

HOMEMADE TOMATO SAUCE IN THE MEDITERRANEAN DIET: A RICH SOURCE OF ANTIOXIDANTS

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ABSTRACT

The basic ingredients used to make the Italian *soffritto* were studied in order to define the polyphenol, antioxidant capacity and lycopene content of homemade or commercial tomato sauces, as well as their contribute in whole wheat or refined wheat pasta.

The addition of aromatic herbs to sauces increased polyphenols and antioxidant capacity, with basil providing the biggest boost, whereas ready-made commercial tomato sauces showed the lowest antioxidant values. Cooked whole wheat pasta with homemade tomato sauce offers an enormous amount of antioxidants, which could protect against oxidative stress.

Keywords: antioxidant activity, extra virgin olive oil, lycopene, polyphenols, tomato sauces, vegetables and aromatic herbs

1. INTRODUCTION

The Mediterranean Diet (Med Diet) is based on the daily consumption of fresh vegetables, aromatic herbs, whole grains and extra virgin olive oil (EVOO), cooked quickly to conserve the molecular integrity of their nutrients (BERTUCCIOLI and NINFALI, 2014). Indeed, most of the beneficial effects of the Med Diet stem from the high level of vitamins, carotenoids and in particular polyphenols, found in homemade Mediterranean cuisine (DRAGSTED, 2003).

Soffritto (sauté) is the Italian word that perfectly describes the process of gently cooking vegetables in oil to soften them and release their flavours. During the preparation of a sauté, onions, garlic, celery and carrots are chopped and gently sautéed in extra virgin olive oil (EVOO) for some minutes. The addition of the tomato (*Solanum lycopersicum*) sauce is another important step in the preparation. Forty polyphenols and seven carotenoids have been identified in a typical Med Diet tomato sauce, whose composition has attracted the interest of food professionals for its nutritional and chemo preventive value (MARTÍ *et al.*, 2016; SHEN *et al.*, 2007; VALLVERDÚ-QUERALT *et al.*, 2013).

Tomatoes contain several micronutrients, including vitamin C, vitamin E, folates, phenolic compounds and lycopene (VALLVERDÚ-QUERALT *et al.*, 2012).

Beyond differences in their nutritional contents, due to the tomato cultivar and agronomic conditions, the antioxidant compounds and lycopene concentration found in processed tomato products is markedly affected by the average maturity stage of the bulk of processed tomatoes (COOPERSTONE *et al.*, 2015; GHASEMZADEH *et al.*, 2016; GÓMEZ *et al.*, 2001; GUINE and GONCALVES, 2016; RAFFO *et al.*, 2002; ZANFINI *et al.*, 2016).

In the Med Diet tomato sauce, the addition of aromatic herbs, mainly basil, oregano and marjoram, near the end of the cooking represents an important step able to enhance its taste and flavor (GUINE and GONCALVES, 2016). Basil (*Ocimum basilicum*) contains more than 200 bioactive compounds, including monoterpenes, phenolic acids, steroids, vitamins (A, C, E, K) and flavonoids (GHASEMZADEH *et al.*, 2016). Oregano (*Origanum virens*) mainly contains carvacrol, cinnamaldehyde and essential oils and marjoram (*Origanum marjorana*) is rich in phenolic acids, flavonoids and essential oils (GUINE and GONCALVES, 2016).

The Med Diet tomato sauce may play a key role in conferring higher antioxidant activity to the pasta dish. Antioxidant activity is an important parameter in assessing the quality of products, as it measures the global antioxidant system of the product and appears to be closely related to the prevention of oxidative stress linked diseases (GHISELLI *et al.*, 2000).

Pasta is the popular worldwide product made with durum wheat semolina. Remarkable total antioxidant capacity is attained when pasta is made with whole grain flour, due to the higher polyphenol content of whole grains compared to refined wheat (ANTONINI *et al.*, 2017; LIU, 2007).

The aim of this study was to evaluate the polyphenol, ORAC and lycopene values of four homemade tomato sauces containing EVOO, fresh vegetables, tomato puree, and different types of aromatic herbs. These homemade sauces were compared with their commercially available industrially produced counterparts. Whole wheat pasta was compared with refined wheat pasta, to rank their respective polyphenol and ORAC values.

