VENDING MACHINE FOODS: EVALUATION OF NUTRITIONAL COMPOSITION

A. RAPOSO[1]*, C. CARRASCOSA[2], E. PÉREZ[2], A. TAVARES[3], E. SANJUÁN[2], P. SAAVEDRA[4] and R. MILLÁN[2]

[1]Centro de Investigação Interdisciplinar Egas Moniz, CiiEM, Instituto Superior de Ciências da Saúde Egas Moniz, ISCSEM, Quinta da Granja, Monte de Caparica, 2829-511 Caparica, Portugal
[2]Department of Animal Pathology and Production, Bromatology and Food Technology, Faculty of Veterinary, Universidad de Las Palmas de Gran Canaria, Trasmontaña s/n, 35413 Arucas, Spain
[3]Escola de Ciências e Tecnologias da Saúde, Universidade Lusófona de Humanidades e Tecnologias, Campo Grande, 376, 1749-024 Lisboa, Portugal
[4]Department of Mathematics, Universidad de Las Palmas de Gran Canaria, Mathematics Building, Campus Universitario de Tafira, 35018 Las Palmas de Gran Canaria, Spain
*Corresponding author. Tel. +351 918376093
E-mail address: araposo@egasmoniz.edu.pt

ABSTRACT

The nutritional quality of vending machine foods may be a factor that contributes to significantly increase obesity and associated diseases, and the vending industry is significantly growing worldwide. This study aims to evaluate the nutritional composition of vending machine foods and to compare it with the consumption of the Gran Canaria population.

Food products from 74 snack and 71 refrigerated vending machines located in Las Palmas (Gran Canaria), and on university campuses, were nutritionally assessed. The percentages of sales per food type were accessed during a 12 month-period to verify user preferences. Significant differences ($p < 0.05$) were found in the content of nutrients compared with the Kruskal-Wallis test with all the food groups. Sandwiches (wholemeal and white bread) had the lowest energy levels, while croissants had the highest. We highlight the increased sodium content in baguettes compared to the other foods.

The findings suggest that vending machine foods contain more fat/saturated fat, calories and sodium than recommended. Further studies on the nutritional assessment of vending machine foods, governments' awareness and policies that promote the intake of healthy foods are essential to increase the amount of foods with an appropriate nutritional profile according to recommendations in vending machines.

Keywords: consumer, food choices, nutritional assessment, vending machines

1. INTRODUCTION

Recent decades have witnessed a significant increase in industrial vending machine development. Japan is the world leader in this sector, the USA makes 30 billion American dollars per year (LIN *et al*., 2011), and the UK makes approximately 1,700 million pounds sterling (MINTEL, 2009).

Spain is a European power in using vending machines, with a consolidated industry and highly integrated use (RAPOSO *et al*., 2015). There are 560,000 vending machines across Spain; that is, one machine for every 80 inhabitants. Japan, the industry leader, has 5.5 million vending machines, which is one for every 23 people (MTV, 2008).

For decades, the nutritional value of foods present in vending machines has been consistently documented (CHENEY, 1974; EZELL *et al*., 1985; HRUBAN, 1977; KOEHLER *et al*., 1977; SHEARER *et al*., 1980). In general, authors have voiced concern about the relatively low value of nutrients, and the high sugar and fat contents in many of the most frequently chosen items (HUNTER, 1992; KUBIK *et al*., 2013; PASCH *et al*., 2011). Nowadays, such concern has led to some governments, as in Spain, to legislate the products sold in vending machines in schools and colleges (Spanish Law 17/2011, of July 5, of Food Safety and Nutrition, especially Article 41), and also because of the high childhood obesity rates and unhealthy food habits detected among consumers (CAVALIERE *et al*., 2014; EBENEGGER *et al*., 2010; MACKAY, 2011). Although the vending machine policy has been effective in changing snack behaviour in a wide variety of settings, no published research has investigated vending snack behaviour in a university campus community (CARUSO *et al*. 2014).

Despite the potential risks or health benefits, very little is known about the variety of food and beverages sold in vending machines on university campuses. A study carried out by BYRD-BREDBENNER *et al*. (2012), which aimed to assess the drinks and snacks sold in vending machines in different universities, reported that snacks and drinks offered poor nutrient quality. Most snacks were low in fibre and had high calorie and fat contents, and almost half contained too much sugar. Most drinks also contained high levels of sugar and calories. The findings of this study suggested that vending machines offer limited healthy options. Other studies have demonstrated that the sale and consumption of healthy foods can be influenced by increased availability of healthy foods (FRENCH *et al*., 2004; LYTLE *et al*., 2006; MUCKELBAUER *et al*., 2009; PERRY *et al*., 2004). Similarly, purchase behaviour can be positively influenced by driving customers to healthier choices through strategies such as labelling, and by providing information, reminders and reinforcement (GEREND, 2009; HARNACK *et al*., 2008; HOLDSWORTH *et al*., 2004). As the effect of labelling itself is slight, it is likely to be more effective if combined with other methods (FRENCH *et al*., 2001; GRUNERT *et al*., 2010; SACKS *et al*., 2009); e.g. strategies that influence purchasing behaviour by reducing low-calorie food prices (FRENCH *et al*., 2001). The results of another study (KOCKEN *et al*., 2012) indicated that when the availability of low-calorie foods increased and was combined with labelling that highlighted nutritional properties, and prices lowered at the same time, students made healthier choices without buying more or fewer products from vending machines.

