-6 and CRP [Ziccardi *et al*., 2002]. Furthermore, intervention trials recommended the increased consumption of fruits and vegetables. Liu [2003] stated that vegetables are a rich source of fiber and in addition contain significant amounts of bioactive components (phytochemicals) which provide desirable health benefits beyond basic nutrition, and play important roles in prevention of chronic diseases.

Given the alarming surge in obesity, effective dietary strategies for weight management have praised the incorporation of fruits and vegetables in health promoting diet, and energy restrictive studies [Epstein *et al*., 2001]. This study was aimed at determining the effects of a mixed dried vegetables soup food supplement as an adjunct to a well balanced hypocaloric diet therapy in the management of simple obesity.

SUBJECTS, MATERIALS AND METHODS

SUBJECTS

A final number of sixteen healthy obese Egyptian premenopausal women consented to participate in, and who were compliant and completed a four-week slimming program at the Food Science and Nutrition Department, National Research Centre, Cairo, Egypt. Ethical approval was obtained from the National Research Centre Committee on Human Research. The participants were evaluated by standard physical examination and routine clinical laboratory

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tests. None of them had any acute or chronic diseases, nor had taken any medication. They were divided into two equal groups and were instructed to follow the same hypocaloric (1000 kcal/day) balanced diet. On average, the diet consisted of: 48.30 g of protein, 136 g of carbohydrates, and 29 g fats, which supply about 993 kcal per day. Most of the carbohydrates used were complex carbohydrates. The patients were also instructed to use plant oil in food preparation. Only the subjects of the first group consumed an additional soup supplement quarter of an hour before each lunch and dinner.

MATERIALS

The supplement was composed of a natural radish-root-based vegetable mixture dried at 40°C in a circulating air oven and divided into 15 g portions prepared at home by the subjects into a soup by boiling them in water. The percent distribution of the dried vegetables in the soup was as follows: radish-root 35, onion 20, sweet green pepper 20, tomato 15 and parsley 10. The choice of the radish-root was based on its antioxidant properties [Dukes, 2004]. Presenting the supplement (Table 1) in a soup form has the following advantages: the water it contains increases the volume of its serving and also increases the bulk of the fibre content of the vegetable mixture which would be an ideal filling of the stomach promoting satiety, preventing constipation and emphasizing positive rather than negative restrictive messages. It contains vegetables that are rich in micro-nutrients vitamins, minerals and phytochemicals many of which have potential antioxidant properties. The mild cooking in water increases the bioavailability of some bioactive components, *e.g.* lycopene, and hence their benefits [Gartner *et al*., 1997]. Processing the vegetables in a dried form enables the consumer to ingest larger quantities, which could not be consumed when eaten as fresh, to benefit mostly from the additive and synergistic functions of their ingredients which extend beyond basic nutrition to the prevention of chronic diseases.

Anthropometric data were recorded with the subjects dressed in light clothing. Height and weight were taken following the standards methods [Jelliffe, 1966]. Body mass index (BMI) was calculated as weight in relation to height (kg/m^2). Girths were measured using a flexible light metal tape at two sites: abdominal ”minimal waist” and hip. Skinfold thicknesses were measured by Harpenden Calipers obtained from Holtain Ltd, Crosswell, Crymych, Dyfed, UK. Body fat mass and fat free mass were calculated by equations [Durnin & Womersley, 1974].

TABLE 1. Chemical analysis of the macro-and micronutrients of the dried radish-root-based vegetable mixture in the soup.

Nutrients	Content
Water (g/100 g)	13.3
Total protein (g/100 g)	11.5
Fat (g/100 g)	2.53
Ash (g/100 g)	8.93
Carbohydrate (g/100 g)	59.6
Vitamin B_1 (mg/100 g)	0.176
Niacin (mg/100 g)	17.4
Calcium (mg/100 g)	338
Magnesium (mg/100 g)	240
Iron (mg/100 g)	35.1
Zinc (mg/100 g)	4.29
Potassium (mg/100 g)	2464
Sodium (mg/100 g)	5589
Total phenolics (mg of gallic acid)	10.8

Blood pressure was measured in participants sitting quietly for 5 min using a mercury sphygmomanometer. Three readings were recorded, the means of the second and third of the first (systolic) and fifth (diastolic) Korotkoff sounds were used.

