Original article

The dietary adequacy of organic *vs* conventional food consumers

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Abstract. *Purpose:* Aim of the article is to compare the diet of organic and conventional food consumers in order to assess whether their diet -both in terms of single component and as a whole diet- is balanced and how respectful it is compared to the reference levels for the Italian population. *Design/methodology/approach:* A sample of 110 Italian individuals was homogeneously categorized as Conventional, Organic-Weak and Organic-Strong consumers to assess and compare the nutritional adequacy of their diet. Food consumption was self-recorded on diaries structured by meal during three consecutive days in four different periods of the year specifying whether the food eaten was organic or not. A data management system developed by the Italian National Research Institute for Food and Nutrition was used to analyze data. The impact of eating habits on health was assessed by using a national-modified Healthy Food and Nutrient Index (iHFNI). *Findings:* Strong-organic subjects show significant higher caloric intake values but lower proteins and lipids compared with the conventional consumers. The diet of organic consumers, especially the strong ones, is characterized by a higher intake of dietary fiber, vitamins, minerals, and fruit and vegetables. A significant higher score of the iHFNI is measured for strong organic consumers. None of the groups shows improper eating habits and are especially away from national recommendations. *Originality/value:* First, the originality of the study remains in considering the nutritional profile, based on individual nutrients and on global food diets, together with the type of food consumption choices. Furthermore, rather than being based on a qualitative assessment, the collection of real consumption data based on a detailed diary, and the distinction between strong and weak organic consumers are essential to get more accurate results.

Keywords: Balanced Diet, Diet Index, Food Choice, Organic Consumers, Conventional Consumers

Introduction

Consumer's interest in organic food has increased worldwide in response to concerns about conventional agricultural practices and their implications in terms of food safety, human health, animal welfare and the environmental sustainability (1).

The organic production system strives for minimal disruption of the natural equilibrium while ensuring the production of high-quality food. Organic farming in the EU is a method of agricultural and food production that combines favorable environmental and animal welfare standards (Regulations EC- No 834/2007). Currently, organic food is becoming more and more popular all over the world, and the European market of organic products has been developing very intensively since the early '90s. According to a recent report on organic farming by the European Commission (2), the

European organic food market is the second largest in the world after US and amounted to 34 billion euros in 2017, with an increase in sales of about 48% from year 2012. Four countries together account for 54.4% of the EU total organic area, namely Spain 16.9%, Italy 15.1%, France 12.9% and Germany 9.5%. In Italy, the expenditure for organic food products was close to 2.5 billion euros in 2018(3). From niche phenomenon, the Italian food organic sector continues its rise, due to a growing demand for certified quality products and favoured by the massive entry in the large-scale retail trade and the discount store. As far as the primary productions, much as 15.5% of the entire Italian agricultural area is organic, 2 million hectares in total (data from the Ministry of Agriculture). Compared to the European Union, Italy holds the highest number of operators, followed by France and Germany, while it ranks second for organic agricultural surface, preceded by France. The "Sistema d'Informazione Nazionale sull'Agricoltura Biologica" - SINAB (3) estimated increases over 800 thousand hectares and 20 thousand farms since 2010.

As far as the demand side of the market, consumers have started to understand that their food choices may have consequences for their health and are paying more attention to the health benefits of food (4). Some clinical and epidemiological studies have showed the impact of eating habits on morbidity and mortality (5, 6, 7). These studies have focused primarily on the relationship between a nutrient or a food on the one hand, and on total or cause-specific mortality on the other hand.

Consumers expect a higher health and nutritional quality from organic foods and believe that organic products are more nutritious than conventionally grown products (2), but the research supporting that belief is not definitive. Many studies, dealing with the nutritional quality of organic *vs* conventional food, have provided different and controversial results (8, 9, 10). On the other side, foods and nutrients are not consumed in isolation but as part of an overall diet and it is plausible that the effects of single dietary components on the risk of disease depend on the overall dietary pattern (11). Indeed, not necessarily the food choices of organic consumers are coherent with a correct diet and lifestyle; as an example, someone (12) assessed that people infer that organic cookies are lower in calories and can be eaten more often than conventional cookies.

As consumers of organic foods are particularly sensitive to issues related to good health, the study aims to investigate whether organic consumers are more attentive to proper nutrition and respectful of nutritional recommendations, and whether their diet is balanced in comparison with that of conventional consumers. Hence, we assessed the nutritional adequacy of the different diets compared with the recommended levels of intake with reference to the Italian population (13). Following a previous study (14), the present analysis was updated to include more nutrients; furthermore, the impact of eating habits on health was assessed by using the Italian Healthy Food and Nutrient Index (iHFNI) and comparing consumers of organic and conventional food.

Methods

Survey Participants

A target sample of 110 individuals residing in five towns located in the main geographical areas of Italy (North-West, Centre and South) was considered with the aim of characterizing their food consumption style.