Vending machines reflect the good availability and suitability of food and beverages in western society, and also in many environments, including schools (RIDEOUT *et al*., 2007; VAN DER HORST *et al*., 2008), workplaces (FRENCH *et al*., 2010) and health centres (LAWRENCE *et al*., 2009). In some places, availability of alternative foods and beverages from vending machines may be limited (FARLEY *et al*., 2010). Based on these data, providing healthy varied foods in such machines is extremely important to counteract the facts that some studies have reported (FINKELSTEIN *et al*., 2008; FRENCH *et al*., 2003;

LYTLE *et al*., 2006), which have documented that most vending machines are typically stocked with food and beverages that are rich in energy, but low in nutrients.
Some studies have shown the relationship between students who use vending machines regularly and excessive consumption of sugary drinks (WIECHA *et al*., 2006). However, not only sugary drinks from vending machines contribute to a significant increase in obesity and associated diseases, but snack vending machines form part of an environment that may lead to obesity, which encourages easy access to energy-dense and nutrient-poor food (KUBIK *et al*., 2015; PARK and PAPADAKI, 2016). Typically vending machines offer few healthy options (LAWRENCE *et al*., 2009). We must take into account that vending machines increasingly grow in number, become more prevalent and available, thus they supply daily energy intake to more and more individuals. So it is important to accurately assess and monitor the nutritive value of vending machine products (MATTHEWS and HORACEK, 2015).
For all these reasons, and taking into account the implementation of Law 17/2011 in Spain on Food Safety and Nutrition, we believe that it is necessary to determine the nutritional composition of the food dispensed in vending machines to compare not only the nutritional profiles of various foods, but also the consumption of such foods in the Gran Canaria population (Canary Islands, Spain).

2. MATERIALS AND METHODS

For this work, we comprehensively considered the Gran Canaria island (Spain) and placed particular emphasis on the ULPGC (*Universidad de Las Palmas de Gran Canaria*) university campuses located on it. The ULPGC has 25,172 students enrolled in various degree programmes distributed over four campuses on Gran Canaria (ULPGC, 2015).
This study was carried out with 108 vending machines located in the town of Las Palmas de Gran Canaria (50 snack vending machines and 58 refrigerated vending machines that dispensed solid food products), and all 37 vending machines of snacks/refrigerated solid food products in ULPGC campus buildings (24 snack vending machines and 13 refrigerated vending machines that dispensed solid food products).
Only the vending machines (145) of a single company in the sector were considered, which has 65% of the volume of business in Las Palmas de Gran Canaria, Spain. Regarding the 37 machines located at the ULPGC, the company has been awarded the exclusive installation of these machines throughout the campus.

2.1. Nutritional Assessment

Over 3 months we accessed the cuisine of the vending company involved, which collaborated in this study and calculated all the products it made. While food handlers were preparing food, ten samples of each product were taken to be weighed on a balance (Model 2200c, Precisa, Dietikon, Switzerland).
Finally the mean weight of each ingredient was used to calculate nutrients (proteins, total and saturated fats, carbohydrates and fibre), the total energy value and sodium present in each product item. It should be noted that the nutritional information of 61% of the ingredients used in all the products was supplied by the vending company's providers. For the remaining 39% for which it was not possible to obtain such information, we used the food table of the DIAL program (2011), developed by a group of professors from the Department of Nutrition and Bromatology I in the Faculty of Pharmacy at the *Universidad Complutense de Madrid* (Spain).

Among the processed products, the following categories appeared: 9 different types of wholemeal baguettes (85 g); 12 different types of croissants (100 g); 11 different types of white bread baguettes (85 g); 14 different types of white bread sandwiches (50 g); 5 different kinds of wholemeal sandwiches (50 g). All these products were composed only of the ingredients described in Tables 1-5, except those prepared with tuna, chicken, crab and watercress, which also contained mayonnaise.
We randomly took ten different products marketed in vending machine foods: five chocolate bars and five industrial pastry products. The purpose of this procedure was to establish the nutritional, total energy and sodium values of the above food categories by collecting the information provided by these foods.
Finally from the vending company, we requested the percentage of sales for each food type during a 12-month period to verify what user preferences were.

Table 1: Nutritional assessment - wholemeal baguettes.

