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Trabajo Original

Valoración nutricional

Antioxidant capacity and diet pattern evaluation in a university community in south eastern Spain

Evaluación de la capacidad antioxidante y el patrón dietético en una comunidad universitaria del sudeste español

Lorena Martínez-Zamora, Rocío Peñalver, Gaspar Ros, and Gema Nieto

Department of Food Technology, Nutrition, and Food Science. Facultad de Veterinaria. Universidad de Murcia. Murcia

Abstract

Background: antioxidants can eliminate excess free radicals present in our bodies, and it has been shown that eating a diet rich in polyphenols and anthocyanins, present in vegetables, fruits and legumes, has a protective effect against cancer, heart disease, and some neurological diseases.

Objectives: the objective of the present work was to evaluate the eating habits of the university community in Murcia.

Methods: the research was carried out by means of surveys on the choice of dishes at university canteens. In addition, the antioxidant activity of the most widely consumed dishes (pork Milanese style, pasta Bolognese, lentil and chorizo stew, Spanish omelette, and vegetable paella) were evaluated using the DPPH, FRAP, and ORAC methods.

Results: the results obtained indicated that canteen users preferred consumption of pasta, meat, and fried potatoes rather than vegetables, pulses, and fish as main courses. The most consumed dessert was yogurt, closely followed by fruits. The consumption of water also stands out, and a majority of subjects accompanied their meals with white bread and salad. With regard to antioxidant capacity, it was found that the dish with the highest antioxidant capacity was lentil and chorizo stew, with Spanish omelette being the less antioxidant dish.

Conclusion: in conclusion, consumption of fruit, vegetables, and legumes should be encouraged, as they contribute decisively to the antioxidant capacity of the diet.

Keywords:

Food habits. Students. University population. Preferences. Nutrition. ORAC. FRAP. DPPH.

Resumen

Introducción: los antioxidantes pueden eliminar el exceso de radicales libres presentes en nuestro organismo, y se ha demostrado que consumir una dieta rica en polifenoles y antocianinas, presentes en verduras, frutas y legumbres, tiene un efecto protector frente al cáncer, las enfermedades cardíacas y algunas enfermedades neurológicas.

Objetivos: el objetivo del presente trabajo fue evaluar los hábitos alimentarios de la comunidad universitaria de Murcia.

Métodos: la investigación se llevó a cabo mediante encuestas sobre la elección de platos en los comedores universitarios. Además, se evaluó la actividad antioxidante de los platos más consumidos (cerdo a la milanesa, pasta boloñesa, lentejas con chorizo, tortilla española y paella de verduras) a través de los métodos DPPH, FRAP y ORAC.

Resultados: los resultados obtenidos indicaron que los usuarios del comedor prefirieron el consumo de pasta, carne y patatas fritas en lugar del de verduras, legumbres y pescado. El postre más consumido fue el yogur, seguido de cerca por la fruta. También destaca el consumo de agua, y la mayoría acompañan sus comidas con pan blanco y ensalada. En cuanto a la capacidad antioxidante, se encontró que el plato con mayor capacidad antioxidante fueron las lentejas con chorizo, siendo la tortilla española el plato menos antioxidante.

Conclusión: en conclusión, conviene fomentar el consumo de frutas, verduras y legumbres, ya que contribuyen de forma decisiva a la capacidad antioxidante de la dieta.

Palabras clave:

Hábitos alimentarios. Estudiantes. Comunidad universitaria. Preferencias. Consumidores. Nutrición. ORAC. FRAP. DPPH.

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Correspondence:

Gema Nieto. Department of Food Technology, Nutrition, and Food Science. Facultad de Veterinaria. Universidad de Murcia. Campus de Espinardo. C. Campus Universitario, 7. 30100 Espinardo, Murcia. Spain
e-mail: gnieto@um.es

INTRODUCTION

Moreiras et al. (2016) define food habits as "recurrent manifestations of food-related behaviour by which an individual or group of individuals prepare and consume food directly or indirectly as part of cultural, social, and religious practices." In this way, knowing and studying the dietary habits of communities is necessary to identify possible risks of developing chronic diseases, largely resulting from dietary causes (2).

Eating habits in humans are developed mainly in childhood, when people around children, especially their parents, are able to influence them by transmitting their dietary patterns (3,4). The beginning of the university period often coincides with the end of adolescence and the transition to adulthood. Although many students are now adults, the physiological and psychological changes characteristic of late adolescence are still developing. Younger university students, mainly because they are in the process of nutrient replenishment and growth, and with higher requirements than at other stages of life, may have a limited nutritional status due to alterations or disruptions in their lifestyle or dietary patterns (López et al., 2015; Ruiz-Moreno et al., 2013).

The lifestyle and dietary pattern of the university community is often associated with a high consumption of alcoholic beverages, a high incidence of eating disorders such as anorexia or bulimia, the following of nutritionally inadequate diets due to their low nutritional density, irregular eating patterns, a high consumption of 'fast food', etc. If we add this to the fact that they are at a stage of life with higher nutritional requirements, it will be difficult for them to follow a healthy and balanced diet (López et al., 2015; Ruiz-Moreno et al., 2013).