The literature about organic food consumption behavior often proposes two criteria for defining an organic consumer's profile instead of a conventional one: the frequency of purchasing and the percentage of organic food expenditure on total food expenditure (15, 16). The distinction between conventional and organic consumers based on these criteria was not considered accurate for this study which has a nutritional objective rather than an objective of analyzing food consumer's behavior. For this reason, three types of diet were considered: Conventional (CV), Organic-Weak (OW) or Organic-Strong (OS). Pre-selected individuals defined as "CV" did not buy and use organic food. Pre-selected individuals defined as "OW" and "OS" buy organic food certified by the European Union label. The weak and strong organic profiles were defined in a timely manner considering different criteria (17): the percentage of organic food expenditure on total food expenditure (with a 30% threshold: less than 30% OW; greater than 30% OS); the number and the percentage of expenditure for specific organic food items (two items and a 30% threshold), and finally, the frequency of purchase of organic food (a once a week threshold).

Individuals were recruited for homogeneous socio-economic and cultural conditions, so having similar economic availability to buy organic products. All subjects were recruited in good health and did not have food allergies. In the sample were not present pregnant women or nursing. The information about food purchases and also demographic, physical activity and anthropometric (self-reported height and weight) characteristics have been obtained using an appropriate questionnaire. Weight and height have been used to calculate the BMI (Body Mass Index) based on self-reported measures. BMI was used here in order to classify our sample for the purposes of better understanding their food-related lifestyle and to evaluate the effects of BMI, as reported by Saba *et al.* (18); the present study does not make any attempt to infer specific health risks that might be overestimated or underestimated by self-reporting of height and weight.

The sample was homogeneously composed according to the three groups of CV (37 individuals), OW (37 individuals), and OS (36 individuals).

Protocols and materials

The analysis of food styles relies on the self-reporting of consumption behavior and food intake, elicited by very detailed diaries. Study participants were asked to record all foods ingested on hard-copy diaries structured by meal during three consecutive days in the four seasons of the year, for a total of 12 days.

All foods and beverages consumed had to be registered, and for each item individuals indicated the commercial name and specified whether it was organically or conventionally produced. The use of vitamin and/or mineral preparations and of a range of medicines and products containing nutrients (cod liver oil-based preparations, herbal, botanical and homeopathic preparations, etc.) were also registered in the diaries. Any of these products is hereafter called 'supplement'. The assessment of individual diaries allowed estimating the dietary intakes and eating behaviors.

The survey protocol is described in detail in publications related to previous food surveys performed by the Italian Agricultural Research Council - Research Center for Food and Nutrition (CREA-NUT), formerly INRAN (19). The survey was implemented by eight experienced staff member that were previously trained through theoretical and practical courses organized by INRAN. A pilot survey was conducted on a sample of 20 volunteers in order to assess the adequacy of the preparation and training of the interviewers.

In order to assess the lifestyle of the sample, a questionnaire used in previous surveys conducted by the national Institute of Health was integrated to collect information on the habits of physical activity (available on-line athttp://old.iss.it/binary/ofad/cont/questionario%20giovani%20in%20forma.1225957648.pdf).

Interviewers individually met each participant three times during the survey period. For every eating occasion, subjects were asked to carefully record: time, place of consumption, detailed description of foods (or beverages), quantity consumed, brand (for manufactured foods) and specifying whether organic or CV. Portion sizes were reported by subjects with the help of a picture booklet (19).

For each of the twelve days, subjects were asked if they were following a particular diet and if the consumption they had reported differed from their usual consumption. Data collector subsequently registered their judgement on the reliability of the information recorded in each single day.

Methods: data entry and coding, data analysis and processing

The data management system and software INRAN-DIARIO_3.1 developed by INRAN (20) and applied in previous national surveys (19) were used to codify, enter, process and analyze the collected data. The software was used to put in electronic form all the information recorded in the diary: the food description reported in the diary was entered as such by the interviewer in an open format text field; the quantity consumed was entered together with the unit of measurement (e.g. grams, glasses, spoons, portions) and a food descriptor was selected from foods, recipes and supplements/medicines databases.

The data entry procedure included a consistency check between units of measurements and food descriptors. A central procedure of this software applies quality control routines. The software includes several checkpoints to ensure the accuracy and completeness of the recorded data. The hard-copies of the diaries were checked to identify possible data entry errors when no eating occasion had been entered for one of the meals, or when the total energy from food and beverages reported in a diary was more than 120% or less than 70% of the predicted Energy Expenditure (EE) of the subject. Once digit errors and codification errors were corrected, the average food consumption and the average Energy Intake (EI) during the survey period were calculated for each individual.

During the data entry, for any food/recipe consumed during the survey but missing in the databases, a new food code was created and added to the food composition and portions databases. Missing nutrient values were estimated on the basis of nutrient levels in similar foods or of manufacturer's data (e.g., food labels), in particular, for fortified foods. Recipe calculations were made without any adjustment for nutrient losses during cooking. Once the digit errors and codification errors were corrected and the databases were updated, the software calculated the average food consumption and the average energy intake during the survey period for each individual. Results report energy and nutrient intakes as mean per day.

