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## Original

# The use of low glycemic and high satiety index food dishes in Mexico: a low cost approach to prevent and control obesity and diabetes

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**Abstract**

**Obesity and diabetes are epidemics in Mexico and the prevalence is currently highest among the low-income population. The aim of the present study was to compare the action of different breakfasts on satiety and subsequent food intake among healthy women. Eight healthy women participated in the study. Participants were given four experimental breakfasts. Visual analogue rating scales were completed before and every 30 minutes for 3 hours after each experimental meal to record subjective feelings of satiety. Subjects were exposed to an *ad libitum* buffet 3 h after the experimental breakfast. Energy and macronutrient intakes were calculated at each meal.**

**Mean ± SD SAUC for white bread was 355 ± 60, for rice and bananas: 405 ± 108, for whole wheat bread and boiled beans: 446 ± 83, and for fruit salad: 585 ± 79 (Table II). Statistical differences were observed among the four experimental meals (p = 0,002). After the consumption of white bread, energy intake was the highest with 872 ± 58 kcal, and after the consumption of fruit salad the intake of calories was the lowest: 461 ± 51 kcal. Energy intake 4 h after each breakfast shows statistical differences (p = 0,0001). These results suggest the need to promote culturally based combined foods with high fiber and low GI, as well as foods with high volume and water content. This approach might contribute to the prevention of obesity by increasing satiety and reducing food consumption and energy intake.**

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Key words: *Satiety index. Glycemic index. Obesity. Diabetes. Mexican style diet.*

**EL EMPLEO DEL ÍNDICE GLUCÉMICO Y PLATOS CON UN INDICE DE SACIEDAD ELEVADA EN MÉXICO: UN ABORDAJE DE BAJO COSTE PARA PREVENIR Y CONTROLAR LA OBESIDAD Y LA DIABETES**

**Resumen**

**La obesidad y la diabetes son una epidemia en México y la prevalencia es superior en la población de más bajos ingresos. El objetivo del presente estudio fue comparar el efecto de diferentes desayunos sobre la saciedad y el consumo subsecuente de alimentos en mujeres sanas. Ocho mujeres participaron en el estudio, a quienes se les dieron cuatro desayunos. Se les solicitó llenar la escala de análogo visual antes y cada 30 minutos durante 3 horas, después de cada alimento para registrar la percepción de hambre. Tres horas después de los alimentos se les expuso a un buffet para su consumo *ad libitum*. Se calculó la ingesta de energía y macronutrientes en cada episodio.**

**El promedio de el Área de saciedad bajo la curva (ASBC) fue para el pan blanco de 355 ± 60, para arroz con plátano de 405 ± 108, para pan integral y judías cocidas de 446 ± 83, y para ensalada de frutas de 585 ± 79 (tabla II). Se observó diferencias de saciedad entre los cuatro alimentos experimentales (p = 0,002). Después del consumo de pan blanco, se observó el mayor consumo de energía, con 872 ± 58 kcal, y posterior al consumo de la ensalada de frutas, se observó el consumo más bajo: 461 ± 51 kcal. La ingesta de energía cuatro horas después de cada desayuno fue diferente (p = 0,0001).**

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Palabras clave: *Índice de saciedad. Índice glucémico. Obesidad. Diabetes. Dieta al estilo mejicano.*

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## Introduction

Diabesty is currently a burden on the Mexican health care system[1]. The increase of overweight in children indicates the augmentation of prenatal and postnatal factors as well as the increase of consumption of high density foods and the decrease in physical activity[1-3]. High Glycemic index (GI) diets might have implications in the prevention and treatment of several cardiovascular risk factors, such as type 2 diabetes mellitus, obesity, and hyperlipidemia[4-6]. Some studies have observed a strong and inverse association between GI and satiety[7,8]. It has also been shown that foods with high fiber content and fiber supplements have a strong effect on satiety, while the consumption of refined foods increase insulin response and decrease satiety[9]. In addition, satiety index has been associated with the food content of water, fiber, and protein[9].

Several studies have shown that the consumption of specific macronutrients might also have an important effect on the amount of total consumed food at a particular time; high protein content foods might be followed by satiety, while low protein foods produce low satiety[10]. On the other hand, the size of the portions also have an effect on food intake[11]; while fats and carbohydrates have different effects on satiety and the following food intake[12-14]; additionally, energy intake is also associated to food density[14].

The diets consumed by Mexicans in rural areas as well as by the low income population from urban areas, traditionally are based on tortillas, beans, and fruits, which are foods with high low GI; however, the urbanization and globalization of "ready to eat " foods has increased the consumption of cereals, soft drinks, and high energy foods[3], which might be associated to the increase in prevalence of obesity among the Mexican population[1]. In two previous studies, people with type 2 diabetes improved the lipid profile after a three week moderate GI Mexican style diet[15], and improved AIC and BMI after a six week low GI Mexican style flexible diet[16]. Low GI Mexican style diets have also shown improvement of lipid profile among hyperlipidemics[17], and higher satiety perception after lunch among Type 2 Mexicans with diabetes[18].