METHODS

Twelve-hour fasting blood samples were drawn three times: the first before starting the program (baseline), then after 2 weeks and then at the completion of four weeks. Heparinized whole blood was used for estimation of glutathione peroxidase (GPX) by using WAK Chemie Medical GMBH, Germany, kit. Superoxide dismutase (SOD) enzyme was determined in washed erythrocytes using WAK-Chemie Medical GMBH, Germany, kit. Blood was centrifuged and serum was stored at -50°C and analysed later. Serum total cholesterol (TC), HDL-cholesterol (HDL-C), and triglycerides (TG) were measured using respectively: cholesterol procedure No.1010, stanbio, HDL-C procedure No.0599, stanbio, Liquicolor triglycerides procedure No 2100. Friedewalds formula:

LDL-cholesterol = (total cholesterol)-(HDL-cholesterol)-(triglycerides/5) [Friedewald *et al*., 1972]

was used to calculate LDL-Cholesterol (LDL-C). Serum minerals including copper, zinc and magnesium were determined using: SENTINEL, CH KIT (determination of copper and zinc in serum without deproteinization, Cat. 17 1255, respectively). Serum calcium was determined using SPAINREACT KIT. C-reactive protein (CRP) was determined using CRP-turbilatex (SPAINREACT KIT).

Chemical analyses of the radish-root-based vegetable mixture (Table 1) were undertaken for: (1) macronutrients including protein, fat and total carbohydrate using respective AOAC Standards [AOAC: 954.01, 920.39, 1990]; (2) micronutrients including: vitamins using high performance liquid chromatography (HPLC), Hewlett Packard, HP 1050 Series [Ghase, 1993]; (3) minerals: using atomic absorption spectrophotometer (Varian Spectr. AA, 220) [Hussein & Bruggeman, 1997]; and (4) total phenolic contents were determined using calorimetric methods. The values are expressed in terms of gallic acid equivalent [Singleton & Rossi, 1965].

Statistical analysis. Data were expressed as means ± standard error of the means. Two-tailed Student's t-test was used to compare the variables at a significance level of $p<0.05$. The computer SPSS ver. 7.5 software was used for calculations.

RESULTS

Anthropometric data showed (Table 2) that the weight lost in both groups was mainly from fat, thus sparing much of the fat free mass. The soup dieters showed a significant reduction in the blood pressure starting by the end of the 2nd week which persisted till the end of the trial, contrary to that

TABLE 2. Age, anthropometric parameters and blood pressure of middle-age women during hypocaloric therapy.

Parameters	Soup dieters (n=8)					Control dieters (n=8)				
	Visits			Percent change		Visits			Percent change	
	at baseline	after 2 weeks	after 4 weeks	after 2 weeks	after 4 weeks	at baseline	after 2 weeks	after 4 weeks	after 2 weeks	after 4 weeks
Age (yrs)	37.0±1.9^{1}					37.8±1.8				
Height (cm)	154.7±0.6					152.8±1.0				
Weight (kg)	82.3± 4.8	79.6± 4.5	78.8±4.4	-3.3	-4.3	91.6±3.4	89.4±3.2	87.3±3.2	-2.4	-4.7
Body Mass Index (kg/m^2)	34.4±2.2	33.4±2.11	33.0±2.10	-2.9	-4.1	39.2±1.4	38.3±1.4	37.4±1.4	-2.3	-4.6
Fat mass (kg)	35.3±0.8	34.1± 0.8	32.9±0.6^{2}	-3.4	-6.8	40.1±1.6^{8}	38.8±1.7^{8}	37.4±1.5^{8}	-3.2	-6.7
Fat free mass (kg)	47.0±4.1	45.5±3.9	45.9±3.9	-3.2	-2.3	51.4±2.9	50.7±2.7	49.9±2.8^{8}	-1.4	-3.0
Biceps skinfold (mm)	12.1±0.8	10.20±0.6	9.9±0.5^{2}	-15.7	-18.8	15.6±1.9	14.4±1.9^{7}	13.3±1.3^{8}	-7.7	-14.7
Triceps skinfold (mm)	26.0±2.2	23.4± 1.8	22.1±1.6	-10	-15.	28.7±0.7	26.5±0.6^{5}	24.9±0.6^{6}	-7.7	-13.2
Suprailiac, skinfold (mm)	33.2±1.7	30.0±1.1	27.4±1.1^{3}	-9.6	-17.5	36.9±2.3	34.0±2.4	31.2±1.4^{5,8}	-7.9	-15.5
Abdominal-I. circum. (cm)	86.7±1.6	84.9±1.4	83.5±1.4	-2.1	-3.7	93.9±1.9^{10}	91.1±2.3^{9}	89.9±2.4^{9}	-2.9	-4.2
Hip circumf. (cm)	118.3±5.4	116.0±4.8	115.1±4.9	-1.9	-2.7	128.5± 4.7	126.4±4.3	124.3±4.5	-1.6	-3.3
Waist : hip ratio	0.74±0.02	0.74±0.02	0.73±0.02	–	-1.4	0.74±0.03	0.73±0.03	0.73±0.03	-1.4	-1.4
Blood pressure (mm/Hg) systolic	130±2.3	118.3± 0.8^{4}	121.3±2.5^{2}	-9.0	-6.7	115±4.0^{9}	113.8±0.8^{9}	111.3±1.6^{9}	-1.1	-3.2
Blood pressure (mm/Hg) diastolic	86.3±0.8	77.5±1.6^{4}	77.5±2.1^{3}	-10.2	-10.2	76.3± 0.8^{10}	78.8±0.8^{5}	77.5±0.9	+3.3	+1.6