The definition of nutrients was that adopted in the Italian National Food Composition Tables (21). Food energy was expressed as kilocalories (kcal); available carbohydrates were expressed as monosaccharides equivalent, that is, the sum of free sugars and complex carbohydrates. Dietary fiber was intended as the sum of hemicelluloses, celluloses, lignin, pectins, gums, waxes and resistant starch. All analyzed nutritional variables are shown in Table II.

Procedures: Nutritional index calculation

One of the approaches developed to represent overall diet is based on the construction of scores evaluating the quality of the diet, either as a function of the diversity of foods consumed, or as a function of national or international recommendations (5,6, 7). Several indexes have been proposed to assess overall diet quality, such as the HEI, DQI-R, RFS and the HFNI indexes. The Healthy Eating Index (HEI) is a measure of diet quality in terms of conformance to the Dietary Guidelines for Americans (22). The Diet Quality Index Revised (DQI-R) is based on similar guidelines from the National Research Council but also includes iron and calcium (23), while the Recommended Food Score (RFS) was constructed from foods recommended from the current intake guidelines (24). The Healthy Food and Nutrient Index (HFNI), developed by Bazelmans*et al.* (25), assumes that a low-quality diet is positively associated with chronic disease risk.

Among the various indices proposed in the literature to assess the adequacy of the diet, the Healty Food and Nutrient Index (HFNI) was chosen for this study. This index was selected because the nutritional guidelines of Bazelmans et al. (23) are very similar to the Italian ones, although it was necessary to adapt protein, fiber and carbohydrates to the Italian LARN. The modified index was called iHFNI (italian HFNI).

For each food or nutrient considered in the iHFNI, a dichotomous variable was created as a function of the thresholds defined in the recommendations (Table I). For some nutrients there are reference ranges and not absolute values. When a person's consumption was within the limits of the recommendations, the variable is encoded as 1, while when the consumption was outside the limits, the variable is encoded as 0. Nutrients and foods therefore all have the same weight in the calculation of the score. The index is calculated by adding up the values over the nine nutrients and food groups, and therefore it goes from 0 to 9. The higher the index, the more the diet conform to the recommendations (25). We used this index, adjusting it to LARN (13); in particular, the data for SFA (Saturated Fatty Acids), MUFA (Monounsaturated Fatty Acids), PUFA (Polyunsatured Fatty Acids), protein, dietary fiber, cholesterol, and carbohydrates, were compared with the reference levels of intake of nutrients and energy LARN (13). As regards beta-carotene, for which the LARN does not set specific indications, the fourth quartile was considered as a threshold value, following the study of Bazelmans*et al.* (25). In relation to the consumption of fruit and vegetables, the values refer to the recommendation of Food, Nutrition, Physical Activity and Prevention of Cancer (26).

Table I. Thresholds of some nutrients and fruits and vegetables covered in the Italian Healthy Food and Nutrient Index (iHFNI)

Nutrients and food groups	Dichotomous variable=1	Dichotomous variable=0
Saturated fatty acids *	< 10% En tot	≥ 10% En tot
Monounsaturatedfattyacids *	> 10% En tot	≤ 10% En tot
Polyunsaturatedfattyacids *	5-10% En tot	< 5% or > 10% En tot
Protein*	12 – 18 % En tot	<12 % or > 18% En tot
Dietaryfiber*	12.6 – 16.7 g/1000 kcal	< 12.6 or > 16.7 g/1000 kcal
Carbohydrates*	45-60% En. Tot	< 45% or > 60% En tot
DietaryCholesterol*	< 300	≥ 300 mg
Beta carotene**	≥ Quartile 4	< Quartile 4
Fruits and vegetables***	≥ 400 g	< 400 g

**LARN, 2014.*
***Currently there is no consensus on the quantity of beta carotene that should be consumed, so we have taken the last quartile of the distribution as the threshold.*
**** World Cancer Research Fund/American Institute for Cancer Research, 2018.*

Ethics

The data is processed with informed consent. The survey was exclusively observational and non-invasive and it aimed only to the collection of information on food habits. It was a survey study based on anonymous questionnaires about food consumption behavior. Results consider only if consumption habits are consistent with recommended guidelines.

Statistical analysis

One-way analysis of variance (ANOVA) followed by the Scheffe's post-hoc comparisons tests were performed in all statistical analyses.

Results were considered to be statistically significant at $p < 0.05$ with 95 per cent CI. Data were analyzed using SPSS for Windows (27).

Results

The sample was structured as follows: 48.9% male and 51.1% female; mean age of men 50.26± 3.32, and mean age of women 45.73 ± 2.78. Analysis of the data revealed no statistically significant differences between CV, OW and OS subjects for the BMI (22.8 ± 2.3; 23.7 ± 3.12, and 24.4 ±2.6 kg/m^2 respectively).

A statistically significant difference was observed for different variables between individuals who follow a CV, OW or OS diet. Mean values of nutrients analyzed are shown in Figure 1 and Table II.

The results of analysis showed a significant difference in the caloric intake with higher values in subjects who more closely follow an organic diet. As regards the protein, a smaller amount was observed in OS subjects compared with CV individuals.

