Weight Loss Associated With a Daily Intake of Three Apples or Three Pears Among Overweight Women

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OBJECTIVE: We investigated the effect of fruit intake on body weight change.

METHODS: Hypercholesterolemic, overweight (body mass index > 25 kg/m^2), and non-smoking women, 30 to 50 y of age, were randomized to receive, free of charge, one of three dietary supplements: apples, pears, or oat cookies. Women were instructed to eat one supplement three times a day in a total of six meals a day. Participants (411 women) were recruited at a primary care center of the State University of Rio de Janeiro, Brazil. Fifty-one women had fasting blood cholesterol levels greater than 6.2 mM/L (240 mg/dL) and 49 were randomized. Subjects were instructed by a dietitian to eat a diet (55% of energy from carbohydrate, 15% from protein, and 30% from fat) to encourage weight reduction at the rate of 1 kg/mo.

RESULTS: After 12 wk of follow-up, the fruit group lost 1.22 kg (95% confidence interval = 0.44–1.85), whereas the oat group had a non-significant weight loss of 0.88 kg (0.37–2.13). The difference between the two groups was statistically significant ($P = 0.004$). To explore further the body weight loss associated with fruit intake, we measured the ratio of glucose to insulin. A significantly greater decrease of blood glucose was observed among those who had eaten fruits compared with those who had eaten oat cookies, but the glucose:insulin ratio was not statistically different from baseline to follow-up. Adherence to the diet was high, as indicated by changes in serum triacylglycerols, total cholesterol, and reported fruit intake. Fruit intake in the oat group throughout treatment was minimal.

CONCLUSIONS: Intake of fruits may contribute to weight loss. *Nutrition* 2003;19:253–256. ©Elsevier Science Inc. 2003

KEY WORDS: apple, pear, oat cookies, diet, clinical trial, weight loss

INTRODUCTION

Although fruit intake is considered a protective factor for many chronic diseases[1] and dietary guidelines have recommended increased intakes of fruits and vegetables,[2,3] there is no intervention study of adding fruits to diet as a weight-loss treatment. Testing whether increased intake of fruits contributes to weight loss requires a population with a low intake of fruits, a frequent dietary pattern in the low-income population in Brazil.

The rationale for such a hypothesis of weight loss with increased intake of fruits is based on three premises: the low-energy density of most fruits, their higher fiber composition, and a less striking variation of diets high in fruit. In support of this hypothesis, a recent review indicated that, under fixed energy intake, soluble or insoluble fiber intake increases postmeal satiety and decreases subsequent hunger. In addition, this review suggested, at least for short-term follow-up, that high-fiber diets decrease energy intake and body weight.[4] High-fiber content also can be a marker for lower palatability or a monotonous diet. Dietary variety within food groups and palatability were shown to be important predictors of body fatness.[5] Because individuals tend to consume a fixed amount of food,[6,7] a large intake of a low-energy food, such as fruits, makes excessive energy intake more difficult. Findings from several investigations have shown that low-energy density foods reduce total energy intake,[6,8,9] and US women consumed 20% less energy in a low-energy compared with a high-energy density diet.[8] Therefore, we carried out a clinical trial among hypercholesterolemic, overweight women to test primarily the effect on serum cholesterol with the addition of three apples, three pears, or three oat cookies (with the same amount of fruit fiber) to the daily diet. For the present analysis, the pear and apple groups were combined to verify the effect of fruit intake on body weight.

MATERIALS AND METHODS

Overweight (body mass index > 25 kg/m^2), hypercholesterolemic, non-smoking women, 30 to 50 y of age, were randomized to receive, free of charge, one of three dietary supplements for 12 wk: apples, pears, or oat cookies. Women were instructed to eat one of each supplement three times a day as snacks between meals. The overall intake of supplements per day was 300 g of apple (variety Fuji), 300 g of pear (William), or 60 g of oat cookies (Table I).