$^{1}\bar{X}\pm$SEM; ^{2,3,4}, significantly different from baseline values of soup dieters : $^{2}p<0.05$, $^{3}p<0.01$, $^{4}p<0.001$; ^{5,6,7}, significantly different from baseline values of control dieters : $^{5}p<0.05$, $^{6}p<0.01$, $^{7}p<0.001$; ^{8,9,10} significantly different from the soup dieters : $^{8}p<0.05$, $^{9}p<0.01$,$^{10}p<0.001$

of the controls which did not change and which was originally significantly lower than that of the soup dieters.

The total cholesterol (TC) was decreased in both groups (Table 3) but there were no significant differences between baseline and TC value reported at the end of the experiment. The decrease in LDL-cholesterol (LDL-C) was significant only for the controls, while no significant differences in HDL--cholesterol (HDL-C) for both experimental groups. Triglycerides (TG) were beneficially significantly decreased by 36.1% soup eaters group only C-reactive protein (CRP) was increased by 237% for the controls. Superoxide dismutase (SOD) was beneficially significantly increased in soup eaters group. The activity of glutathione peroxidase (GPX) did not change over the experimental period. In soup dieters, the concentration of magnesium significantly increased and the level of calcium decreased, whereas in the control group a significant increase was observed for the level of zinc and magnesium at the end of the experiment.

DISCUSSION

Modest weight loss of 10% of baseline weight is beneficial and achievable for overweight and obese patients [Wee *et al*., 2004]. At the end of this study, each of the two dieters groups

TABLE 3. Serum lipids, C–reactive protein, antioxidant enzymes and minerals in middle-age women during hypocaloric therapy.