Wholemeal baguette (85 g)	Energy value (kcal)	Protein (g)	Total fat (g)	Saturated fat (g)	Total carbohydrate (g)	Dietary fibre (g)	Sodium (mg)
Salami and cheese	547.6	23.8	33.6	13.4	34.1	6.5	1732.5
Chicken and cheese	537.2	52.0	20.7	12.3	32.3	6.4	516.8
Salami	437.3	14.9	25.4	9.1	33.9	6.6	1559.5
Tuna and corn vegetable	432.9	14.5	20.4	3.1	42.9	9.9	723.3
Tuna and corn	427.9	13.9	23.6	3.6	36.5	7.0	737.5
Pork loin and cheese	424.9	41.2	12.8	5.9	33.0	6.4	1450.9
Ham and cheese	396.7	32.4	13.1	6.8	33.5	6.4	1198.3
Goat cheese	349.4	15.9	16.1	8.6	32.3	6.4	792.4
Tortilla	291.5	10.4	8.6	1.8	39.5	7.5	885.7
$\bar{x}$	427.3	24.3	19.4	7.2	35.3	7.0	1066.3
σ	80.7	14.5	7.7	4.0	3.7	1.2	431.2

$\bar{x}$: mean of all types of wholemeal baguette.
σ : standard deviation of all types of wholemeal baguette.

2.2. Statistical analysis

The data analysis of this work was carried out with the statistical software package SPSS 20.0 (SPSS, Chicago, IL, USA) for MAC OS X (Apple Computers, Cupertino, CA, USA).
For the nutritional evaluation, different products were grouped by category, wholemeal baguette; croissant; white bread baguette; white bread sandwich; wholemeal sandwich, and the means and standard deviations of the nutrients (markers), sodium and total energy values per category were calculated.
Variables (markers) were summarised as medians and interquartile ranges (IQR). They were compared by the Kruskal-Wallis test. Multiple comparisons were made by the Wilcoxon test. Statistical significance was set at $p<0.05$.

Table 2: Nutritional assessment - croissants.

Croissant (100 g)	Energy value (kcal)	Protein (g)	Total fat (g)	Saturated fat (g)	Total carbohydrate (g)	Dietary fibre (g)	Sodium (mg)
Tomato, salad, turkey, tuna and corn	758.8	40.4	34.5	10.9	68.3	6.0	2676.3
Tuna and corn	686.8	18.9	42.5	12.2	55.2	3.2	763.3
Tuna, corn and vegetables	675.4	19.1	36.7	11.3	63.4	7.0	696.5
Tuna and peppers	671.2	21.5	40.3	11.8	54.0	4.4	690.2
Corn, crab and pineapple	668.6	13.3	40.8	11.8	59.1	4.9	685.8
Crab	658.5	13.2	43.1	12.3	52.6	2.5	658.3
Salami and cheese	647.7	37.1	35.8	19.1	50.3	2.3	998.5
Chicken	622.4	14.7	39.6	11.7	50.2	2.5	595.6
Watercress	597.3	8.4	39.4	11.6	50.5	2.6	580.1
Tuna	571.9	18.3	32.6	10.6	49.8	2.4	612.7
Ham and cheese	570.3	32.8	25.8	15.8	50.0	2.3	721.2
Tortilla	474.0	13.1	20.4	9.2	57.7	3.5	870.6
$\bar{x}$	633.6	20.9	36.0	12.4	55.1	3.6	879.1
σ	72.9	10.3	6.9	2.6	6.0	1.6	578.3

$\bar{x}$: mean of all types of croissant.
σ : standard deviation of all types of croissant.

Table 3: Nutritional assessment – white bread baguettes.

White bread baguette (85 g)	Energy value (kcal)	Protein (g)	Total fat (g)	Saturated fat (g)	Total carbohydrate (g)	Dietary fibre (g)	Sodium (mg)
Sobrasada and cheese	570.4	20.0	34.5	12.6	43.0	3.0	947.9
Salami and cheese	555.4	25.6	29.6	10.3	44.5	3.0	1622.4
Pork loin and cheese	468.3	45.2	11.7	5.8	43.7	3.0	1519.4
Tuna and corn	404.4	14.3	17.1	2.6	46.2	3.5	692.7
Chicken and cheese	403.5	40.3	7.2	3.6	43.0	3.0	552.8
Ham and cheese	396.3	28.7	11.1	6.8	43.5	3.0	766.2
Tuna, corn, tomato and vegetables	393.3	14.2	13.8	2.1	50.3	5.5	666.0
Salami	383.5	14.1	16.1	5.8	44.0	3.0	1203.5
Goat cheese	372.5	17.6	13.8	7.9	43.0	3.0	792.6
Tortilla	304.8	11.8	5.9	1.2	49.0	3.9	829.9
Serrano ham and tomato	285.1	16.9	3.1	0.9	45.2	3.9	1381.7
$\bar{x}$	412.6	22.6	15.0	5.4	45.0	3.4	997.7
σ	89.2	11.2	9.7	3.8	2.5	0.8	371.4

$\bar{x}$: mean of all types of white bread baguette.
σ : standard deviation of all types of white bread baguette.

Table 4: Nutritional assessment – white bread sandwiches.