2. MATERIALS AND METHODS

2.1. Chemicals

Folin-Ciocalteu reagent, Trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid), AAPH (2,20-Azobis(2-methylpropionamide) dihydrochloride), fluorescein (2-(3-hydroxy-6-keto-xanthen-9-yl)benzoic acid) and caffeic acid were purchased from Sigma-Aldrich, Inc. (St. Louis, MO, USA). Sodium carbonate (Na_2CO_3) was supplied by Carlo Erba Reagents (Milano, MI, Italy). Acetone, ethanol, ethylacetate, methanol, n-hexane were purchased from VWR International Inc. (Radnor, PA, USA).

2.2. Samples

Fresh vegetables, garlic (cv. *Aglio bianco*), celery (cv. *Plein Blanc Pascal*), carrots (cv. *Flakkè 2*), onions (dorata cv. *Dorata di Parma*; tropea cv. *Tropea Rossa Tonda Record*; suasa cv. *Cipolla di Suasa*), aromatic herbs (basil, oregano and marjoram), tomato puree (glass bottle, 750 g) and sunflower seed oil (plastic bottle, 1 l) were purchased from the local supermarket. Artisanal EVOO (cv. *Coratina*) was supplied by a producer from Apulia.

2.3. Chemical quality parameters of EVOO

Regarding the chemical quality parameters of EVOO, free acidity (given as % of oleic acid) and peroxide values (meqO_2/kg of oil) were evaluated according to the European Economic Community Regulation no. 2568/91 and its later modifications (EEC, 1991).

2.4. Homemade tomato sauce preparation

The sauces were prepared as follows (portions for 4 people).

Sauce 1. EVOO (30 g), onion (dorata, 50 g), celery (25 g), carrots (25 g), garlic (2 g). The mixture was heated 10 min at 180°C , tomato puree (180 g) was then added and cooked for an additional 10 min.

Sauce 2. The same steps and ingredients as *sauce 1* with the addition of basil (2 g), which was added at the same time as the tomato puree.

Sauce 3. The same steps and ingredients as *sauce 1* with the addition of oregano (2 g), which was added at the same time as the tomato puree.

Sauce 4. The same steps and ingredients as *sauce 1* with the addition of marjoram (2 g), which was added at the same time as the tomato puree.

The sauces were cooked on electric or gas heating plates and the temperature was controlled by a thermometer. The evaporation of the water reduced the weigh from about 300 g to 200 g, thus allowing the dressing of 4 pasta dishes.

Eight samples of industrially produced sauces were purchased at a local supermarket. Average composition was: tomato pulp (75%), tomato concentrate, onion, olive or seed oil, basil (2%), carrots, sugar, salt, celery, natural basil aromas.

Refined wheat pasta (RWP) was purchased from the local supermarket, whereas whole wheat pasta (WWP) was made by a local producer with whole grain (*Triticum durum*, cv. *Odisseo*), milled with a stone mill (sifting rate 15%), extruded using bronze dies and dried at 45°C .

Table 1 shows the nutritional data of RWP and WWP, as reported by the manufacture's indications, as well as those of sauce 1 obtained with a nutritional software.

Table 1. Macronutrient composition and fiber in the typical Med Diet pasta dish.

Nutritional data per serving*	Sauce 1 (50 g)	RWP (80 g)	WWP (80 g)	Sauce 1 (50 g) + RWP (80 g)	Sauce 1 (50 g) + WWP (80 g)
Energy (kcal)	55	282	259	337	314
Carbohydrates (g)	1.8	63.3	53.0	65.1	54.8
Proteins (g)	0.6	8.7	10.7	9.3	11.3
Lipids (g)	5.1	1.1	2.0	6.2	7.1
Fiber (g)	0.8	2.2	5.1	3.0	5.9

*Per serving: 50 g of Sauce 1; 80 g of RWP or WWP. RWP, refined wheat pasta; WWP, whole wheat pasta.

2.5. Lycopene extraction and assay

The lycopene analysis was performed as previously described (DAVIS *et al.*, 2003; PERIAGO *et al.*, 2004), with some modifications. Briefly, 2 g of sauce was mixed with 4 mL of distilled water and homogenized for 5 min with a Potter homogenizer. Then 1 g of homogenate was extracted with 20 mL of hexane:acetone:ethanol (2:1:1) mixture. The solution was shaken for 10 min and then centrifuged at 1800 × g at 5°C for 10 min. The absorbance of the supernatant was measured at 472 nm. A calibration curve was prepared with lycopene pure powder (Sigma-Aldrich Inc., St. Louis, MO, USA). Values were expressed as mg of lycopene per 100 g of sauce.