Even with regard to the analysis of the lipid profile, a lower percentage level was observed in organic consumers (both OS and OW, respectively 35.2% and 35.8%) with statistically significant differences between these and CV consumers (37.7%). The acidic profile does not show statistically significant differences for both saturated and monounsaturated fatty acids, even if the OS take greater amount of oleic acid that is mainly contained in extra virgin olive oil. As regards the content of PUFA, in OS subjects a value less (4.5%) than the CV one (5.31%) has been observed.

As regards the essential fatty acids, its intake is greater in OS consumers (9.4 g of linoleic acid-ω6 and 1.5 g of ω3-linolenic acid). Finally, OW have an intake of cholesterol lower (212.4 mg) than the other two groups (269.2 mg and 283.4 mg, respectively for CV and OS).

As regards the content of available carbohydrates -starch and simple carbohydrates-, statistically significant values were observed among the subjects belonging to the different food consumption profiles. In particular, OS subjects take more foods rich in starch and more foods rich in simple carbohydrates compared with OW and CV consumers.

As far as the intake of dietary fiber, OS subjects show a significantly high value (24.7 g). A feature of the diet of strong-organic individuals is also a higher consumption of beta carotene (6652.6 mcg), vitamin C (161.1 mg), vitamin E (15.3 mg), vitamin K (226.4 mg), total folate (479.0 μg) and of water (1.964 g). Instead, CV subjects have a higher intake of vitamin A compared with other consumers' groups. In OW subjects a higher intake of vitamin D (5.50 μg) compared with that of CV (2.08 μg) and OS subjects (2.80 μg) is observed.

Strong-organic subjects have a higher daily consumption of fruit and vegetables compared with that of conventional and weak-organic individuals.

Strong-organic subjects assume a higher daily intake of magnesium (330 mg) compared with OW (252.0 mg) and CV consumers (264.2 mg). A similar situation is observed for the daily intake of zinc: 20.7 mg in OS and 9.57 mg and 10.9 mg respectively for OW and CV consumers. OWs have an intake of potassium lower than the other two groups: 2722.6 mg and 3574.9 respectively for CVs and OSs. As regards phosphorus intake, OS subjects reported the highest value (1526.5 mg) compared with that of CV (1231.0 mg) and OW subjects (1117.3 mg).

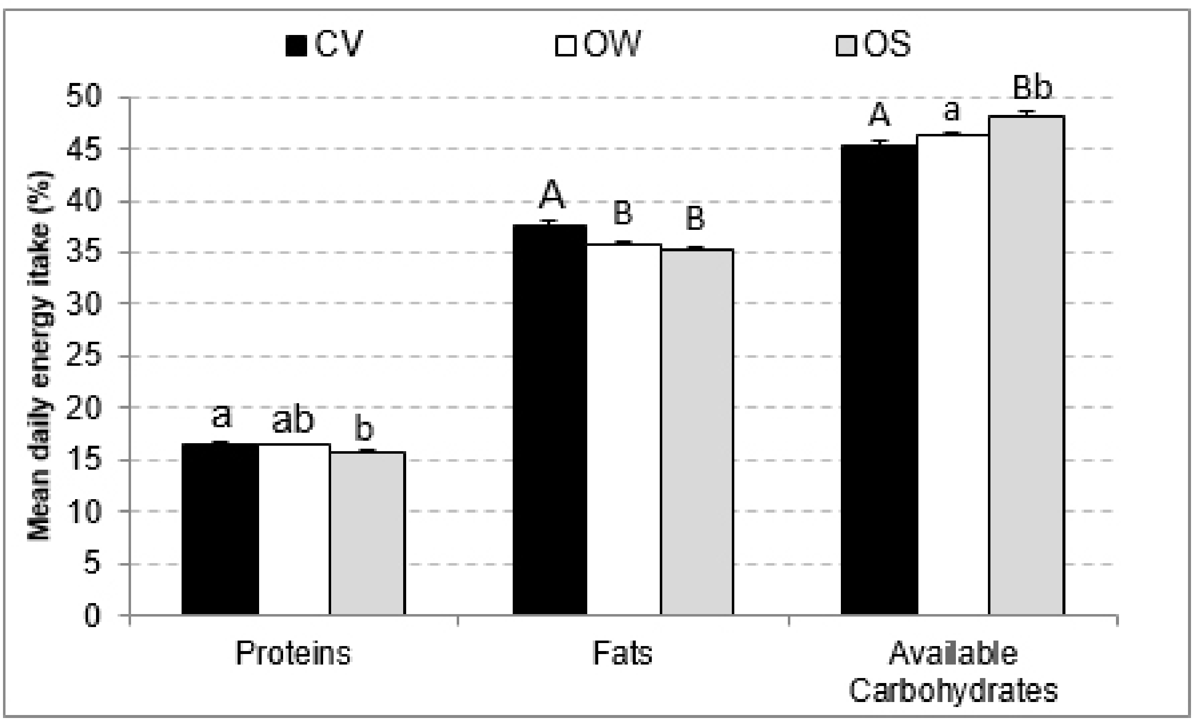

Figure I. Mean daily energy intake of macronutrients (% Energy) stratified for consumers' different nutrient profiles: Conventional (CV), Organic-Weak (OW) and Organic-Strong (OS).