The aim of this study was to evaluate the effect of usually consumed breakfast in the northwestern region of Mexico on satiety on healthy subjects.

## Methods

*Population*

Eight healthy women were recruited for inclusion in the study. Criteria for inclusion were as follows: body mass index (BMI) between 20 and 27 $kg/(m)^2$, age between 34 and 72 yrs, and consuming a usual breakfast before 10:00 a.m. Criteria for exclusion were as follows: any restrictive diet in the previous 2 months, any medication likely to modify food intake or eating behavior, consumption of > 5 cigarettes or > 20 g of alcohol per day, dyspepsia, pregnant women, women on a high performance training regimen, or those persons with any systemic disease.

All subjects gave informed consent, and the study was approved by the Ethics Committee of the Graduate Program of Nutrition of the Autonomous University of Baja California.

*Procedure*

Subjects were asked to maintain their usual level of physical activity on the day before each test day. Subjects were also asked to refrain from drinking alcohol on the day before throughout each test. The evening meal of the day before each test was designed to be a 700 kcal meal consumed between 8 p.m. and 10 p.m. On the day of the test, subjects were instructed to be transported by car or bus. Food and activity diaries were used to monitor compliance. On each test day, subjects were weighed and measured. The test meal was consumed at 10:00 a.m.. At the start of the test, subjects rated their hunger and fullness on visual analogue scales (fig. 1). For example, hunger was rated on a 100 mm line preceded by the question: "How hungry are you right now?" and anchored on the left by "not at all hungry" and on the right by "extremely hungry".

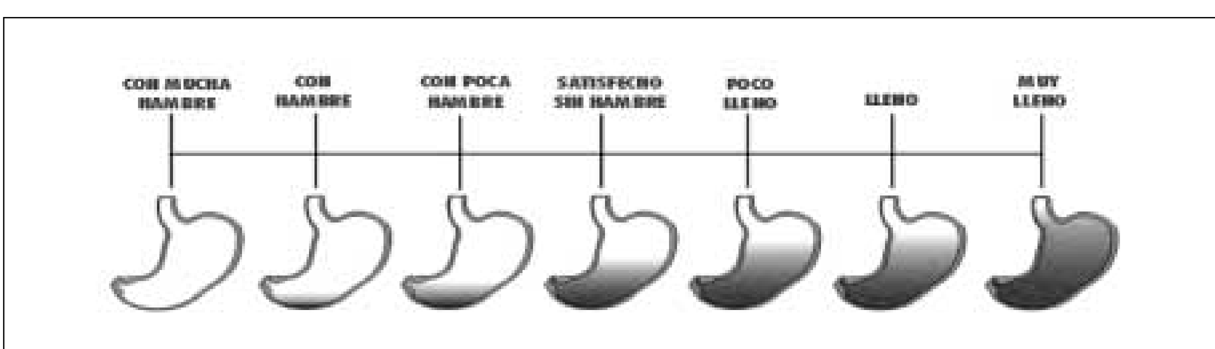


*Fig. 1.—Visual Analogue Rating Scale.*

Ratings were performed before and after each test meal every 30 min for 3 h. Each test meal was consumed with a 360 ml bottle of water during a period of 15 min. During the test period subjects were permitted to read magazines, excluding any articles related to food, body image, or weight loss. Subjects could watch TV or listen to the radio.

Incremental areas under the response curves were calculated using the trapezoidal rule with fasting levels as the baseline. Any negative area was ignored. The SI of each meal was determined by the Wolever[19] formula for glycemic index.

Three hours after the test breakfast subjects were presented a buffet style lunch that allowed individuals to choose *ad libitum* from a variety of meal-appropriate foods. The foods varied in fat, carbohydrate and protein content to allow subjects to vary their energy intake. After consumption of the buffet, leftovers were weighed and the nutrient content of the food consumed was estimated by the Nutritionist Pro (Ver 1.2). Each experimental breakfast and lunch was randomly assigned. Test meals were assessed in a period no shorter than 15 days.

### *Diets*

The experimental breakfast was composed of the following: a) white bread; b) whole grain bread and beans; c) rice with bananas, and d) fruit salad (apples, peaches, strawberries, cottage cheese, and honey). Table I shows the weight, energy content, macronutrients, and glycemic index of each experimental breakfast.