According to Ruiz-Moreno et al. (2013), the factors that basically condition the diet of teenagers are: physical activity, growth, nutritional education, friends, social acceptance, food tastes and preferences, and, lastly, fashion and advertising.

In order to assess the diet of an individual or group of individuals, dietary surveys are used to evaluate dietary habits to check whether nutrient intake is adequate, or to study the adherence to established dietary recommendations (4,7). From an epidemiological, clinical, therapeutic, or individual point of view, conducting a dietary survey consists of questioning a person about how he/she performs the act of eating (3).

Antioxidants, as healthy substances of the diet, are compounds present in foods that have the ability to significantly reduce the adverse effects of unstable oxygen molecules, called free radicals, which are potentially harmful to our body cells (8). The antioxidant activity of each food is related to the amount and composition of antioxidant substances (vitamin C and E, phenolic compounds, flavonoids, and carotenoids) (9). Scientific evidence suggests that much of the beneficial effects of the Mediterranean diet are due to the effect of dietary antioxidants, which can inhibit low-density lipoprotein (LDL) oxidation, protecting against neurodegenerative diseases, cancer, and heart disease (2,10).

The aim of the present study was to evaluate the eating habits of the university community (mainly students, but also staff and professors) who have lunch in the canteens of University of Murcia (south-eastern Spain). To do so, the dietary patterns of consumers were assessed, and the most consumed dishes were nutritionally evaluated together with their total antioxidant capacity.

MATERIAL AND METHODS

EXPERIMENTAL DESIGN AND PARTICIPANTS

The present study was carried out jointly with the Environmental Quality, Food Safety, and Nutrition Service (CASAN), which assesses the menus offered by the canteens at University of Murcia to all students, professors, and staff.

During the research, the most popular University of Murcia canteens, sited at the University Social Centre (CSU) and the Faculty of Economics, were visited twice per week from October 2017 to February 2018 (a total of 40 sampling days). A total of 30 users per day were evaluated (n = 1143), who filled a questionnaire (Table I), that was previously explained, where their choices of dishes (Table II) were noted. The participants in the study were mainly students, but also professors and University of Murcia staff, with an age range between 18 and 60 years.

Once all the data were collected and examined, the most frequently consumed dishes were identified and analyzed for their antioxidant capacity following several methods as explained below.

SURVEY AND MENU

The questionnaire (Table I) was used to collect the information on the menu chosen by canteen users. In the survey, this information was evaluated as:

- Starters and main course: a letter was assigned to each starter (A, B, C, and D) and main course (A and B).
- Garnish: a number was assigned to each offered garnish, these being:
  1. French fries; 2. pasta salad; 3. boiled vegetables.
- Dessert: a number was assigned to each offered dessert, these being:
  1. yogurt; 2. custard; 3. flan; 4. rice pudding; 5. fruit.
- Drink: a number was assigned to each offered drink, these being:
  1. water; 2. juice; 3. soft drinks; 4. beer.
- Bread: the consumer can choose between brown or white bread. Yes/No was also marked.
- Salad: Yes/No was marked.

The two canteens offered the same "winter" menu, which daily offered four starters, two main courses, and four possible garnishes, accompanied by salad, bread, dessert, and drink. The monthly menu offered by the canteens from September to March is shown in table II. The possible options chosen by canteen users were:

- Complete menu: starter + main course (+ garnish) + salad + bread + dessert + drink.
- Half menu: starter or main course (+ garnish) + salad + bread + dessert + drink.
- Single dishes.

Table I. Survey used to evaluate the chosen menu by canteen users

1st course	Main course	Garnish	Dessert	Drink	Bread	Salad
A	A	1. French fries	1. Yogurt	1. Water	Brown	Yes
B	B	2. Pasta salad	2. Custard	2. Juice	White	No
C		3. Boiled vegetables	3. Chocolate mousse	3. Soft drinks	No bread	
D		4. No garnish	4. Rice pudding	4. Beer		
			5. Fruit	5. No drink		
			6. No dessert			