During a run-in period of 2 wk and the 12-wk treatment, subjects were instructed by a dietitian to eat a standardized and hypocaloric diet (55% of energy from carbohydrates, 15% from protein, and 30% from fat) designed to reduce body weight at a rate of 1 kg/mo. During treatment the women were instructed to eat one supplement three times per day in a total of six meals per day.

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TABLE I.

NUTRIENT COMPOSITION OF DAILY INTAKE OF SUPPLEMENTS*

Nutrient intake	Fuji apple (300 g)	William pear (300 g)	Oat cookies (60 g)
Energy (kcal)	177	177	221
Carbohydrate (g)	45.7	45.3	40.9
Glucose (g)	2.3	1.9	0.09
Fructose (g)	22.8	19.2	0
Fiber (g)	6.42	7.32	6.46
Insoluble fiber (g)	3.42	5.58	2.51
Soluble fiber (g)	3.00	1.74	4.09
Calcium (mg)	21	33	16.4

* USDA Nutrient Database for standard reference (35) and fiber (22).

Diets were energy adjusted every 2 wk, and the differences in energy composition of supplements were compensated with reduction of rice and beans for energy adjustment.

Of 411 women eligible for inclusion, 107 showed finger cholesterol levels greater than 6.2 mM/L (240 mg/dL). Fifty-two subjects repeated the venous examination after fasting for 8 to 12 h, and 51 women had confirmed cholesterol levels of at least 6.2 mM/L (240 mg/dL) and started the run-in period. Forty-nine were randomly assigned with the use of a stratified randomization scheme to three treatment groups.[21]

Women with cholesterol levels greater than 6.2 mM/L (240 mg/dL) and who expressed an interest in participating in the cholesterol-lowering dietary study were asked to attend an orientation session during which conditions, procedures, and intervention were explained. Written consent was obtained from each subject before beginning the study. The Ethic Committee of the State University Rio de Janeiro approved the protocol. Women who had a diagnosis of diabetes, who had a regular intake of medicine or substances that might alter the cholesterol levels, or who did not like apples, pears, or cookies were excluded.

Fruit and nutrient intakes at baseline were determined by a food-frequency questionnaire previously validated for the Brazilian population.[10] Three-day dietary records were completed after 3 and 12 wk of follow-up. Subjects received detailed instruction on recording their intakes on 3 consecutive days including 2 weekdays and 1 weekend day. Compliance to the diet was estimated by the dietary records and by serum triacylglycerols and cholesterol.

Venous blood was drawn in the morning after an overnight fast of 8 to 12 h. Blood was processed at the Pedro Ernesto Laboratories (UERJ, Rio de Janeiro, Brazil). Triacylglycerols and glucose were measured enzymatically with an auto analyzer manufactured by Mega Bayer (Sera-Pak, Tarrytown, NY, USA). Insulin was measured by a chemiluminescence immunoassay method with a human insulin–specific enzyme-linked immunosorbent assay (Crystal Chem Inc., Chicago, IL, USA).[11,12] All blood samples were measured at the end of the study, and samples were stocked in a −80°C freezer. The technician performing the blood analysis was blind to the protocol.

Comparison of baseline characteristics including those lost to follow-up used one-way analysis of variance. Paired *t* test was used to compare the changes from baseline to the end of follow-up. For statistical analysis over time, the procedure (Proc Mixed) in SAS[13] was used to account for the variance due to repeated measurements. To normalize the distribution, weight, triacylglycerols, insulin, and blood glucose were log transformed.

RESULTS

Of the 49 subjects initially recruited, 40 were followed for 6 wk and 35 were followed for 12 wk. Baseline characteristics of the fruit and oat groups were not statistically different, and both treatment groups did not differ from those lost to follow-up (Table II). After 12 wk of follow-up, the fruit group lost 1.21 kg (95% confidence interval = 0.44–1.85), whereas the oat group lost 0.88 kg (0.37–2.13). The fruit group, but not the oat group, had a statistically significant reduction of weight because the confidence interval did not include zero. Therefore, the difference between groups was statistically significant ($P = 0.003$; Table III). Energy intake also was reduced in the fruit group, but not in the oat group (Table III).