White bread sandwich (50 g)	Energy value (kcal)	Protein (g)	Total fat (g)	Saturated fat (g)	Total carbohydrate (g)	Dietary fibre (g)	Sodium (mg)
Tortilla, ham and cheese	363.3	23.7	15.9	5.4	31.6	3.5	1272.8
Sobrasada and cheese	337.5	17.0	21.0	8.9	21.2	2.1	490.1
Salami and cheese	336.9	19.6	19.5	9.0	21.9	2.1	785.6
Chicken	326.4	8.9	23.1	3.6	21.8	2.3	464.1
Tuna, corn, tomato and vegetables	319.9	10.7	17.4	2.7	29.8	4.9	515.9
Corn, crab and pineapple	313.5	7.0	19.7	3.0	27.3	3.7	489.1
Two cheeses	312.6	18.0	17.3	10.2	22.1	2.1	652.8
Tuna	310.6	12.1	20.1	3.1	21.4	2.2	498.0
Watercress	308.6	4.0	23.2	3.6	22.0	2.4	458.5
Tuna and peppers	290.1	11.1	17.3	2.7	23.9	3.3	467.7
Turkey and cheese	283.0	26.9	8.5	4.5	25.6	2.1	1446.6
Ham and cheese	276.1	25.1	10.1	4.9	22.4	2.1	996.6
Crab	266.8	6.2	17.3	2.7	22.9	2.2	436.0
Tuna and corn	257.6	9.8	14.4	2.2	23.5	2.4	467.1
$\bar{x}$	307.4	14.3	17.5	4.8	24.1	2.7	674.4
σ	29.7	7.4	4.3	2.7	3.3	0.9	331.5

$\bar{x}$: mean of all types of white bread sandwich.
σ : standard deviation of all types of white bread sandwich.

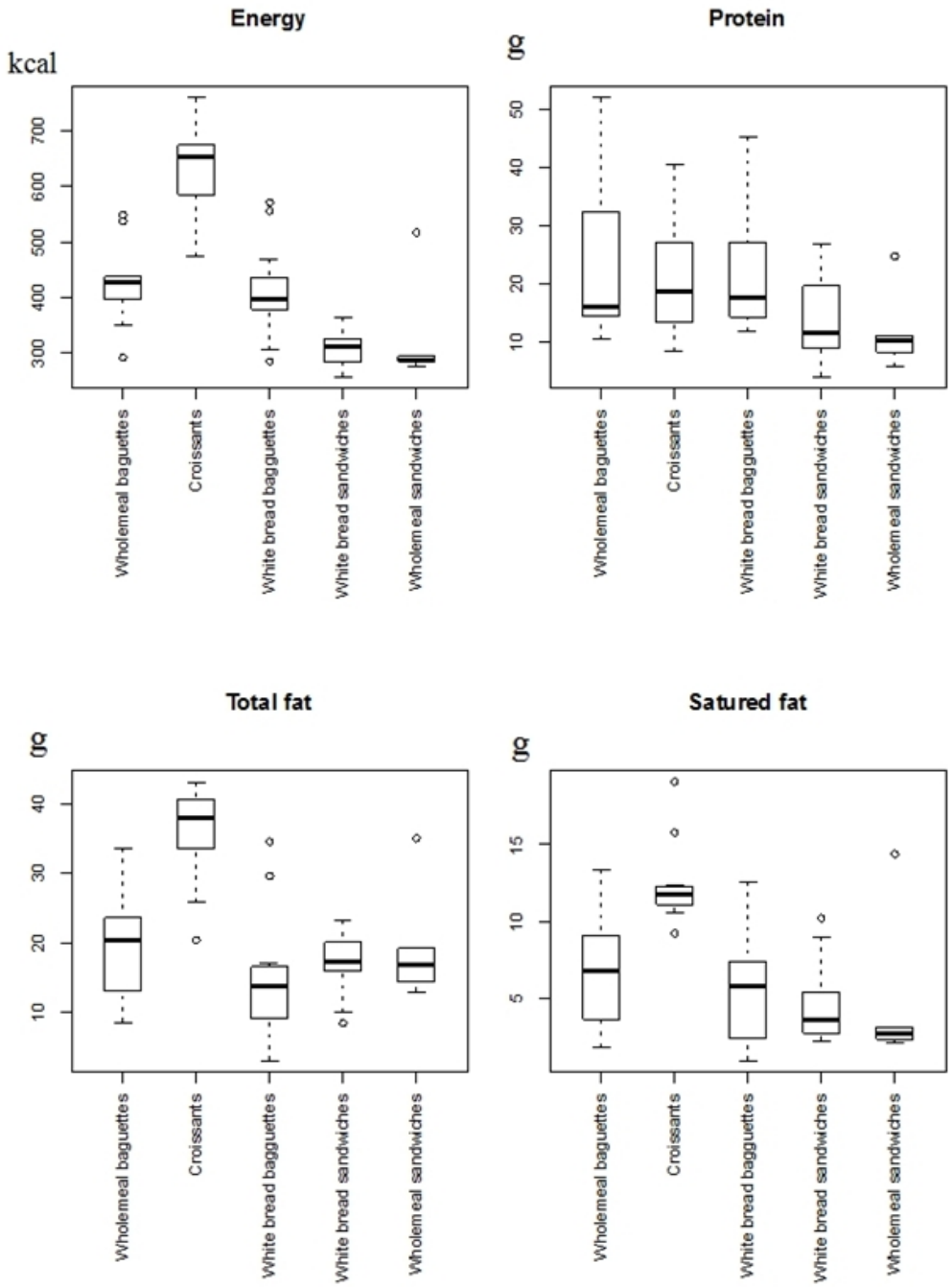
Table 5: Nutritional assessment – wholemeal sandwiches.