Table II. Monthly menu served in the studied canteens

	Monday	Tuesday	Wednesday	Thursday	Friday
1st week	Lentil stew Nordic noodles Cuban-style rice Stuffed aubergines *Lean pork in tomato sauce* *Hake, Basque style*	Fish cous-cous Meat cannelloni Mashed potatoes, cod and eggs Garlic cauliflower *Chicken in beer sauce* *Squid and onions*	Murcia-style cauldron (*caldero*) Pasta Bolognese Castilian soup Vegetable pie *Roast ham* *Grilled fish*	Gypsy pot (*olla gitana*) Tuna pasta Chicken stew Courgette and ham *Hamburger* *Battered haddock*	Seafood paella Mediterranean "coca" pie Meatball stew Vegetable cream soup *Grilled veal fillet* *Tuna and "pisto"*
2nd week	Pork rib paella Pasta and tuna Meat pie Green bean and potato stew *Grilled pork loin* *Fish in almond sauce*	Bean stew 4-cheese pizza Veal stew Scrambled eggs and vegetables *Pork, Milanese style* *Fish in tomato sauce*	Vegetable risotto Spaghetti carbonara Lentil and chorizo stew Fried artichokes *Garlic chicken* *Fish in wine sauce*	Seafood "fideua" Neapolitan-style pasta Soup Creamed spinach *Stewed ham and eggs* *Cod in "pil-pil" sauce*	Rabbit paella Vegetable lasagna Fish stew Grilled vegetables *Turkey breast in sweet mustard sauce* *Trout stew*
3rd week	Chicken cous-cous Pasta puttanesca Pork stew Stuffed courgette *Sausages in tomato sauce* *Fish and shellfish*	Chicken paella Spanish omelette Vegetable soup Creamed aubergines *Hamburger* *Tuna, Biscay style*	Lentil stew Mediterranean "coca" pie Rice with vegetables and egg Leek cream *Veal goulash* *Grilled fish*	Vegetable paella Tuna cannelloni Meatball soup Fried chard *Pork chop in mushroom sauce* *Squid in its own ink*	Rice and beans Pasta Bolognese Tuna-stuffed potatoes Boiled cauliflower *Castilian-style chicken* *Fish pie*
4th week	Paella Barbecue pizza "Picadillo" soup "Zarangollo" (scrambled eggs, potatoes, courgette, and onion) *Roast chicken* *Lemon salmon*	Lentils and rice stew Meat lasagna Cod stew Artichokes and ham *Rabbit in garlic sauce* *Cod in dill sauce*	Pork and vegetable paella Italian pasta Bean and chorizo stew Spinach and raisins *Meatballs and vegetables* *Vegetarian omelette*	Chickpea and cod stew Spaghetti carbonara Vegetable "fideua" Pumpkin cream soup *Breaded chicken breast* *Fish in "piquillo" sauce*	Pasta arrabiata Bacon and ham risotto Veal stew Fried green beans *Roast lamb* *Fish in almond sauce*

In normal font: starters. In italic font: main courses.

NUTRITIONAL ASSESSMENT

From among all of the most consumed dishes, five of the most consumed were chosen (pork Milanese style, pasta Bolognese, lentil and chorizo stew, Spanish omelette, and vegetable paella) and a nutritional assessment was carried out using the technical data sheets for these dishes offered by CASAN nutritionists. The ingredients used to prepare the analyzed dishes are shown in table III. The nutritional assessment was automatically carried out by calculating total calories, proteins, carbohydrates, fat, cholesterol, vitamins, and minerals using the software DietSource® 3.8.

TOTAL ANTIOXIDANT CAPACITY OF THE MOST COMMONLY CONSUMED DISHES

Before the analysis, extracts of each dish sample (pork Milanese style, pasta Bolognese pasta, lentil and chorizo stew, Spanish omelette, and vegetable paella) were obtained in quintuplicate (n = 5). To do so, 2 g of homogenized and mixed sample were placed in plastic tubes with 10 mL of ethanol/milliQ water (25/75). This solution was mixed during 1 hour at 500 rpm in an ice bath and centrifuged at 3500 rpm at 4 °C for 4 min. The supernatant was filtered (0.2 µm) and kept at -80 °C until the analysis (Martínez-Zamora et al., 2021).

Total scavenging activity against DPPH (2,2-diphenyl-1-picrylhydrazyl) was determined using the method described by Martínez et al. (2019). Trolox standard solutions at different concentrations were used as standard curve in order to compare the obtained results from the samples. Scavenging power was expressed as percentage (%) using the following formula: ((Abs DPPH (initial) – Abs DPPH (final "added sample")) / Abs DPPH (initial)) × 100.

The ferric ion reducing antioxidant power assay (FRAP) was also performed (Martínez-Zamora et al., 2021). The FRAP reagent was prepared daily with 20 mL of 300 mmol/L acetate buffer, pH = 3.6; 2 mL of 20 mmol/L $FeCl_3 \cdot 6\ H_2O$; and 2 mL of 10 mmol/L TPTZ (2,4,6-tripyridyl-s-triazine) in 40 mmol/L HCl. Trolox standard solutions at different concentrations were used as standard curve in order to compare the obtained results from the samples. Antioxidant power was expressed as µM Trolox equivalents (TE) per g of sample.

Hydrophilic antioxidant capacity was measured using the ORAC (Oxygen Radical Absorbance Capacity) method (13). For that, the method described by Martínez-Zamora et al. (2021) was carried out. All dilution samples were prepared in triplicate. The antioxidant activity of the sample was expressed as µM of Trolox equivalents (TE) per g of sample.