[a,b,c] *Scheffè test, unequal letter within same macronutrient indicate significant difference (P < 0.05).*
[A,B,C] *Scheffè test, unequal letter within same macronutrient indicate significant difference (P < 0.01).*

Table II. Mean daily intake and Standard Error (SE) of Energy, some nutrients, and food group "fruit and vegetables", stratified for consumers' different nutrient profiles: Conventional (CV), Organic-Weak (OW), and Organic-Strong (OS)

Nutrients and Food Groups	CV		OW		OS		P
	Mean	±SE	Mean	±SE	Mean	±SE	
Energy (kcal)	1928.1 Aa	35.5	1775.1 Ab	34.8	2504.2 B	65.8	<0.001
Energy (kj)	8059.8	148.3	7419.9	145.7	8586.7	275.4	
Saturatedfattyacids (%En)	12.9	0.1	12.3	0.1	12.2	0.2	ns
Monounsaturatedfattyacids (%En)	19.5	0.2	18.6	0.2	18.5	0.2	ns
Polyunsaturatedfattyacids (%En)	5.31 A	0.1	4.84 B	0.0	4.5 B	0.0	<0.001
Oleic acid (g)	35.3 A	0.8	30.9 B	0.7	44.8 C	1.4	<0.001
Linoleic acid (g)	8.1 A	0.2	6.9 B	0.2	9.4 C	0.3	<0.001
Linolenic acid (g)	1.2 aA	0.04	1.1 bA	0.03	1.5 B	0.05	<0.001
Dietarycholesterol (mg)	269.2 A	10.2	212.4 B	7.6	283.4 A	12.7	<0.001
Starch (g)	143.85 A	3.4	138.63 A	3.8	199.99 B	6.6	<0.001
Simple Carbohydrates (% En)	14.4 A	1.6	15.2 A	1.5	16.1 B	3.2	<0.001
Dietaryfiber (g)	15.2 A	0.4	15.4 A	0.3	24.7 B	0.8	<0.001
Beta carotene (mcg)	2472.2 A	130.0	2598.1 A	138.6	6652.6 B	664.4	<0.001
Zn (mg)	10.91 A	0.23	9.57 A	0.22	20.7 B	1.60	<0.001
Mg (mg)	264.21 A	6.94	252.09 A	5.57	330 B	12.93	<0.001
P (mg)	1231.09 A	27.05	1117.39 B	22.31	1526.53 C	39.67	<0.001
K (mg)	2722.67 A	56.68	2638.9 A	63.34	3574.94 B	100.53	<0.001
Na (mg)	1464.73 A	50.32	1377.37 A	51.25	2034.7 B	13.63	<0.001
Ca (mg)	742.77 A	20.4	705.66 A	21.1	963.2 B	29.1	<0.001
Vit A (μg)	659.6 A	84.8	234.62 B	8.92	309.04 B	14.26	<0.001
Vit K	202.9	19.8	171.34	14.5	226.42	20.0	ns
Vit D (μg)	2.08 A	0.18	5.50 B	0.84	2.80 A	0.28	<0.001
Vit B12 (μg)	6.02	0.36	5.26	0.48	6.20	0.47	ns
Vit C (mg)	108.9 A	4.1	104.0 A	4.6	161.1 B	7.9	<0.001
Vit E (mg)	12.2 A	0.3	10.6 B	0.2	15.3 C	0.5	<0.001
Iron (mg)	10.8 A	0.4	9.7 A	0.2	15.3 B	1.1	<0.001
Total folate (μg)	310.8 A	9.6	248.7 B	9.8	479.0 C	19.4	<0.001
Water (g)	1590 A	32.9	1433 B	22.6	1964 C	43.9	<0.001
Alcool (g)	2.01 a	0.31	3.23 b	0.38	2.22 ab	0.34	<0.05
Fruits and Vegetables (g)	302.7 A	10.9	326.1 A	9.5	508.8 B	21.4	<0.001

[a,b,c] *Scheffè test, unequal letter within same row indicate significant difference (P < 0.05).*
[A,B,C] *Scheffè test, unequal letter within same row indicate significant difference (P < 0.01).*
ns = not significant.

Furthermore, OS have a higher intake of sodium 2034.7 mg compared with that of CV (1464.7 mg) and OW subjects (1377.3 mg). Even for calcium, OWs have a significantly higher value than the other two consumers' groups. No difference was observed for vitamin B12 and for vitamin K.

Finally, besides the single nutrients, the whole diet of the three consumers' groups was investigated in order to appreciate the differences among them. The nutritional adequacy, assessed by using the iHFNI index, highlighted significantly higher scores in subjects with organic diet and in particular in OS compared with CV consumers (Figure. 2). This result is mainly due to the higher content of fruits and vegetables, fiber, beta carotene and reduced lipid content.