Wholemeal sandwich (50 g)	Energy value (kcal)	Protein (g)	Total fat (g)	Saturated fat (g)	Total carbohydrate (g)	Dietary fibre (g)	Sodium (mg)
Salami and cheese	516.6	24.7	35.0	14.4	24.0	3.1	1623.8
Watercress	294.4	5.8	19.2	3.1	22.7	3.2	394.3
Tuna, corn and vegetables	286.3	11.0	13.0	2.1	28.7	5.4	428.0
Crab	285.4	8.2	16.8	2.7	23.7	3.1	402.8
Tuna and corn	275.5	10.3	14.4	2.3	24.5	3.4	429.3
$\bar{x}$	331.6	12.0	19.7	4.9	24.7	3.6	655.6
σ	103.6	7.4	8.9	5.3	2.3	1.0	541.4

$\bar{x}$: mean of all types of wholemeal sandwich.
σ : standard deviation of all types of wholemeal sandwich.

3. RESULTS AND DISCUSSION

By means of box plots, Fig. 1 shows the seven categories of processed food products against markers by their quartiles, where data are medians and IQR.



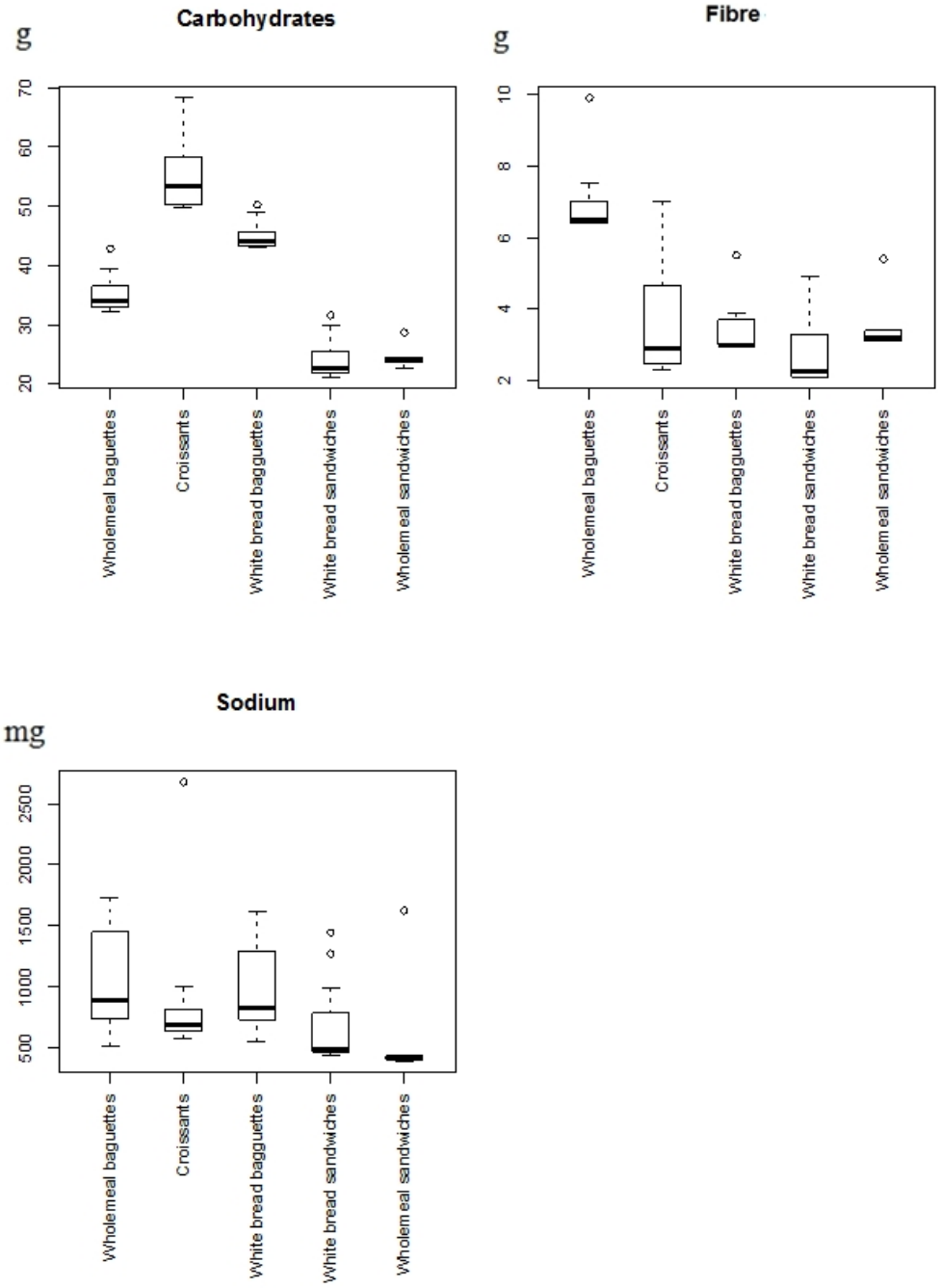


Figure 1: Categories of processed food products against markers by box plots graphics.