### *Statistical analyses*

Data was analyzed using SPSS for Windows (V.10). Differences of the satiety area under the curve (SAUC) and the subsequent energy and nutrient intake were estimated by the Friedman test (tables II and III). The incremental areas under the satiety response curves were calculated using the trapezoidal rule with fasting scores as the baseline[19]. Satiety area differences between meals were compared by Wilcoxon rank-test.

**Tabla II**
*Area Under the Curve of Satiety*

| *Food* | *n* | *Mean ± SD* | *Minimum* | *Maximum* |
|---|---|---|---|---|
| White bread | 8 | 355 ± 60 | 300 | 450 |
| Rice and banana | 8 | 405 ± 108 | 285 | 577 |
| Whole grain bread and beans | 8 | 446 ± 83 | 322 | 570 |
| Fruit salad | 8 | 585 ± 79 | 427 | 652 |

Friedman test $p = 0.002$.

## Results

The final sample consisted of eight healthy women with an average age of 44 yrs (34-72) and body mass index (BMI) of 25.1 (23-27) kg/(m)$^2$.

Mean ± SD SAUC for white bread was 355 ± 60, for rice and bananas: 405 ± 108, for whole wheat bread and boiled beans: 446 ± 83, and for fruit salad: 585 ± 79 (table II). Statistical differences were observed among the four experimental meals ($p = 0,002$). *Ad libitum* consumption of energy and nutrients is shown in table III. After the consumption of white bread, energy intake was the highest with 872 ± 58 kcal, and after the consumption of fruit salad the intake of calories was the lowest: 461 ± 51 kcal. Energy intake 4 h after each breakfast shows statistical differences ($p = 0.0001$) (table III).

## Discussion

The result of this study shows that highest satiety was observed with the consumption of the fruit salad and the whole grain bread and beans (table II). Subsequent energy intake was also lower after those combi-

**Tabla I**
*Nutrient content and glycemic index of the experimental meals*

| *Food* | *Weight* | *Kcal (g)* | *Carbohydrates (g)* | *Proteins (g)* | *Fiber (g)* | *Fat (g)* | *Water (ml)* | *GI* |
|---|---|---|---|---|---|---|---|---|
| White bread | 220 | 589 | 114 | 18 | 5 | 3 | 81 | 100 |
| Bean | 171 | 596 | 110 | 25 | 23 | 9 | 153 | 80 |
| Whole grain bread | 130 | | | | | | | |
| Rice | 360 | 640 | 151 | 10 | 10 | 3 | 513 | 88 |
| Banana | 360 | | | | | | | |
| Apple | 550 | 599 | 144 | 11 | 26 | 3.6 | 950 | 60 |
| Cottage cheese | 55 | | | | | | | |
| Strawberries | 288 | | | | | | | |
| Peach | 196 | | | | | | | |
| Honey | 20 | | | | | | | |

GI = Glycemic Index.

**Tabla III**
*Ad libitum consumption of energy and nutrients after 4 h of experimental dishes (mean ± SD)*

| *Energy and nutrients* | *n* | *White bread* | *Banana and rice* | *Whole bread and beans* | *Fruit salad* | *p* |
|---|---|---|---|---|---|---|
| Energy (kcal) | 8 | 872 ± 58 | 791 ± 72 | 562 ± 150 | 461 ± 51 | 0.000 |
| Protein (g) | 8 | 60 ± 7 | 57 ± 7 | 39 ± 16 | 50 ± 6 | 0.002 |
| Carbohydrates (g) | 8 | 68 ± 13 | 93 ± 8 | 62 ± 25 | 48 ± 15 | 0.002 |
| Fat (g) | 8 | 47 ± 5 | 16 ± 2 | 47 ± 32 | 8 ± 2 | 0.001 |
| Total fiber (g) | 8 | 17 ± 4 | 12 ± 4 | 13 ± 4 | 13 ± 4 | 0.092 |

(*) Friedman test.

ned foods (table III). These results show that, in this group of women, the responses after the visual analogue scale are validated by the subsequent consumption of energy. The results are consistent with other studies reporting that foods with low GI, high protein and high fiber content have the greatest effect on satiety[9,10]. Latner and Schwartz[20] reported that food high in protein food resulted in lower energy intake, while Burley et al.[9] observed highest satiety after high fiber consumption. In this study, energy content was similar in the four meals. However, the weight of food, water, and fiber content was higher in the fruit salad meal, which suggests the combined effect on satiety of three of those features. Other studies have shown the effect of food volume on satiety independent of the nutrient content of foods[21]. In addition, the water content of food increases the food volume, reduces the energy density of foods and results in higher satiety, possibly due to the effect of gastric distention produced by water. Adequate promotion of physical activity and culturally based diets with low GI and high SI might be a low cost approach for the prevention and control of obesity and diabetes in a population with a high prevalence of diabesity and high index of marginality. This approach could be cost-effective in developing countries such as Mexico, where health care is limited for the people under the poverty level.

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