Parameters	Soup dieters (n=8)					Control dieters (n=8)				
	Visits			Percent change		Visits			Percent change	
	at baseline	after 2 weeks	after 4 weeks	after 2 weeks	after 4 weeks	at baseline	after 2 weeks	after 4 weeks	after 2 weeks	after 4 weeks
Total Cholesterol (mg/dL)	201.3±17.3	193.2±12.6	170.0±13.0	-4.0	-15.6	198.5±15.4	177.1±17.5	179.2±18.3	-10.8	-9.7
LDL-C (mg/dL)	131.1±22.0	129.8±10.7	110.8±3927	-1.0	-15.5	144.2±16.1	109.6±18.2	96.1±12.0^{5}	-23.9	-33.4
HDL-C (mg/dL)	53.7±4.5	52.1±5.2	48.5±5.1	-2.8	-9.5	36.3±3.0^{9}	47.1±4.1	39.2±3.6	+29.8	+7.9
Risk factor T.Ch/HDL	4.3±0.9	3.9±0.5	3.8±0.6	-9.3	-11.6	6.1±1.0	4.2±0.8	5.1±0.9	-31.2	16.4
Triglycerides (mg/dlL)	82.9±7.5	56.6±5.1^{2}	53.0±10.8^{2}	-31.7	-36.1	90.6±18.9	102.3±13.6^{9}	92.6±14.9^{8}	+12.9	+2.2
C-Reactive protein (mg/L)	6.2±0.9	5.9±0.8	7.2±1.0	-4.8	+16.1	3.0±0.5^{9}	5.4±1.8	10.1±1.3^{7}	+80.0	+236.7
Superoxide dismutase (U/mL)	140.0±2.7^{1}	176.3±20.6	212.5±16.3^{4}	+25.9	+51.8	155.1±2.1^{10}	161.0±5.8	144.8±10.3^{9}	+3.8	-6.6
Glutathione peroxidase (U/mL)	68.4±7.3	62.3±12.8	68.7±10.1	-8.9	+0.4	41.6±6.3^{8}	41.2±8.8	44.1±2.5^{8}	-0.9	+6.0
Copper (μg/dL)	121.5±7.1	123.4±10.9	128.1± 10.1	+1.6	+5.4	123.9±13.1	152.39±8.0^{8}	128.4±3.2	+23.0	+3.6
Zinc (μg/dL)	79.5±10.1	101.2±11.0	87.6±5.5	+27.3	+10.2	84.4±7.1	98.9±9.3	108.3± 6.5^{5,8}	+17.2	+28.3
Magnesium (mg/dL)	2.0±0.04	1.6±0.2	2.2±0.1^{2}	-20.0	+10.0	2.4±0.03^{10}	2.32±0.1	2.6±0.03^{7,9}	-3.3	+8.3
Calcium (mg/dL)	8.9±0.3	8.7±0.2	7.7± 0.3^{2}	-2.3	-13.5	8.3± 0.1	7.3±0.2^{6,10}	7.6±0.4	-12.1	-8.4

$^{1}\bar{X}\pm$SEM; ^{2,3,4}, significantly different from baseline values of soup dieters : $^{2}p<0.05$, $^{3}p<0.01$, $^{4}p<0.001$; ^{5,6,7}, significantly different from baseline values of control dieters : $^{5}p<0.05$, $^{6}p<0.01$, $^{7}p<0.001$; ^{8,9,10} significantly different from the soup dieters : $^{8}p<0.05$, $^{9}p<0.01$,$^{10}p<0.001$

had lost approximately the same percentage of their body weight (-4.18% for the soup eaters, and -4.71% for the control). An impressive decline in the blood pressure was recorded in the soup dieters only. Of the two major minerals known to exert hypotensive properties, potassium has the advantage of being mostly absorbed from the gastrointestinal tract contrary to calcium which, when originating from vegetables, would be of variable bioavailability [Delgado, 2004; Bronner & Pansu, 1999]. Many of the radish soup constituents, like magnesium, zinc, chromium and fibre, are also potential hypotensives and could all be considered as acting synergistically to reduce the blood pressure. The lipid profile also benefited favourably among the soup dieters in that TC, LDL-C and the risk factor TCh/HDL-C showed tendency to decrease. HDL-C was also decreased due to the decrease in the total cholesterol values, but was maintained within its normal limits. Mild improvement was reported among the obese women followed diet alone which led to a tendency in rise of HDL-C and a significant decline of LDL-C. This is in accordance to what was reported that dietary therapy alone is most often efficiently reserved for persons without coronary heart disease, before using drugs to alter the serum lipids [Jacobson, 2000].

Recently CRP, a marker of systemic inflammation, has been reported to be a stronger predictor of cardiovascular disease than LDL-C [Ridker *et al*., 2002], suggesting that inflammation is a critical factor in cardiovascular disease. Equally important is that CRP is positively linked with the anthropometric and metabolic variables characteristic of obesity which itself is considered as a chronic inflammatory disease [Visser *et al*., 2000; Lyon *et al*., 2003]. Obesity is associated with elevation of CRP, while caloric restriction and weight loss lower it [Heilbronn & Clifton, 2002]. This is reflected in the rising CRP values of the obese control dieters from 79% after 2 weeks to 237% at the end of four weeks in contrast to a final increase of only 16.3% for the soup dieters. This could be explained by the intervention of the dietary antioxidants present in the soup, that become incorporated in the LDL-C and are themselves oxidized when these LDL-C are exposed to prooxidative conditions and before any extensive oxidation can occur in the sterol or the polyunsaturated fatty acids [Sanchez-Moreno *et al*., 2000]. In addition, phytochemicals also exhibit an anti-inflammatory activity [Liu, 2003] which could contribute to attenuate the inflammation that might be responsible for an exaggerated increase in CRP values.