STATISTICAL ANALYSIS

Data were analyzed with the statistical package SPSS 22.0 (Statistical Package for the Social Science for Window (IBM, Armonk, New York, USA). A descriptive analysis was carried out with the obtained data from the survey, and the obtained results

Table III. Food consumption data (g/person/day) in Spanish households from 2017 to 2020 (data collected by MAPA) (18)

	2017	2018	2019	Mean	2020	Difference (%)
Total	1732.1	1727.6	1702.9	1720.9	1969.5	14.4
Eggs	23.0	23.1	22.8	23.0	27.8	20.7
Meat	130.4	127.0	124.0	127.1	140.5	10.5
Beef	14.2	13.5	13.3	13.7	15.1	10.3
Chicken	35.6	34.5	33.9	34.7	39.0	12.5
Pork	28.0	27.4	26.4	27.3	30.9	13.3
Fish	61.5	61.3	61.7	61.5	68.5	11.5
Milk	189.8	189.8	189.8	189.8	210.5	10.9
Dairy products	96.3	96.3	96.3	96.3	107.5	11.6
Yogurt	21.0	21.3	26.8	23.0	29.7	28.9
Cheese	21.4	21.4	21.4	21.4	25.0	16.8
Bread	85.1	85.1	85.1	85.1	93.4	9.7
Brown	5.3	5.3	5.3	5.3	6.0	13.0
White	63.6	63.6	63.6	63.6	68.1	7.0
Rice	10.5	10.5	10.5	10.5	12.2	16.3
Pasta	11.4	11.4	11.4	11.4	13.0	14.0
Pulses	10.2	10.4	9.1	9.9	11.3	14.0
Oil	31.9	31.9	31.9	31.9	38.0	19.0
Wine	22.4	22.4	22.4	22.4	27.6	23.3
Beer	49.6	49.6	49.6	49.6	66.4	33.8
Potatoes	75.7	75.7	75.7	75.7	91.6	21.1
Vegetables	156.0	156.0	156.0	156.0	184.1	18.0
Fruit	249.1	249.1	249.1	249.1	287.4	15.4
Orange	44.5	44.5	44.5	44.5	48.8	9.5
Banana	33.7	33.7	33.7	33.7	39.7	18.0
Apple	26.1	26.1	26.1	26.1	31.5	20.8
Pear	12.9	12.9	12.9	12.9	15.0	16.7
Nuts	8.4	8.4	8.8	8.5	10.5	23.6
Ready-to-eat products	41.6	41.6	41.6	41.6	47.8	15.0
Water	168.0	166.8	167.2	167.3	194.2	16.1
Soft drinks	106.4	106.4	106.4	106.4	120.6	13.4
Cola	49.5	49.5	49.5	49.5	56.3	13.7

Total was calculated as the sum (g/person/day) of all the ingredients analyzed. The difference (%) was calculated as the percentage of increase in comparison with the mean for the last three years (2017, 2018, and 2019).

of the nutritional assessment and antioxidant capacity of the studied menu were analyzed using ANOVA. A value of $p < 0.05$ was considered statistically significant. Scheefe's test was applied to test differences between groups.

RESULTS AND DISCUSSION

DIET PATTERNS

Data were collected from a total of 1,143 people, of whom 727 were men (63.6 %) and 416 women (36.4 %).

Firstly, the most chosen starters were: spaghetti Bolognese (11.9 %) followed by rice with vegetables and eggs (11.6 %), Spanish omelette (11.5 %), meat cannelloni (6.2 %), spaghetti carbonara (6.2 %), and macaroni carbonara (5.8 %).

Among the main courses, the most consumed ones were escalope Milanese (16 %), roast chicken (9 %), garlic chicken (8.3 %), veal goulash (7.5 %), and chicken in beer sauce (7.3 %). If we separate dishes by their main food (meat, fish, eggs), we can see that meat dishes are most popular (69.7 %) as compared to fish (24.1 %) and eggs (6.2 %).

Although eggs were the main courses less chosen, Spanish omelette was the most consumed and recommended appetizer, amounting to 75.7 % of all appetizers consumed before lunch.

If we classify main courses according to food group (pasta, pulses, rice, stews, or vegetables), then 46.9 % of canteen users choose pasta dishes, 23.4 % choose rice, 14.4 % would rather have pulses, 8.8 % prefer vegetables, and only 6.5 % opt for stews.

Within the pasta group, the most popular dish was pasta Bolognese (50.2 %) followed by pasta carbonara (34.4 %), while in the pulses group the most popular dish was lentil and chorizo stew (30.2 %) followed by "olla gitana" (17.2 %). Within the rice group, the most popular dish was vegetable paella (37.6 %) followed by vegetable risotto (21.1 %).

For choice of garnish, 60.2 % of canteen users chose French fries as first option. The most consumed garnishes after fried potatoes were pasta salad (6.3 %), scrambled vegetables (3.9 %), and "pisto" (ratatouille-like dish) (3.4 %).

The most consumed dessert was yogurt (34.5 %) followed by fruit (32.5 %), custard (11.4 %), and chocolate mousse (11.1 %). Within the fruit group, the most consumed fruit was apple (32.1 %), followed by orange (22.3 %), banana (20.2 %), and pear (14.6 %).

With regard to the choice of bread, 70.6 % of the individuals surveyed preferred white bread, compared to 29.4 % who rather chose wholemeal bread. By contrast, 27.5 % of consumers did not eat bread at mealtimes. Similarly, 60.5 % of the individuals surveyed ate salad with their meal, while 39.5 % of consumers did not, which is a positive parameter as followed by consumers. Also, regarding the drinks chosen, water was the most consumed drink (85.5 %), while 6.2 % of canteen users chose soft drinks such as Coca-Cola to accompany their meals, and 1.5 % chose beer. These facts demonstrate a high adherence to the Mediterranean diet (14,15), at least with regards to the incorporation of fresh vegetables to the meal, and the election of water instead of soft-drinks, which are rich in sugars. In addition, a possible improvement for canteen menus may be the replacement of the soft drinks offered by sugar-free soft drinks, to avoid excess sugar during lunch.