2.6. Extraction of polyphenols from vegetables and sauces

This analysis was performed following the procedure previously described (AGBOR *et al.*, 2014), with some modifications. Each sample (11 g) was homogenized with the Potter homogenizer. Then 0.5 g of homogenate was added to 8 mL of 50% methanol/water containing 1.2 M HCl. The sample was heated for 2h at 95°C and then centrifuged at 1000 × g at 5°C for 10 min. The supernatant (SN1) was brought to 10 mL with distilled water. 2M NaOH (8 mL) was added to the pellet and the mixture was shaken for 2 h at room temperature and centrifuged at 1000 × g at 5°C for 10 min.

The supernatant (SN2) was transferred into a flask and brought to 10 mL with distilled water. Both supernatants were combined (SN1 + SN2), and this solution (20 mL) was used for the total polyphenol and antioxidant capacity determination.

2.7. Extraction of polyphenols from oils

This analysis was performed as previously reported (ANTONINI *et al.*, 2016a). Briefly, the oil sample (3 g) was mixed with 5 mL of 80% methanol. The solution was vortexed for 2 min and then centrifuged at 1000 × g at 5°C for 10 min.

The supernatant was transferred into a Falcon tube at 4°C. The extraction was repeated twice, and the two supernatants were combined and preserved for the polyphenol and antioxidant capacity assay.

2.8. Extraction of polyphenols from raw and cooked pasta

Whole wheat pasta (WWP) and refined wheat pasta (RWP) samples (80 g) were cooked for 10 min in 2 L of boiling water. Raw and cooked pasta was freeze-dried and milled in a ZM 200 ultracentrifugal mill with a 0.5 ring sieve (Retsch, Haan, Germany). Free and bound

polyphenols were extracted from the freeze dried material as previously reported (ANTONINI *et al.*, 2016b). The extracts were used for polyphenol and antioxidant capacity assays.

2.9. Polyphenols assay

The phenol compounds were assayed using the Folin-Ciocalteu method, as previously reported (SINGLETON *et al.*, 1999). The absorbance of the mixture was measured at 725 nm. A calibration curve was prepared with caffeic acid (Sigma-Aldrich Inc., St. Louis, MO, USA).

For vegetables, polyphenol values were expressed as mg/100 g of fresh weight; for oils, as mg/kg; for sauce, as mg/100g of product. For raw and cooked pasta, total phenol values were obtained by the sum of free + bound phenols and expressed as mg/80 g dry weight (d.w.). Moisture was determined in the raw and cooked pasta using a thermal balance (Sartorius MA 40, Gottingen, Germany) after drying at 120°C to constant weight.

2.10. Oxygen Radical Absorbance Capacity (ORAC) assay

The antioxidant capacity of phenols was determined by the ORAC method (NINFALI *et al.*, 2005; PRIOR *et al.*, 2003), using a Fluostar Optima plate reader fluorimeter (BMG Labtech, Offenburgh, Germany) equipped with a temperature-controlled incubation chamber and an automatic injection pump. The incubator temperature was set at 37°C.

The following mix was used for the hydrophilic ORAC (H-ORAC): 200 μ l of 0.096 μ M fluorescein sodium salt in 0.075 M Na-phosphate buffer (pH 7.0), 20 μ l of sample or Trolox. The reaction was initiated with 40 μ l of 0.33 M AAPH. The blank was 0.075 M Na-phosphate buffer (pH 7.0). Fluorescence was read at 485 nm ex. and 520 nm em. until complete extinction (NINFALI *et al.*, 2005). A calibration curve was made each time with the standard Trolox in 0.075 M Na-phosphate buffer (pH 7.0).

The lipophilic ORAC (L-ORAC) for the antioxidant contribution of lycopene and liposoluble vitamins was measured as follows. The sauce was extracted with hexane (1:5 w/v) twice. After centrifugation at 1800 \times g for 10 min, the supernatants were combined and dried under nitrogen flow, then re-suspended in 1 mL of 50% acetone, which was mixed with 7 mL of 7% hydroxypropyl β -cyclodextrin (Kleptose HP oral grade, Roquette, France) in 50% acetone (OU *et al.*, 2013). After the incorporation of the lipophylic extract into the β -cyclodextrins by rotating overnight in the dark, the solution was centrifuged and read with the Fluostar Optima plate reader fluorimeter, with the same reaction mixture of the H-ORAC and the blank with 20 μ l of 7% β -cyclodextrins in 50% acetone, diluted with phosphate buffer. A calibration curve was made each time with the standard Trolox in β -cyclodextrins.