A significantly greater decrease of blood glucose was observed among those who had eaten fruits (−5.2 mg/dL, $P = 0.02$) compared with those who had eaten oat cookies (−0.75 mg/dL, $P = 0.87$). However, the fasting insulin and glucose:insulin ratio was not statistically different from baseline to follow-up in both groups (Table IV).

Adherence to the diet was greater as measured by reported intake (Fig. 1). Also, triacylglycerol levels for the fruit group increased by 0.74 mmol/L ($P = 0.004$) during follow-up compared with a reduction of 0.01 mM/L ($P = 0.98$) for the oat group. With regard to cholesterol, we observed a non-significant reduction of 0.08 mM/L ($P = 0.66$) in the fruit group but a greater reduction of 0.58 mmol/L ($P = 0.08$) in the oat group. Fruit intake in the oat group was kept to a minimum throughout treatment (Fig. 1).

TABLE II.

CHARACTERISTICS OF PARTICIPANTS AT BASELINE

	Fruit ($n = 26$)		Oat cookie ($n = 9$)		Lost to follow-up ($n = 14$)		
	Mean	SD	Mean	SD	Mean	SD	*P**
Age (y)	43.7	4.8	45.0	3.8	43.9	7.6	0.86
Body weight (kg)	77.7	10.6	78.9	9.7	80.2	11.3	0.77
Blood glucose (mg/dL)†	103	38	91	10	103	47	0.72
Triacylglycerols (mM/L)‡	1.96	0.79	1.57	0.36	1.86	0.85	0.46
Fruit intake/d (U)	0.75	0.64	1.02	0.77	0.59	0.63	0.33

* Analysis of variance.

† To convert values for triacylglycerols to mg/dL, multiply by 87.57.

‡ To convert values for glucose to mM/L, multiply by 0.05.

SD, standard deviation

TABLE III.

AGE-ADJUSTED ESTIMATED WEIGHT AND ENERGY INTAKE CHANGES*

	Change	Standard error	*P*
Fruit†	−1.21	0.38	0.001
Oat cookie†	−0.88	0.65	0.18
Treatment difference†	0.33		0.003
Fruit‡	−22.50	2.30	0.001
Oat cookie‡	+0.93	0.97	0.90

* From a procedure-mixed model, where treatment difference is estimated from the time treatment variable. Time has two levels: baseline and 12-week follow-up.
† Weight (kg).
‡ Energy intake (kcal).

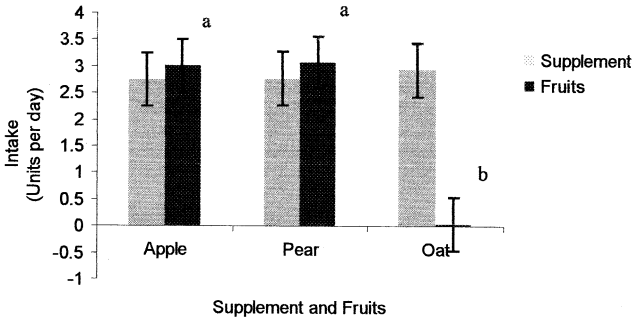

FIG. 1. Reported total daily intake of fruits and reported daily intakes of supplements (fruits or oat cookies). Means of 3-d records in weeks 3 and 12 of follow-up are reported. $^{a,b}P < 0.05$, analysis of variance.

DISCUSSION

Results indicated that overweight, hypercholesterolemic women have important changes in their body weights and metabolic profiles by adding fruits to their diets. The serum increase of triacylglycerol with fruit supplementation was in accordance to the literature. Several intervention dietary studies found an increase on triacylglycerols due to fructose intake.[14–17] In the present study daily fructose intake reached 22.8 g in the apple group and 19.2 g in the pear group. Chronic intake of diets high in carbohydrates (>60% of carbohydrate) was associated with higher fasting plasma triacylglycerol levels,[4,18] and short-term modifications of dietary carbohydrate composition also modulated serum lipids. Thus, a 12 wk diet of similar caloric intake (1200 kcal/d) but differing in carbohydrate contents (25% and 45%) showed a decrease in triacylglycerol levels with the low-carbohydrate diet.[19]

In the present study, macronutrient composition of the diet was almost unchanged from baseline to follow-up. Carbohydrate intake at baseline, as reported in the food-frequency questionnaire, was about 60% of energy and decreased to approximately 55% with the dietary intervention during follow-up. Therefore, changes in the macronutrient composition of the diet cannot explain our findings.