Obesity is also known to be a condition of perpetual oxidation stress [Keaney *et al*., 2003]. In this context, recent studies have revealed that superoxide formation is enhanced and that SOD is inhibited by non-enzymatic glycation in obesity and in metabolic disorders associated with obesity [Tungtrongchitr *et al*., 2003]. This supports our results that showed low SOD at baseline, before consumption of the soup and which was gradually increased in time to a significant 51.7% reaching a normal enzyme activity. This was in contrast to the values in the obese control which decreased even more (-6.63%) by the end of the program. Thus, the effect of the soup consumption is obvious when comparing the significantly lower values of SOD for the soup consumers than their obese controls, and that by the end of the program was reversed to a significantly higher value. On the other hand the values of GPX which, although higher in the soup consumers, did not show effective variations during the whole period.

Results of the triglycerides (TG) highlighted the beneficial effects of the radish soup starting from the end of the 2nd week with a 31.76% decrease from baseline values proceeding to a 36.1%, further decrease at the end of the 4th week, in contrast to 12.95% increase after 2 weeks receding to 2.25% above the baseline values at the end of the program in the case of the obese controls whose values were significantly higher than those of the soup dieters.

In this context, it has been demonstrated that fasting TG values are a potential predictor of obesity and a possible high risk factor for atherosclerosis, because they reflect a reduction in the capacity for fatty acid oxidation [Martins & Redgrave, 2004]. Studies have shown that there are defects at several levels in the catabolic process for lipids in obese skeletal muscle mitochondria thus favouring carbohydrate over fat oxidation [Astrup *et al*., 1997; Schutz, 1995; Kim *et al*., 2000]. A decreased reliance on lipids as an energy source has been identified as a metabolic risk factor for weight gain [Astrup *et al*., 1997; Colberg *et al*., 1995; Kelley *et al*., 1999; Zurlo *et al*., 1990]. It has also been suggested that impairment in skeletal muscle fatty acid oxidation also contributes to weight regain following weight loss [Kelley *et al*., 1999]. Moreover it has been demonstrated that even in a weight reduced state of formerly obese females, there was a persistence of reduced fatty acid oxidation and the inability to utilize fat for energy [Guesbeck *et al*., 2001]. These findings therefore necessitate the monitoring of the TG of the obese subjects as predictive of future weight gain rather than being simply reflective of current adiposity.

The initially normal serum copper, zinc and magnesium of both groups exhibited favourable increases, in contrast to declines in, and which led to subnormal, calcium concentrations of the soup and control dieters, probably due to the hypocaloric diet. Concern about low calcium values is not only due to its pivotal role in the metabolism but also because dietary calcium is now regarded as one of the most promising weight loss stimulants. It was found that high calcium diets markedly stimulate lipolysis while inhibiting lipogenesis, resulting in significant weight loss, and that also, more dramatic was the slimming effect of dairy calcium and the proteins associated with it, both in animals and in man [Zemel, 2003]. Furthermore, it was recently recognized that fermented milk products yield high levels of biologically available calcium [Seppo *et al*., 2003]. Thus, it would be advisable to implement dietary and specially dairy calcium in combating obesity, making sure all the time that serum calcium never drops to subnormal concentrations.

CONCLUSIONS

In conclusion, based on the results of this study, we propose the periodic determination of three sensitive biomarkers to monitor obese subjects during dietary therapy and particularly in the post-diet periods. These are: serum TGs, CRP and calcium that will help to define obesity and its impending complications so that any increases of the TG and CRP or decreases of the calcium concentrations would alert and prompt the physician in charge to resume and prescribe the appropriate diet. This strategy would help to blunt and/or delay weight cycling and other complications. In addition, by inducing beneficial metabolic responses in the obese, the regular consumption of the radish soup as a valuable adjunct to dietary control should be encouraged. Furthermore, because the soup is a safe and micronutrient nutritive food, it could be blended with the household menus as a step towards healthier nutritional habits.