Discussion

Much literature highlights the absence of differences or the presence of minimal differences in the nutritional value of conventional and organic foods / diets (28, 29). For this reason, the present study analyzed conventional and organic diets in order to verify the existence of differences that may have effects on the nutritional status of individuals due to improper or unbalanced choices. In other words, questions were asked as to whether the nutritional value of organic diets versus conventional ones, far from being attributed to the quality of food items, could be attributed to the quality of food choices made by the different consumer's profiles.

Estimating nutrient intake is an important part of activities aimed at monitoring people's nutritional status. It allows the identification of groups nutritionally at risk due to insufficient or excessive intake of specific nutrients (30). There is an international consensus that healthy food choices and adequate physical activity level may improve health conditions and prevent chronic diseases (31, 32). An imbalanced intake of nutrients is associated with increased morbidity and mortality from diseases, including cardiovascular

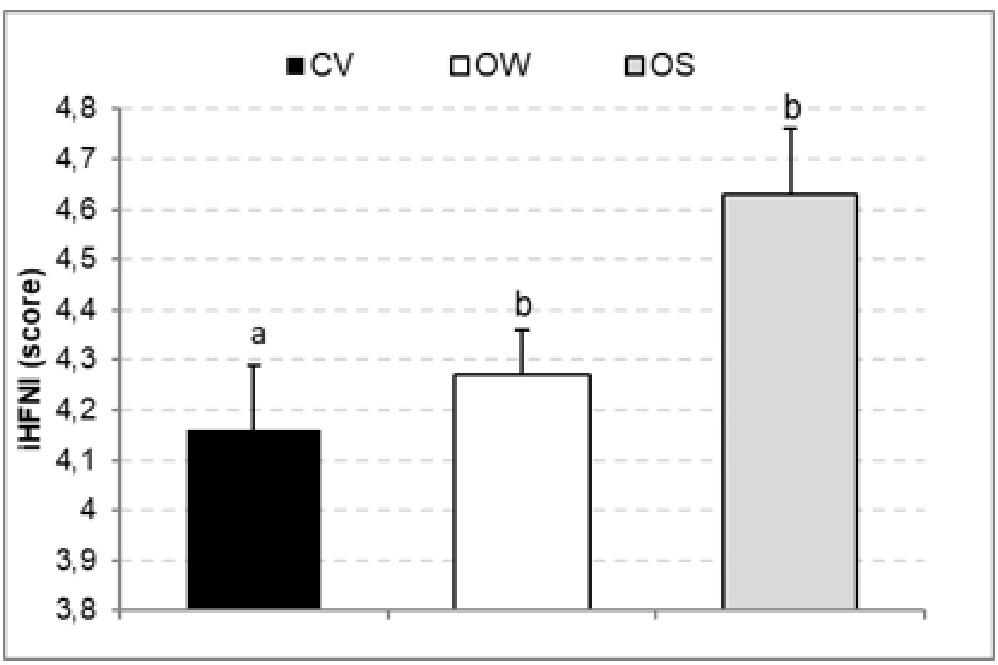

Figure II. Nutritional adequacy assessed by Italian Healthy Food and Nutrient Index (iHFNI) stratified for consumers' nutrient profiles: Conventional (CV), Organic-Weak (OW) and Organic-Strong (OS).

[a,b] Scheffè test, unequal letter indicate significant difference (P < 0.05).
Even if the score goes from 0 to 9, for a better visibility of the figure only the range in which the detected values fall has been reported.

diseases, cancer, diabetes, osteoporosis etc. (30). As far as the food choices investigated in this study, a significant difference in the caloric intake was observed, with higher values in subjects more closely following an organic diet. It should be emphasized that in the OS group there was a tendency to have a higher BMI (although within a normal interval) even if significant differences did not result compared with the other two groups. The highest energy intake could be due to the higher BMI compared with the other two groups. In particular, the higher caloric intake observed among individuals who follow an organic diet is due to the fact that such people normally assume a larger quantity of carbohydrates, fruits and vegetables, than other individuals.

The protein intake for all groups is in the normal range; in fact, according to LARN (13) indications, protein intake should remain in the range between 12-18% of total daily energy intake. In the three groups of consumers included in the study sample (CV, OW and OS groups), the average data relative to proteins (16.2 % En) is in line with data reported by Sette *et al*. (30) for the Italian adult population (15.8% En) and with those reported by García-Meseguer*et al.* (33), by Ruitz *et al.* (34) and by Correa-Rodriguez *et al.* (35) for the Spanish population.

Dietary fat profile, independent of the total intake amount, may play an important role in the development of obesity and obesity-related disorders (36). Dietary fat represents a major source of energy intake. Among the Organics (both OSs and OWs, with no significant differences), the percentage is at the upper limit recommended by LARN (13) - between 20 and 35% of the total energy-, but is lower than that assessed among the CV. These data are in line with that reported in a previous study of the Italian population, which showed an average intake of total lipids by about 36% of total energy (30), but are lower than those reported by Correa-Rodriguez *et al.* (35), García-Meseguer *et al.* (33) and Ruitz *et al.* (34).