Dietary carbohydrates also can modulate blood glucose level according to the glycemic index. A high index causes high postprandial glucose and insulin response, and it has been associated with decreased insulin sensitivity and increased risk of coronary heart disease.[20] For foods low on the glycemic index such as beans, peas, spaghetti, barley, and fruits, changes are less striking.[21] Reduced levels of blood glucose in the fruit group in the present study might have been a consequence of the low values of apples and pears on the glycemic index.[22] In normal subjects, the glycemic index values were 56 for apples versus 77 for oat cookies when bread was the reference.[22]

Fructose also has been associated with significantly lower serum glucose and decreased insulin responses as compared with sucrose-sweetened foods.[23] However, high dietary fructose consumption can significantly increased fasting plasma triacylglycerol and cholesterol concentrations.[24] Nevertheless, moderate fructose intake (7.5 g) in normal health volunteers (five men and six women) improved the glycemic response without enhancing the triacylglycerol response.[25] Also, consumption of glucose or syrup drinks in humans produced significantly higher levels of plasma insulin,[26] with subjects whose blood glucose response levels were above 155 mg being particularly responsive to the effects of fructose on insulin levels.[26] Participants in the fruit groups of the present trial had a fructose consumption of about 20 g/d, but our findings did not show an effect on insulin levels.

TABLE IV.

MEANS, SD, AND ESTIMATED CHANGES IN WEIGHT, FASTING GLYCEMIA, FASTING INSULIN, AND GLUCOSE:INSULIN RATIO

	Baseline		12-w follow-up			
	Mean	SD	Mean	SD	Mean change	*P*†
Weight (kg)						
Fruit (n = 26)	77.7	10.8	76.5	11.2	−1.21	0.02
Oat (n = 9)	78.9	9.7	78.0	9.1	−0.88	0.11
Blood glucose (mg/dL)						
Fruit (n = 25*)	96.6	17.6	94.5	22.8	−5.2	0.02
Oat (n = 9)	91.5	11.0	90.7	15.4	−0.75	0.87
Fasting insulin (μU/mL)						
Fruit (n = 26)	12.3	9.0	16.7	12.2	3.1	0.18
Oat (n = 8)	6.3	2.5	11.6	14.6	5.3	0.34
Glucose:insulin ratio						
Fruit (n = 25)	11.0	5.2	8.9	5.6	−2.0	0.14
Oat (n = 8)	16.7	5.4	13.7	5.8	−3.0	0.40

* One measurement with more than 200 excluded.
† Paired *t* test.
SD, standard deviation

Although the oat group had the greatest loss to follow-up, those lost to follow-up were not different at baseline from those followed in both experimental groups, as shown in Table II. Also, most losses occurred after week 6 of follow-up, with most participants contributing with weight measurements until the third wave of follow-up. A possible explanation for the losses in the oat group might be that fruits are less affordable than cookies.

We found that the fruit group had a greater reduction in energy intake compared with the oat group. Data from short-term studies indicated that consumption of carbohydrates of low glycemic index may decrease hunger.[27] Therefore, eating three fruits per day may decrease energy intake due to greater satiety.

To explore further the body weight loss associated with fruit intake, we measured the glucose:insulin ratio. A significantly greater decrease of blood glucose was observed among those who had eaten fruits than among those who had eaten oat cookies, but the glucose:insulin ratio was not statistically different from baseline to follow-up in either group. Modification of insulin resistance might be a causal pathway of the association between fruit intake, hunger, and weight reduction, but a larger sample size is needed to test this hypothesis.

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