These are comparable to the results obtained by Gracia (2010), who showed that meat is consumed in 56.9 % of all Spanish meals, while fruit was consumed in 50 %, followed by vegetables (39.1 %), pasta and rice (29.8 %), salads and gazpachos (cold tomato and vegetable soup) (27.3 %), fish (21.2 %) and, lastly, pulses (16.9 %). Moreover, in this study (16), it was also found that the most common drink consumed at mealtime was water (56.7 %).

According to Durá Travé & Castroviejo Gandarias (2011), only 31.9 % of the students surveyed between 20 and 25 years of age ate pasta and rice on a daily basis, and consumption of yogurt was proportionally low.

To compare the obtained data in the same time period, the food consumption data in Spanish households reported by MAPA from 2017 to 2020 have been deeply studied (18) and analyzed. In fact, food consumption data in Spanish households was very similar during 2017, 2018, and 2019. However, it increased by 15.6 % during 2020 (from January to November). To compare our obtained data with the current pandemic situation, table III shows the evolution in the consumption (g/person/day) of the main food groups from 2017 to nowadays.

In this sense, with regard to drinks, mean consumption of water by the Spanish population from 2017 to 2019 was 167.3 g/person/day, while mean consumption of soft drinks was 106.4 g/person/day, with almost 50 % being cola drinks. Total milk consumption was 190 g/person/day, while dairy products 96.3 g/person/day. Regarding the main food groups, consumption was 231.7 g/person/day of vegetables, including potatoes, 249.1 g/person/day of fruits, 87.1 g/person/day of bread, 11.4 g/person/day of pasta, 10.5 g/person/day of rice, 127.1 g/person/day of meat and meat products, 61.5 g/person/day of fish and seafood, 23 g/person/day of eggs, and 9.9 g/person/day of pulses.

Moreover, during these years, the main fruits consumed were orange (18 %), banana (13.5 %), apple (10.5 %), and pear (5.2 %). Also, bread consumption was mainly driven by white bread (75 %), while brown bread only represented 6.2 % of total bread consumption. Thus, our results agree with the mean consumptions observed in Spanish households from 2017 to 2019 (Table III; MAPA, 2018, 2019, and 2020).

Regarding the current pandemic situation, we have chosen to compare the dietary pattern followed during the present study with the last values obtained by MAPA (18) (Table III) (values from January to November, December is still not available). Thus, a general increase in all food groups is evident (14.4 % of total consumption per person and day), mainly since we have been forced to have all our meals at home, in contrast with previous years, when many of our meals took place in canteens, bars, or restaurants close to our workplace. According to the data shown in table III, important increases occurred for products that were usually consumed out, such as alcoholic drinks, which have increased by 23.3 % for wine, and 33.8 % for beer.

In summary, in comparison with the study that we have carried out, the data reported by the evaluated consumers are comparable to those obtained on food consumption during 2017, 2018, and 2019 by MAPA, although these data have now been modified given the current situation.

NUTRITIONAL ASSESSMENT

Regarding the most consumed dishes in the studied canteens, pork Milanese style, pasta Bolognese, lentil and chorizo stew, Spanish omelette, and vegetable paella were nutritionally analyzed in the present study. Table IV shows the ingredients of each dish and table V detailes their nutritional value.

As observed in table V, pork Milanese style is the dish with the richest protein content (24.7 g) and the lowest carbohydrate content (10.65 g). Moreover, it is also rich in cholesterol (101.16 mg) and has got the highest content in B group vitamins, such as B1 (1.01 mg), B2 (0.25 mg), and B12 (3.43 µg).

With regard to pasta Bolognese, this is the most caloric dish, and has got the highest carbohydrate content. In addition, it is the dish with the richest niacin (10.43 mg) and folic acid content (60.01 µg). Also, among the analyzed dishes, pasta Bolognese has got the highest content in minerals such as sodium (451.12 mg), potassium (972.86 mg), calcium (62.58 mg), phosphorus (245.17 mg), magnesium (92.35 mg), iron (7.39 mg), and zinc (3.36 mg).

Lentil and chorizo stew is the dish with the highest content in fiber (8.4 g), vitamin A, (117.56 g), and vitamin B6 (0.65 mg). In contrast, Spanish omelette was characterized by the highest cholesterol (180.4 mg) and fat content (27.49 g), the latter being mainly monounsaturated (31 %) and polyunsaturated fatty acids (39 %). Moreover, Spanish omelette showed the highest content in vitamin D (0.77 µg), and E (11.57 mg).

Lastly, vegetable paella had the lowest fat content (9.67 g) with the highest proportion of monounsaturated fatty acids (53.4 %), and the lowest saturated fatty acid (1.15 g) and cholesterol content. Additionally, it has the highest content in vitamin C (64.8 mg) and iodine (14 µg), while it has the lowest content in sodium (8.63 mg).