Fatty acids are a wide family of compounds with important and manifold biological activities. For all types of consumers in the study sample the intake of saturated fatty acids is slightly higher than the recommendations, although the observed differences are not significant. The calculated intake is similar to the average value reported by Trichopoulou *et al.* (37) for the Greek population (12.8%) and by Correa-Rodriguez *et al.* (35) for the Spanish population. The energy derived from these fatty acids should not exceed 10% of total energy daily intake in adults (13).

Individual saturated fatty acids, overall fat and dietary cholesterol intake were directly associated with Coronary Heart Disease (CHD) mortality, whereas this was not the case for oleic acid and polyunsaturated fatty acids (38). The intake of polyunsaturated fatty acids, should cover 5-10% of the total daily energy intake in adults (13). The values observed in all groups are slightly below the lower limit of the recommended range, and similar (4-5% En) to those reported by Sette *et al*. (30) indicating not high intakes in the Italian population; they are also similar to those reported by Correa-Rodriguez *et al*. (35), but lower than the value assessed by Ruitz *et al.* (34) for the Spanish population (6.8%En). The human body is capable of producing all the fatty acids it needs, except for the two types of "essential fatty acids": the$\omega 6$ linoleic acid (LA)and the $\omega 3$ alpha-linolenic acid (ALA), that should be consumed from the diet. As regards ALA, the levels observed in the group of CV, OW and OS consumers are adherent to nutritional recommendations (range: 0.5-2,0% En) and within the range indicated by Hulshof *et al.* (39), but they are higher than the average values (0.66%) reported from Ruitz *et al.* (34). As in the case of ALA, even regarding LA, the values observed within the study groups are slightly below the nutritional recommendations (4-8% En), but higher than the average values (5.45%) reported from Ruitz *et al.* (34).

As far as monounsaturated fatty acids, values obtained in the study adhere to nutritional recommendations (range: 10-18% En), but are higher than the average values (17.35 %) reported by Correa-Rodriguez *et al.* (35).

Cholesterol intake was directly associated with CHD mortality (40, 41); its intake in the study sample is below the value reported in LARN (<300 mg/day); this result represents a positive aspect since it avoids exposure to risks due to excessive plasma concentration of cholesterol which facilitates the onset of different chronic diseases. Our average data (254 mg/day) relative to cholesterol are lower than those reported by Sette *et al.* (30) for the Italian adult population

(298 g/day), and by Correa-Rodriguez *et al.* (35) and by García-Meseguer *et al*. (33) for the Spanish population, respectively 346 mg/day and 393.99 mg/day.

In a balanced diet, carbohydrates should cover from 45% to 60% of total daily energy; for all groups in this study, the observed values of available carbohydrates are within normal range.

Among the carbohydrates, however, sugars must be distinguished from complex carbohydrates (starch and fiber). The consumption of sugars for adults should be less than 15 % of total energy intake daily (13). The OS subjects compared with OW and CV ones, take foods rich in starch and simple carbohydrates with values for the latter slightly higher than the recommendations, probably due to the higher consumption of fruit and vegetables compared with other consumers' groups. For the three groups of consumers in the study sample, the average data (15% En) of simple carbohydrates is in line with data reported by Sette *et al.* (30) for the Italian adult population (14.5% En) and with those reported by García-Meseguer *et al.* (33) for a sample of Spanish university population (16% En).

Dietary fiber in itself does not have a nutritional value and energy, is not attacked by human digestive enzymes, but is very important for the regulation of various physiological functions. The Italian recommendations for fiber intake suggest a minimum contribution equal to 12.6 g/1000 calories (13). The OS intake of dietary fiber is slightly below the limit of recommendations, but with values higher than those found in the other two groups. This is probably due to the higher consumption of fruit and vegetables by the OS group. In the three groups of consumers, the average data for dietary fiber (18 g/day) is equal to the data reported by Sette *et al.* (30) for the Italian adult population (18 g/day). The average values observed in the Italian population are higher than those observed in the Spanish population (16g/day) and reported by García-Meseguer *et al.* (33), but very similar to those reported by Correa-Rodriguez *et al.* (35).

Increased consumption of fruit and vegetables has been recommended as a key component of a healthy diet for the prevention of chronic diseases, cardiovascular disease and cancer (37, 42, 43). The intake of five portions of fruit and vegetables a day is able to ensure the right amount of dietary fiber, minerals and vitamins (especially water-soluble). For the study sample, the mean values (314g/day) relative to the intake of fruit and vegetables are similar to the average values (308g/day) reported by García-Meseguer *et al.* (33). However, it should be underlined that OS consumed a significantly higher quantity of fruit and vegetables (508 g/day) compared with other groups; consequently, Strong Organic consumers had a higher intake of antioxidant pro-vitamin and vitamins. In fact, a characteristic feature of OSs diet is a higher consumption of β-carotene (about 1100 RE/day, well below the maximum tolerable level), vitamin C (even if all groups are above the recommended values) and vitamin E (that only in this group exceeds the adequate intake value of 13 mg for male adults); however, in case of vitamin D, the average value is higher among the Weak-Organic consumers. These results are similar to those reported by Kesse-Guyot *et al.* (44) for a sample of French adults who regularly consume organic foods. Compared with Spanish population (35), people in the study sample have an intake that is lower for vitamin C, very similar for vitamin D, and higher for vitamin E. Considering the role of vitamin D in bone metabolism and immunity and iodine in thyroid health together with the antioxidant and ant-inflammatory properties of vitamin E, it would be relevant to encourage an adequate dietary intake of these micronutrients in order to prevent possible health problems (35).