3.1. Processed foods in the vending company

Tables 1-5 show the nutritional results calculated from the foods processed in the vending company, which were subsequently sold on the market in vending machines. Note that the products in these tables prepared with tuna, chicken, crab and watercress also contained mayonnaise.

Table 6 shows the nutritional value of each bread/croissant type (with no added ingredients) used to make various types of processed products.

Table 6: Nutritional assessment – types of bread/croissant.

Product	Energy value (kcal)	Protein (g)	Total fat (g)	Saturated fat (g)	Total carbohydrate (g)	Dietary fibre (g)	Sodium (mg)
Croissant (100 g)	355.0	8.0	13.4	7.7	49.4	2.3	390.0
White bread baguette (85 g)	219.3	8.2	0.9	0.2	43.0	3.0	484.5
Wholemeal baguette (85 g)	187.9	6.0	2.5	0.5	32.3	6.4	467.5
Wholemeal sandwich (50 g)	129.5	5.5	1.5	0.4	22.0	3.0	265.0
White bread sandwich (50 g)	113.0	3.6	2.2	0.4	21.2	2.1	300.0
$\bar{x}$	200.9	6.3	6.8	1.8	33.6	3.4	381.4
σ	96.3	1.9	6.8	3.3	12.5	1.7	97.8

$\bar{x}$: mean of all types of bread/croissant.
σ : standard deviation of all types of bread/croissant.

To analyse the results presented in Tables 1-6, it was necessary to compare them to the reference Daily Value (DV) values obtained from the Food and Drug Administration (FDA) (FDA, 2013), which are provided in Table 7.
For sodium, it should be noted that on January 31, 2013, the World Health Organization (WHO) considered that its reference value for daily intake for adults should be < 2000 mg (2013).

Table 7: Reference daily intake values (FDA, 2013).

Caloric Intake (kcal)	Protein (g)	Total fat (g)	Saturated fat (g)	Total Carbohydrate (g)	Dietary Fibre (g)	Sodium (mg)
2000	50	65	20	300	25	2400

In the analysis of the results shown in Table 6, the high calorie intake (355 kcal) in croissants was checked and compared to the other products. Their energy value more than tripled that of white bread sandwiches. A large quantity of total and saturated fats in croissants was also noted compared with other products. A croissant had about 20 times more saturated fat than a white bread sandwich. Sodium levels were generally high: a white bread baguette contained 484.5 mg of sodium, which means that according to the WHO (2013), the consumers who ate this product with no added ingredients had already eaten 24.2% of their daily sodium needs.
When interpreting the results of the nutritional calculations made with all the bread/croissant types with added ingredients, those foods with a high sodium content and lots of calories also presented high levels of saturated fat.
When we focused on the different wholemeal baguette types (Table 1), we saw that the average sodium levels surpassed almost half the daily WHO recommendations (2013) ($\bar{x}$=

1,066.3 mg), while the baguettes that contained salami contained more than one third of the sodium level according to the same recommendations. Another point was that two baguette types (salami and cheese / chicken and cheese) contained more than 50% of the DV (FDA, 2013) for saturated fat. Two other types of wholemeal baguettes had a high protein content: the chicken and cheese baguette (52 g) and the pork loin and cheese baguette (41.2 g). When choosing a wholemeal baguette type, e.g. for a mid-morning snack, tortilla was the best option since it contained the least calories (291.5 kcal), less saturated fat (1.8 g) and its sodium content (885.7 mg) was below the average value (1,066.3 mg) of other types of wholemeal baguettes.

The sodium levels of the white bread baguettes (Table 3) were high ($\bar{x}$= 997.7 mg), which also occurred with the wholemeal baguettes. Two types of white bread baguettes (sobrasada and cheese / salami and cheese) surpassed 50% of the DV (FDA, 2013) for saturated fat. Protein content was high in the pork loin and cheese (45.2 g) and the chicken and cheese (40.3 g) sandwiches. When it comes to choosing a white bread baguette, it is important to avoid the sobrasada and cheese and salami and the cheese kinds because, apart from having a high saturated fat content, they contained a large amount of sodium which, for the salami and cheese baguette, represented 81.12% of the WHO's daily recommendations (2013).

No major differences sandwiches were found between wholemeal and white bread and their average nutritional values were similar (Tables 4 and 5). Perhaps wholemeal sandwiches make consumers feel fuller given their high fibre content. The high energy value of the wholemeal salami and cheese sandwich was noteworthy (516.6 kcal), as was its sodium content (1,623.8 mg), compared to the other wholemeal and non-wholemeal sandwiches. Sandwiches that were not made with wholemeal bread stood out for their high sodium content: turkey and cheese (1,446.6 mg) and tortilla with ham and cheese (1,272.8 mg).