As seen, these typical dishes could be incorporated to Mediterranean diet because they are good options to be included into a balanced and varied diet in the correct form and quantity, and accompanied by a proper garnish, such as salad.

Nevertheless, from a general point of view and regarding previously described data on the diet pattern followed during lunch by students, staff, and professors at the University of Murcia, this population ate a Mediterranean diet, although vegetables did not represent a high percentage of their chosen total meals. In fact, a diet rich in antioxidants should consist mainly of fruit and vegetables, and the incorporation of olive oil as main fat source in the dishes evaluated. According to previous results reported by Durá Travé & Castroviejo Gandarias (2011), 71.6 % of university students need to improve their dietary pattern because of their low adherence to the Mediterranean diet, which was associated with a family factor of preservation of traditional dietary habits. Nevertheless, the clear differences observable between the Mediterranean diet followed by the population in northern Spain (University of Navarra) (17) as compared with that of southern Spain (University of Murcia) must be taken into account.

Furthermore, regarding the relationship between adherence to the Mediterranean diet and knowledge about nutrition and health, Montero Bravo et al. (2006) did not found any differences among the university population of Universidad San Pablo CEU (Madrid,

Table IV. Ingredients (g) used to prepare the most commonly consumed dishes in the studied canteens

Dish	Ingredients	Amount
Pork, Milanese style	Pork meat	110
	White breadcrumbs	19
	Egg	7
	Olive oil	10
	Garlic	3
	Parsley	3
Pasta Bolognese	Spaghetti	100
	Beef-pork minced meat	50
	Onion	40
	Garlic	5
	Olive oil	8
	Red wine	4
Lentil and chorizo stew	Bacon	5
	Chorizo	5
	"Serrano" (dry-cured) ham	10
	Olive oil	6
	Garlic	2
	Onion	15
	Potatoes	60
	Carrot	8
	Canned crushed tomatoes	10
	Lentils	60
Spanish omelette	Eggs	50
	Olive oil	22
	Onion	22
	Potatoes	88
Vegetable paella	Rice	80
	Olive oil	9
	Garlic	5
	Crushed tomatoes	10
	Green beans	30
	Courgette	30
	Cauliflower	30
	Red pepper	20
	Onion	40

Table V. Nutritional assessment of the most widely consumed dishes in the studied canteens

	Pork, Milanese style	Pasta Bolognese	Lentil and chorizo stew	Spanish omelette	Vegetable paella
g	151	245.8	180	176	199.1
Calories	321.1	536.91*	349.96	337.34	399.09
Carbohidrates (g)	10.65	81.04†	44.73*	15.63	74.87†
Fiber (g)	0.85	4.81*	8.4†	1.98	3.03*
Proteins (g)	24.7†	23.31†	20.61†	7.83	7.83
Fat (g)	20.22*	15.51	11.08	27.49*	9.67
Monounsaturated fatty acids (g)	7.2†	7.39†	3.66	8.46†	5.16*
Poliunsaturated fatty acids (g)	5.37*	2.96	3.22	10.79†	1.08
Saturated fatty acids (g)	4.99†	2.99*	2.55*	4.09†	1.15
Cholesterol (mg)	101.16†	34.5	12.78	180.4†	0
Vitamin A (µg)	34.2	14.1	117.56†	100.19†	39.24
Vitamin B1 (mg)	1.01*	0.73	0.45	0.14	0.12
Vitamin B2 (mg)	0.25	0.17	0.2	0.19	0.1
Vitamin B6 (mg)	0.53	0.52	0.65	0.3	0.46
Vitamin B12 (µg)	3.43†	1.67*	0.05	0.92	0
Vitamin C (mg)	6.12	6.26	15.84*	17.36*	64.8†
Vitamin D (µg)	0.12	0.01	0	0.77	0
Vitamin E (mg)	5.02	2.09	3.78	11.57†	0.94
Niacin (mg)	10.01†	10.43†	4.53	1.4	3.71
Folic acid (µg)	13.9	60.01†	31.11*	34.54*	41.97*
Sodium (mg)	192.62*	451.12†	229.15*	71.94	8.63
Potassium (mg)	475.23	972.86†	857.9†	602.8*	423.46
Calcium (mg)	29.44	62.58*	59.05*	36.65	35.86
Phosphorus (mg)	35.55	245.17†	211.94†	141.68*	124*
Magnesium (mg)	31.12	92.35†	62.64*	23.72	40.64
Iron (mg)	2.36	7.39†	5.85*	1.71	1.52
Zinc (mg)	3.01	3.36	2.78	0.95	1.32
Iodine (µg)	3.19	1.53	5.45	12.32†	14†

** and † denote significant differences among samples ($p < 0.05$ and $p < 0.001$, respectively).*

Spain). Regardless of knowledge of nutrition and dietetics, other factors such as food preferences, gastronomic habits, social influence, or food availability seem to have a greater influence on dietary choices, which could justify also the consumer preferences found in the present study.