Even if folates are contained both in animal and in vegetal food, a deficiency of them may occur; in fact, only in the OSs group they reach the recommended value for adults (400 μg/day).

Another characteristic feature of OS diet is a higher intake of iron. Iron deficiency is the most common cause of anemia but, in the OS individuals, this element is above the average intake of 11.4 mg/day in the Italian population (30).

All studies population showed a high intake of sodium. Since this mineral play a relevant role in development of several diseases, WHO recommends a reduction to <2 g/day sodium (5 g/day salt in adult (45). Therefore, dietary recommendation must be intended to encourage potassium and reduce sodium intake. For potassium, even if all groups are above the

Italian recommended values, significantly higher values were observed only in OS, probably due to greater consumption of fruit and vegetables.

Zinc nutritional deficiency is a global health problem (46). A characteristic feature of OSs diet is also a higher intake of zinc, even higher than the recommended values.

Calcium is required for vascular contraction and vasodilatation, muscle function, nerve transmission, intracellular signaling and hormonal secretion. Milk, yogurt and cheese are natural sources rich of calcium, while broccoli and spinach provide calcium but its bioavailability is poor. Within the study sample, Calcium values except in the OS subjects, are very below the Italian recommended values but similar to those reported by Correa-Rodriguez (35).

Magnesium is involved in catalyzing multitude biological reactions, including protein synthesis, transmission of nerve impulse, muscle relaxation, energy production, and bone and teeth adsorption. An additional feature of OS diet is the higher intake of magnesium, similar at Italian recommendations values.

Potassium is essential for maintaining cellular osmolality and membrane potentials, thus playing a role in vascular tone and other biochemical pathways related to cardiovascular health. In OS subjects there was a higher daily intake of potassium compared with OW and CV consumers; furthermore, OS individuals only, they have an intake similar to the value recommended for the Italian population.

A water intake level over 1400 mL/day (excluding the 250-350 mL/day of metabolic water production) seems adequate in sedentary adults to compensate for losses (13). In OS significant higher values were observed, probably due to the greater consumption of fruit and vegetables. Alcohol consumption varies from 2 to 3 g/day, a modest quantity for all categories of consumers.

Finally, besides the assessment of single nutrients, a specific feature of the study was the assessment of the adequacy of the whole diet and its comparison among different groups of people based on their food consumption choices, conventional or organic. At this regard, the highest value of the iHFNI index applied in the study was observed in subjects who adopt an organic diet and mainly among those people defined as strong organic consumers. On the contrary, those who adopt a conventional diet reported lower values of the index. However, the values observed in the study are higher than those reported by Bazelman *et al*. (25), probably due to some differences in the diet's composition of the two studied populations. In fact, the diet followed by the sample of this study is characterized by intake of foods that are typical of the Mediterranean diet, such as olive oil, fruits, vegetables, and legumes (47).

Conclusion

Although studies about food consumers' behaviour report that organic consumers are generally more attentive than conventional consumers to the health and nutritional implications of their food choices, the collection of real data based on a detailed diary and the distinction introduced between organic consumers -strong or weak organic- are essential to obtain more accurate results.

Indeed, results of the study confirm a greater attention in the dietary habits of the people who follow an organic diet. Anyway, in particular strong-organic food consumers seem following more closely the nutritional recommendations related to the intake of micronutrients, fiber, fruit and vegetables. As far as those consumers whose organic food choices are less frequent and relevant, previously called weak-organic consumers, results show that their nutritional status is appropriate only for few nutrients, but their global diet assessment does not significantly differ from that of conventional consumers. These results suggest caution in affirming the nutritional superiority of the organic consumer profile which includes different situations, especially when this profile is mainly composed of individuals who have a weak orientation towards the consumption of organic food.

Even if these findings cannot be extended to the universe of Italian consumers, they refer to a wide spectrum of phenomena providing some suggestions from a methodological perspective, and giving insights that could be further investigated on a broader sample base. Furthermore, study findings offer information about potential areas of nutritional deficiency and imbalances, that could be useful for setting up educational campaigns aimed at improving the quality of food choices and diet among the population.

Finally, it should be noted that none of the groups in our sample shows improper eating habits and especially away from the national recommendations. However, it is to remember that a diet only, although adequate, is not sufficient to ensure achieving and/or maintaining a good state of health, if not be considered as part of a healthy lifestyle.

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