Croissants (Table 2) had very high values of sodium, saturated fat and calories. Only one (tortilla) of the twelve available croissant types contained less than 50% of the DV (FDA, 2013) for saturated fat. Its average energy intake value was 633.6 kcal. The croissant that contained tomato, salad, turkey, tuna and corn should be noted as its sodium content was 2,676.3 mg, which surpassed the WHO's 676.3 mg daily recommendation (2013), and its calorie content was 758.8 kcal, which represented 37.94% of the recommended daily intake (FDA, 2013).

Regarding the statistical relationship among the different products grouped by category, Table 8 summarises the seven markers analysed as medians and IQR in each food group. All the markers (energy, proteins, total fat, saturated fat, carbohydrates, fibre and sodium) showed significant differences among the five food groups ($p<0.05$).

Sandwiches (wholemeal and white bread) had the lowest energy levels, while croissants had the highest. The croissants showed a significantly larger amount of total and saturated fats and carbohydrates than the other studied food groups, and also protein when compared with both sandwich types (white bread and wholemeal) (Table 8).

The carbohydrate values in both sandwich types were significantly lower (Table 8).

The larger amount of fibre content detected in the wholemeal baguettes stood out from the other foods, while the sodium content levels in the white bread and wholemeal sandwiches were significantly lower compared to the other food groups analysed herein (Table 8). We highlight the high sodium content in the baguettes compared to the other foods (Table 8).

Table 8: Comparison of nutritional markers between groups of processed foods.

	Wholemeal baguettes	Croissants	White bread baguettes	White bread sandwiches	Wholemeal sandwiches	P*
Energy	427.9 [a] (369 ; 437)	653.1 [b] (591 ; 672)	396.3 [a] (378 ; 436)	311.6 [c] (285 ; 325)	286.3 [c] (285 ; 294)	< .001
Protein	15.9 [a,b] (14.5 ; 32.4)	18.6 [a,b] (13.3 ; 24.3)	17.6 [a] (14.2 ; 27.1)	11.6 [b,c] (9.1 ; 19.2)	10.3 [c] (8.2 ; 11.0)	.044
Total fat	20.4 [a] (13.1 ; 23.6)	38.0 [b] (34.0 ; 40.4)	13.8 [a] (9.1 ; 16.6)	17.4 [a] (16.2 ; 20.0)	16.8 [a] (14.4 ; 19.2)	< .001
Satured fat	6.8 [a] (3.6 ; 9.1)	11.8 [b] (11.2 ; 12.2)	5.8 [a] (2.3 ; 7.3)	3.6 [a] (2.8 ; 5.3)	2.7 [a] (2.3 ; 3.1)	< .001
Carbohydrates	33.9 [a] (33.0 ; 36.5)	53.3 [b] (50.3 ; 58.1)	44.0 [c] (43.2 ; 45.7)	22.6 [d] (21.9 ; 25.2)	24.0 [d] (23.7 ; 24.5)	< .001
Fibre	6.5 [a] (6.4 ; 7.0)	2.9 [b] (2.5 ; 4.5)	3.0 [b] (3.0 ; 3.7)	2.2 [c] (2.1 ; 3.1)	3.2 [b,c] (3.1 ; 3.4)	< .001
Sodium	885.7 [a] (737 ; 1451)	693.4 [a] (647 ; 790)	829.9 [a,c] (729 ; 1293)	494.1 [b] (467 ; 752)	428.0 [c] (402 ; 429)	.004

Data are medians (IQR).
Different superscript letters [a,b,c,d] indicate significant differences ($p < 0.05$).
(*) Kruskal-Wallis test.

Based on all these findings, we once again stress the very high content in sodium and saturated fat of many processed foods, and their high calorie intake. Croissants are the least suitable choice because they contain high saturated fat compared to other foods, and they also contain many calories and a lot of sodium. Sandwiches are the most suitable snack choice. Choosing a food type by considering the ingredients that it contains is important to help avoid eating the foods that contain sausage meat because its sodium, saturated fat and energy values are very high.

3.2. Chocolate and industrial pastry products

The nutritional values that correspond to chocolate and industrial pastry products on sale in vending machines are included in Tables 9 and 10.

Table 9. Nutritional assessment – chocolates.

Chocolate	Energy value (kcal)	Protein (g)	Total fat (g)	Saturated fat (g)	Total carbohydrate (g)	Dietary fibre (g)	Sodium (mg)
1	280.0	4.0	14.0	5.0	35.0	1.0	140.0
2	245.0	4.9	12.7	4.9	29.4	8.6	24.5
3	233.0	3.0	12.0	0.0	29.0	0.0	0.0
4	213.0	3.0	11.0	4.1	26.0	0.8	118.0
5	134.0	1.1	6.8	0.0	18.2	0.0	0.0
$\bar{x}$	221.0	3.2	11.3	2.8	27.5	2.1	56.5
σ	54.4	1.4	2.7	2.6	6.1	3.7	67.4

$\bar{x}$: mean of all samples of chocolate.
σ : standard deviation of all samples of chocolate.