For vegetables, ORAC values were expressed as μ mol Trolox Equivalent (TE)/100 g of fresh weight; for oils, as μ mol TE/kg; for sauce, as μ mol TE/100g of product. For raw and cooked pasta, total ORAC (free + bound phenols) values were expressed as μ mol TE/80 g d.w.

2.11. Statistical analysis

The chemical parameters of oils were detected in triplicate and values were expressed as the mean \pm SD. Polyphenol and lycopene concentrations were measured in triplicate and results were the mean \pm SD. ORAC data were obtained by eight independent determinations for each sample and results were the mean \pm SD. Statistical significance was

tested using Student's *t* test and one-way ANOVA, with a $p \leq 0.05$ indicating a significant difference between data sets (SPSS®17.0 software, IBM, Chicago, IL, USA).

3. RESULTS AND DISCUSSIONS

3.1. Antioxidant content and activity of raw and sautéed vegetables

We first investigated the total phenols and antioxidant capacity of the individual vegetables after they had been sautéed for 10 min in EVOO to assess how each vegetable was stable during the sautéing process. Results are reported in Fig. 1.

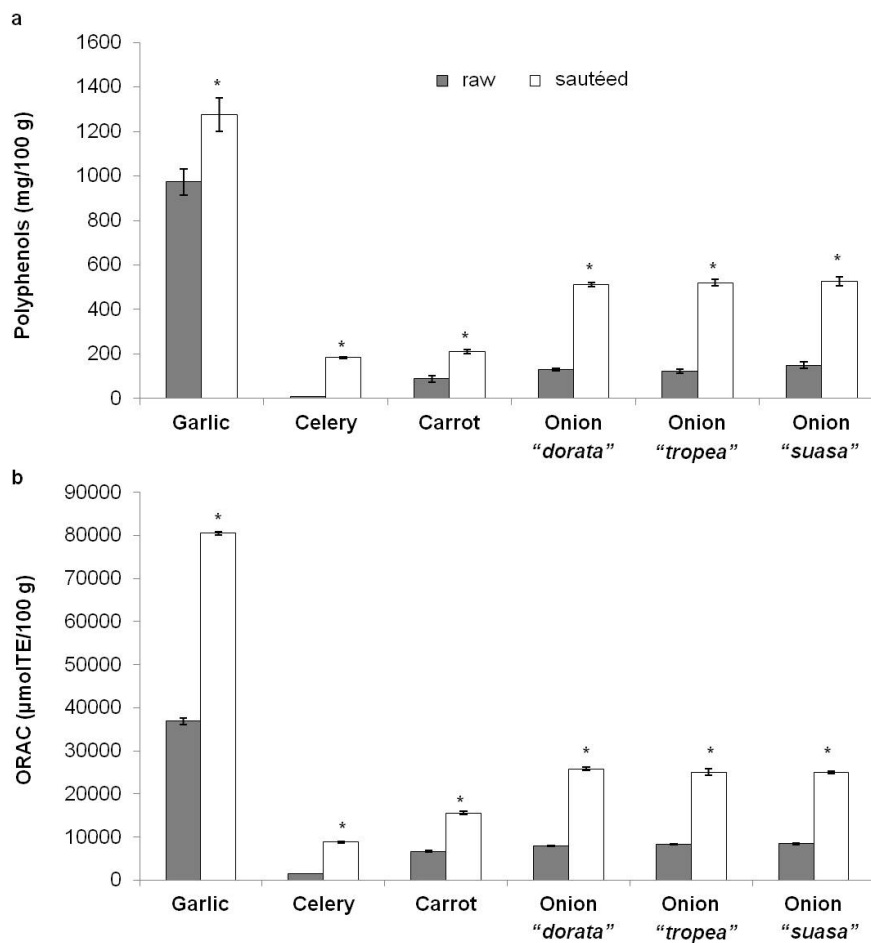


Figure 1. Polyphenols (a) and antioxidant capacity (b) in raw and EVOO sautéed vegetables. The cooking time was 10 min at $180 \pm 5^\circ\text{C}$.

(*) indicates statistically significant differences ($p \leq 0.05$) between raw and sautéed vegetables (Student's *t* test).

After the vegetables had been sautéed in EVOO and placed on filter paper for few minutes to get rid of excess oil, their total phenols (Fig. 1a), as well as their antioxidant capacity (Fig. 1b), increased remarkably compared to their raw values. The increase was due to the penetration of the oil into the vegetable tissues and the evaporation of the water from

those tissues. Moreover, the polyphenols bound to the fiber were freed by the thermal disruption of chemical bonds and new molecules, including Maillard products, may have been formed (FRATI *et al.*, 2016; NICOLI *et al.*, 1999; SANTOS *et al.*, 2013).