In contrast, Sánchez & Lluna (2019) reported that students from health sciences (Physical Activity and Sport Sciences, Physiotherapy, and Nursing) do report more adherence to Mediterranean diet and better nutritional habits than students from other sciences (Criminology, Psychology, Law, Physics, Economics, Journalism and Communications), as well as more and better-quality physical activity practice. This demonstrates a direct relationship between health literacy and better health habits, greater regular practice of vigorous physical activity, and greater adherence to Mediterranean diet among the students of University of Vic, Autonomous University of Barcelona, and Gimbernat University Schools (Catalonia, Spain).

In general, it is recommended to adopt a healthy and sustainable diet characterized by a predominance of plant-based foods and a moderate consumption of animal-based foods. In all cases, the consumption of seasonal and local products should be encouraged (19).

In this sense, nutrition education programs should be designed with the aim of ensuring that the population in general, and young people, are able to eat a healthy diet. To this end, public authorities should promote dietary advice in primary care programs and develop nutrition education programs in formal education, which can be also applied to the population evaluated in the present study. Moreover, given the important relationship between diet and health status, the possibility of including dietetics and human nutrition subjects in university curricula could be considered.

TOTAL ANTIOXIDANT CAPACITY

The total antioxidant capacity of the most consumed dishes by canteen users (pork Milanese style, pasta Bolognese, lentil and chorizo stew, Spanish omelette, and vegetable paella) was measured by three different methods. Figure 1 shows the percentage of scavenging against DPPH free radical. As observed, lentil and chorizo stew shows the highest scavenge ability ($p < 0.001$), and therefore the highest antioxidant capacity, with a scavenging percent of 32.5 %, followed by vegetable paella with 11.2 %, pasta Bolognese with 11.1 %, pork Milanese style with 10.6 %, and finally Spanish omelette with 9.5 %. Lentil and chorizo stew showed a 2-fold higher scavenging ability against DPPH in comparison with the rest of the analyzed dishes.

In a similar manner, the antioxidant capacity measured by the ability to reduce the ferric ion by the analyzed dishes is shown in figure 2A (µM of Trolox equivalents per gram). As previously observed with the DPPH results, lentil and chorizo stew has, significantly ($p < 0.001$), the highest antioxidant capacity (1,020 µM Trolox equivalents/g), followed by pasta Bolognese (414 µM Trolox equivalents/g), vegetable paella (176.5 µM Trolox equivalents/g), Spanish omelette (43 µM Trolox equivalents/g), and pork Milanese style (17 µM Trolox equivalents/g). As described, lentil and chorizo stew had a ferric reduction power 1.5-fold higher than pasta Bolognese, 4.8-fold higher than vegetable paella, 22.7-fold higher than Spanish omelette, and even 59-fold higher than pork Milanese style.

Finally, figure 2B shows the reported antioxidant capacity results by the ORAC method, expressed in µM Trolox equivalents per gram, of the analyzed dishes.

As we can see, lentil and chorizo stew is the most antioxidant dish ($p < 0.001$) with 718.8 µM Trolox equivalents/g, followed by vegetable paella with 244.7 µM Trolox equivalents/g ($p < 0.05$), pork Milanese style with 202.9 µM Trolox equivalents/g, pasta Bolognese with 183.3 µM Trolox equivalents/g), and finally Spanish omelette with 137 µM Trolox equivalents/g. In this sense, lentil and chorizo stew showed 193 % more oxygen-radical scavenge capacity than vegetable paella, 272 % more than pork Milanese style and pasta Bolognese, and almost 425 % more than Spanish omelette.

In summary, these three techniques used to assess antioxidant capacity agree that lentil and chorizo stew has the highest antioxidant capacity, which is due to the polyphenols in lentils and, to a lesser extent, the vegetables that conform the dish (garlic, onion, potatoes, and especially carrot) (Table IV), which contribute to the antioxidant capacity by their high content in vitamin C, E, and carotenes. However, some differences can be appreciated among the obtained values by different assays (DPPH, FRAP, or $ORAC_H$), which could be due to the solubility of the main antioxidant compounds in the tested dishes.

In fact, these results can be justified by previous studies. For instance, Silva-Cristobal et al. (2010) found that the antioxidant capacity of legumes was due to their total soluble polyphenol content. Especially, lentils showed the highest content in soluble polyphenols (3.09 mg/g), with reportedly 16 % scavenging against DPPH free radical. These data can be compared to results obtained in the present study, where lentil and chorizostew showed 32.5 % scavenging activity against DPPH free radical, which can be due to the rest of ingredients in the dish: garlic, onion, carrot, potatoes, tomato, or even the paprika used to prepare the chorizo; their contents in antioxidant compounds (capsa-

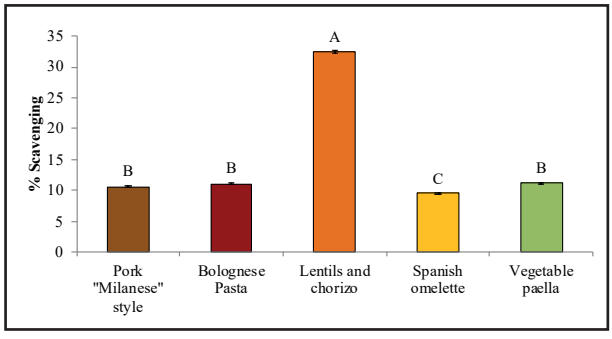

Figure 1.