REFERENCES

1. AOAC. Association of Official Analytical Chemists**.** 1990. Official Methods of Analysis of the Official Analytical Chemists. 2 vols. 15th Ed. Washington, DC. 70, 668, 931, 933 and 937.
2. Astrup A., Raben A., Buemann B., Toubro S., Fat metabolism in the predisposition to obesity. Ann. N. Y. Acad. Sci., 1997, 827, 417–430.
3. Bronner F., Pansu D., Nutritional aspects of calcium absorption. J. Nutr., 1999, 129, 9–12.
4. Colberg S.R., Simoneau J.A., Theate F.L., Kelley D.E., Skeletal muscle utilization of FFA in women with visceral obesity. J. Clin. Invest., 1995, 95, 1846–1853.
5. Delgado M.C., Potassium in hypertension. Curr. Hypertens. Rep., 2004, 6, 31–35.
6. Dukes J.A., Chemicals and their biological activities in *Raphanus sativus* L.(Brassicaceae)- radish. 2004, *in*: Phytochemicals and Ethnobotanical Databases (ed. J.A. Duke). USDA- ARS-NGRL, Beltsville Agricultural Research Center, Beltsville, Maryland EDT.
7. Durnin J.V.G.A., Womersley J., Body fat assessed from total body density and its estimation from skin-fold thickness, measurements on 481 men and women from 16–72 years. Br. J. Nutr., 1974, 32, 77–97.
8. Epstein L.H., Gordy C.C., Raynor H.A., Beddome M., Kilanowski C.K., Paluch R., Increasing fruit and vegetable intake and decreasing fat and sugar intake in families at risk for childhood obesity. Obes. Res., 2001, 9, 171–78.
9. Francis G.A., Fayard E., Picard F., Auwerx J., Nuclear receptors and the control of metabolism. Ann. Rev. Physiol., 2002, 65, 261–311.
10. Friedewald W.T., Levy R., Fredrickson D.S., Estimation of the concentration of low density lipoprotein cholesterol in plasma without use of the preparative ultracentrifuge. Clin. Chem., 1972, 18, 499–502.
11. Gartner C., Stahl W., Sies H., Lycopene is more bioavailable from tomato paste than from fresh tomatoes. Am. J. Clin. Nutr., 1997, 66, 116–122.
12. Ghase G.W., Landen W.O., Soliman G.M., Methods modification for liquid chromatographic determination of thiamine, riboflavin and pyridoxine in medical foods. J. AOAC Intern., 1993,76, 1276–1280.
13. Guesbeck N.R., Hickey M.S., MacDonald K.G., Pories W.J., Harper I., Ravussin E., Dohm G.L., Houmard J.A., Substrate utilization during exercise in formerly morbidly obese women. J. Appl. Physiol., 2001, 90, 1007–1012.
14. Heilbronn L.K., Clifton P.M., C-reactive protein and coronary artery disease, influence of obesity, caloric restriction and weight loss. J. Nutr. Biochem., 2002, 13, 316–321.
15. Hussein L., Bruggeman J., Zinc analysis of Egyptian food and estimated daily intakes among an urban population group. Food Chem., 1997, 58, 391–398.
16. Jacobson T.A., "The lower the better" in hypercholesterolemia therapy, a reliable clinical guideline? Ann. Intern. Med., 2000, 133, 549–554.
17. Jelliffe D.B., The assessment of the nutritional status of the community. World Health Organization. Geneva Monograph, 1966, pp. 53, 63–69.
18. Keaney J.F. Jr., Larson M.G., Vasan R.S., Wilson P.W., Lipinska I., Corey D., Massaro J.M., Sutherland P., Vita J.A., Benjamin E.J., Obesity and systemic oxidative stress, Clinical correlates of oxidative stress in the Framingham study. Arterioscler. Thromb. Vasc. Biol., 2003, 23, 434–439.
19. Kelley D.E., Goodpaster B., Wing R.R., Simoneau J.A., Skeletal muscle fatty acid metabolism in association with insulin resistance, obesity, and weight loss. Am. J. Physiol. Endocrinol. Metab., 1999, 277, E1130–E1141.