Table 10. Nutritional assessment – industrial pastry products.

Industrial pastry product	Energy value (kcal)	Protein (g)	Total fat (g)	Saturated fat (g)	Total carbohydrate (g)	Dietary fibre (g)	Sodium (mg)
1	240.0	3.5	16.0	11.5	19.0	3.0	105.0
2	237.0	5.0	13.8	7.8	25.2	2.3	383.0
3	223.0	4.8	8.4	1.7	31.5	1.3	0.1
4	175.0	2.1	7.2	1.3	26.3	1.4	172.0
5	132.0	1.5	7.0	1.1	15.4	0.3	0.1
$\bar{x}$	201.4	3.4	10.5	4.7	23.5	1.7	132.0
σ	46.7	1.6	4.1	4.7	6.3	1.0	158.2

$\bar{x}$: mean of all samples of industrial pastry products.
σ : standard deviation of all samples of industrial pastry products.

All these foods obtained similar nutritional composition values. It should be noted that most of the carbohydrates in these foods were sugars. Back in the 1990s, HUNTER (1992) voiced concern about the relatively low value of the nutrients and the high sugar content of the foods most frequently chosen from vending machines, including snacks like those cited in this section of our study.
Table 11 shows the relationship of the consumption percentages for all the foods sold in vending machines over a 12-month period. These results reflect a consumer preference for snacks, i.e. chocolate (29.04%) and industrial pastry products (33.84%), and a very low consumption of baguettes (4.18%).
A recent study (BYRD-BREDBENNER *et al.*, 2012) detected snacks in vending machines with a high content of fat and sugar, lots of calories and very little fibre. These results coincide with the products studied herein. In fact since the 1970s, the reduced nutritional value of most products sold in vending machines (CHENEY, 1974; EZELL *et al.*, 1985; FRENCH *et al.*, 2010; KUBIK *et al.*, 2011; LAWRENCE *et al.*, 2009), their high sugar content (EZELL *et al.*, 1985; HRUBAN, 1977; KOEHLER *et al.*, 1977; SHEARER *et al.*, 1980) and their high energy contribution (FINKELSTEIN *et al.*, 2008; FRENCH *et al.*, 2010; KIBBLEWHITE *et al.*, 2010; NAYLOR *et al.*, 2010; PASCH *et al.*, 2011) have been known.

Table 11: Percentage of consumption from vending.

Consumption during a 12-month period	
Category	**Total**
Baguettes	4.18%
Wholemeal baguettes	22.83%*
White bread baguettes	77.17%*
Chocolate	29.04%
Croissants	10.05%
Industrial pastry products	33.84%
Sandwiches (white bread and wholemeal)	13.96%

These values correspond to the breakdown in the category Baguettes. So the total % of Baguettes consumption was 4.18%, and 22.83% for baguettes made with wholemeal bread and 77.17% for white bread baguettes.

3.3. Future perspectives and recommended strategies

Based on the similarity between the results of the above-cited recent studies and those obtained in this paper, the implementation of strategies to promote the sale and consumption of healthier foods is believed necessary. To go about this, it is advisable to adopt measures like those proposed by KOCKEN *et al.* (2012). Their study increased the availability of foods in vending machines with a lower calorie intake, included labelling that highlighted nutritional properties, and also lowered the price of these foods. Another measure to adopt could be to lower the prices of foods with a low fat content, as demonstrated in the study conducted by FRENCH *et al*. (2001).
The impact of implementing these strategies, along with policies to encourage eating healthier foods, and the possibilities of improving the diet of a high percentage of the population would be strong, and the costs associated with treating a group of diseases caused by inadequate diet could lower. Law 17/2011, of July 5, on Food Safety and Nutrition already imposes new legislative terms to this problem by preventing the sale of foods with high contents of saturated fat, sodium and sugar in schools. This has been the first step to ensure that the general population becomes more aware of healthier food choices when choosing food from vending machines.

4. CONCLUSIONS

Plenty of additional work is needed to enhance the nutritional quality and appropriate portion size of the foods offered in vending machines. To improve vending machine selections on university campuses, benchmark data like those reported herein can help stakeholders set priorities and work with decision makers on campuses to advocate healthy campus food environments, which include all food retail outlets. The ultimate goal of studies like the present one is to compel environmental changes that make healthy choices possible and easier. Future research should also investigate the behavioural and financial impact of eliminating unhealthy snacks from vending machines.
Thus we propose that vending companies take steps to change the processed foods sold in their machines. It would be much more appropriate to provide these machines with foods that contain fewer calories, especially with much lower levels of saturated fat and sodium, compared to those currently available to vending users. In this way, the intake of these foods would be more in line with WHO recommendations (2013) and with the DV set by the FDA (2013). We believe that awareness of governments and the adoption of policies to promote consumer intake of healthy food choices are essential measures to increase the amount of foods with an appropriate nutritional profile that meets these recommendations (WHO, 2013; FDA, 2013). Therefore, conducting further studies would help support and implement public health policies and environmental changes, which could improve healthy food access and availability in vending machines.

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