Scavenging activity against DPPH reagent for the most commonly consumed dishes in the studied canteens. Different letters denote significant differences between samples ($p < 0.05$).

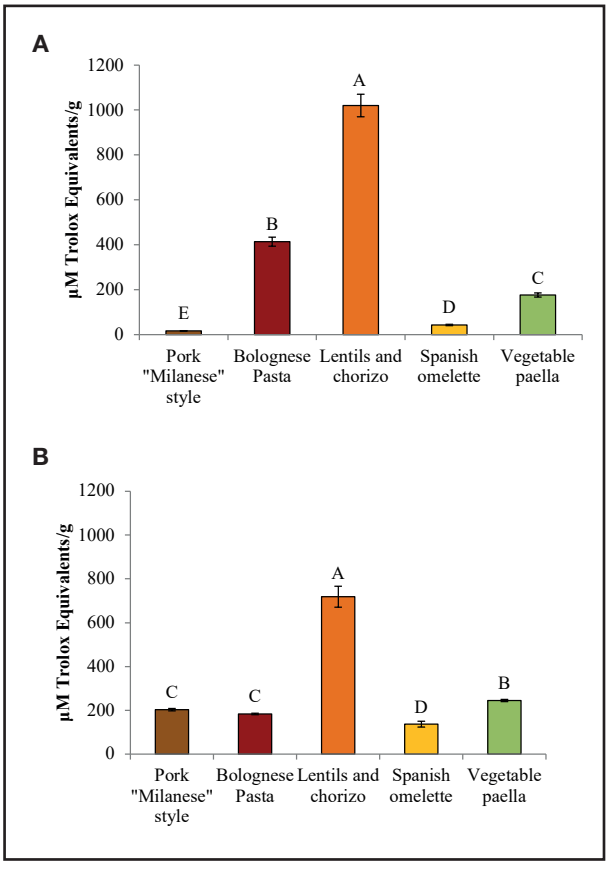

Figure 2.

Total antioxidant capacity, measured by FRAP (A) and ORACH (B), of the most commonly consumed dishes in the studied canteens. Different letters denote significant differences between samples ($p < 0.05$).

icin, phenolics, carotenoids, anthocyanins, organo-sulforaphane compounds) (21) may help increase the higher antioxidant ability of lentil and chorizo stew.

Furthermore, Navarro-González et al. (2017) carried out an estimation of the antioxidant capacity of the main foods consumed by the Spanish population, which demonstrated that 15 % of the total antioxidant activity ($ORAC_H$) provided by vegetables and pulses (31 % of the contribution to total antioxidant capacity in the Spanish diet) comes from the consumption of lentils. According to this study (22), the ORAC antioxidant capacity of the estimated average intake per person and day was around 10,000 µmol TE. As a consequence, 3100 µmol TE/person/day come from vegetables and pulses, and specifically 465 µmol TE/person/day may come from lentils. In this way, a dish of lentils and chorizo could cover these approximated estimations (718.8 µM Trolox equivalents/g).

Prior et al. (2007) estimated that an antioxidant capacity of 4.6 µmol TE per calorie consumed should be ingested (9,200 µmol TE/person/day for a 2,000-calorie diet). We can therefore affirm that the Spanish population can reach these recommendations for antioxidants, this being slightly higher than in other countries that follow very similar diets such as Greece, which also follows a Mediterranean diet (6,700 µmol TE/person/day, according to Kolomvotsou et al. (2013)). Also, according to Navarro-González et al. (2017), the food group with the highest ORAC antioxidant index in the Spanish population is fruits, followed by vegetables and pulses.

CONCLUSIONS

Upon evaluating the habits of the students, professors, and service staff who have lunch at university canteens, it was observed that in the main meal of the day there is a high consumption of pasta, rice, and meat, and an acceptable consumption of pulses (mainly lentils), leaving vegetables aside. As for drinks, water is the most popular choice, which contrasts with the scarce consumption of soft drinks, known to have high sugar levels. It was also found that most canteen users chose fried potatoes as garnish, fruit for dessert, white bread, and salad to accompany their main course. In this sense, fruit and salad included in a regular diet would contribute to a diet rich in antioxidants.

Furthermore, regarding the antioxidant capacity of the analyzed dishes, it may be concluded that the dish with the highest antioxidant power was lentil and chorizo stew, due to a high content of soluble polyphenols in lentils and the dish vegetable ingredients (garlic, onion, carrot, and potatoes).

In conclusion, all the analyzed dishes showed an interesting nutritional profile to be included in a balanced and healthy Mediterranean diet in a proper proportion, demonstrating that this dietary pattern is rich in antioxidant compounds able to protect the health of consumers, also in a University community in southeastern Spain. Nevertheless, further studies on the antioxidant capacity of foods are needed, as the available research did not include most foods and/or complete menus used in Spanish cuisine.

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