20. Kern P.A., Ranganathan S., Li C., Wood L., Ranaganthan G., Adipose tissue tumor necrosis factor and interleukin-6 expression in human obesity and insulin resistance. Am. J. Physiol. Endocrinol. Metab., 2001, 280, E745–E751.
21. Kim J.K., Hickner R.C., Cortright R.L., Dohm G.L., Houmard J.A., Lipid oxidation is reduced in obese skeletal muscle. Am. J. Physiol., Endocrinol. Metab., 2000, 279, E1039–1044.
22. Liu R.H., Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. Am. J. Clin. Nutr., 2003, 78, 516S–520S.
23. Lyon C.J., Law R.E., Hsueh, Minireview, adiposity, inflammation, and atherogenesis. Endocrinology, 2003, 144, 2195–2200.
24. Martins I.J., Redgrave T.G., Obesity and post-prandial lipid metabolism. Feast or Famine? J. Nutr. Biochem., 2004, 15, 130–141.
25. Müller M., Kersten S., Nutrogenomics, goals and strategies. Nature Rev./Genetics, 2003, 4, 315–322.
26. Papanicolaou D.A., Wilder R.L., Manolagas S.C., Chrousos G.P., The pathophysiologic roles of interleukin-6 in human disease. Ann. Inter. Med., 1998, 128, 127–137.
27. Rexrode K.M., Prodhan A., Manson J., Buring J.E., Ridker P.M., Relationship of total and abdominal adiposity with CRP and IL-6 in women. Ann. Epidemiol., 2003, 13, 674–682.
28. Ridker P.M., Rifai N., Rose L., Buring J.E., Cook N.R., Comparison of c-reactive protein and low- density lipoprotein levels in the prediction of first cardiovascular events. N. Engl. J. Med., 2002, 347, 1557–1565.
29. Sanchez M.C., Jimenez E.A., Saura C.F., Study of low-density lipoprotein oxidizability indexes to measure the antioxidant activity of dietary polyphenols. Nutr. Res., 2000, 20, 941–53.
30. Schutz Y., Abnormalities of fuel utilization as predisposing to the development of obesity in humans. Obes. Res., 1995, 3(Suppl. 2), 173S–178S.
31. Seppo L., Jauhiainen T., Poussa T., Korpela R., A fermented milk high in bioactive peptides has a blood pressure-lowering effect in hypertensive subjects. Am. J. Clin. Nutr., 2003, 77, 326–330.
32. Singleton V.L., Rossi J.A., Colorimetry of total phenolics with phosphomolybdic- phosphotungstic acid reagents. Am. J. Enol. Vitic., 1965, 16, 144–158.
33. Tungtrongchitr R., PongPaew P., Phonrat B., Tungtrongchitr A., Viroonudomphol D., Vudhivai N., Schelp F.P., Serum copper, zinc, ceruloplasmin and superoxide dismutase in Thai overweight and obese. J. Med. Assoc. Thai., 2003, 86, 543–551.
34. Visser M., Bouter L.M., McQuillan G.M., Wener M.H., Harris T.B., Elevated c-reactive protein levels in overweight and obese adults. J. Am. Med. Assoc., 2000, 282, 2131–2135.
35. Wee C.C., Hamel M.B., Davis R.B., Phillips R.S., Assessing the value of weight loss among primary care patients. J. Gen. Intern. Med., 2004, 19, 1206–1211.
36. Zemel M., Dietary calcium and dairy products accelerate weight and fat loss during energy restriction in obese adults. Am. J. Clin. Nutr., 2003, 75, 342S–343S.
37. Ziccardi P., Nappo F., Giugliano G., Esposito K., Marfella R., Cioffi M., Andrea F., Molinari A.M., Giugliano D., Reduction of inflammatory cytokine concentrations and improvement of endothelial functions in obese women after weigh loss over one year. Circulation, 2002, 105, 804–809.
38. Zurlo F., Lillioja S., Esposito-Del Puente A., Nyomba B.L., Raz I., Saad M.F., Swinburn B.A., Knowler W.C., Bogardus C., Ravussin E., Low ratio of fat to carbohydrate oxidation as a predictor of weight gain, Study of 24-h RQ. Am. J. Physiol. Endorinol. Metab., 1990, 259, E650–E657.

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