In the three sautéed onion cultivars (dorata, tropea, suasa), there was an average increase of 70% in polyphenols and ORAC values compared to raw values, but no statistically significant difference between the three cultivars was observed (Fig. 1).

As onion is the major vegetable in the soffritto, possibly the study of other genetic varieties would be an important issue, for increasing the antioxidants in the sauté.

3.2. Chemical and antioxidant parameters in EVOO and seed oil after cooking

In line with the best tradition of the Med Diet, we only used EVOO for sautéing the vegetable mixture. However, as many people and many industrial companies use seed oil, we analyzed the chemical modifications of the EVOO in comparison with sunflower seed oil after sautéing in the absence or in the presence of the vegetable mixture.

Table 2 shows the quality parameters of oils: acidity, peroxide number, polyphenols and ORAC.

Table 2. Quality parameters of raw and sautéed EVOO and sunflower seed oil in the presence or in the absence of the vegetable mixture.

	Acidity (% oleic acid)	Peroxide number (mEqO ₂ /kg)	Polyphenols (mg/kg)	ORAC (μmolTE/kg)
EVOO				
Raw	0.68±0.05 ^a	5.01±0.47 ^c	360±20 ^a	15,600±940 ^a
Sautéed alone [†]	0.66±0.07 ^a	22.17±1.02 ^a	200±11 ^c	8,580±500 ^c
Sautéed with vegetables [‡]	0.60±0.05 ^a	10.02±0.98 ^b	250±15 ^b	9,900±600 ^b
Sunflower seed oil				
Raw	0.11±0.02 ^b	1.02±0.14 ^c	20±0.3 ^a	678±40 ^a
Sautéed alone [†]	0.22±0.03 ^a	38.47±2.90 ^a	3.0±0.5 ^c	68±4 ^c
Sautéed with vegetables [‡]	0.18±0.04 ^a	27.61±3.11 ^b	8.0±0.4 ^b	151±14 ^b

^{a-c}Different letters indicate, for each quality parameter, statistically significant differences among raw, sautéed alone or sautéed with vegetables EVOO or sunflower seed oil ($p \leq 0.05$; one-way ANOVA). [†]EVOO or sunflower seed oil were sautéed 15 min at 180±5°C in the absence of vegetables; [‡]EVOO or sunflower seed oil were sautéed 15 min at 180±5°C in the presence of the vegetable mixture (the same used to prepare the homemade tomato sauce: onion, celery, carrots and garlic).

The acidity of raw sunflower seed oil was comparatively smaller than that of raw EVOO, due to the neutralization step during refining (CASAL *et al.*, 2010). Nevertheless, in the sautéed EVOO, the acidity remained unchanged, whereas it increased in the sautéed sunflower seed oil (Table 2).

Concerning the peroxide number, Table 2 shows that the thermal treatment led to a moderate increase in the EVOO and a marked increase in the sunflower seed oil, due to the high polyunsaturated fatty acid concentration in the latter, highly susceptible to the oxidation (CASAL *et al.*, 2010). Moreover, the vegetables protected the oils from oxidation, limiting the increase of the peroxide number, with respect to the oils sautéed alone (Table 2).

A similar trend was obtained for polyphenols and ORAC values, as the vegetables protected the oils from the decay of the two parameters during the thermal treatment (Table 2).

Therefore, the EVOO remains the preferred option for making sauces for three main reasons: 1) Higher concentration of polyphenols (NINFALI *et al.*, 2002); 2) Reduced phenol and ORAC losses in the presence of the vegetables; 3) Higher stability of the peroxide index.

3.3. Homemade and commercial tomato sauces and lycopene values

After the addition of the tomato puree to the fried vegetables, we evaluated total ORAC, including both hydrophilic (H-ORAC) and lipophilic (L-ORAC) fraction, the polyphenol and lycopene values of the homemade (sauces 1-4) and industrially produced (commercial) sauces. Results are reported in Table 3.

Table 3. Polyphenols, antioxidant capacity and lycopene in homemade and commercial sauces.

	Polyphenols (mg/100 g)	H-ORAC	L-ORAC ($\mu\text{molTE}/100\text{ g}$)	Total ORAC	Lycopene (mg/100 g)
Sauce 1	207 \pm 9 ^c	10,184 \pm 509 ^c	886 \pm 44 ^c	11,070 \pm 303 ^c	18.72 \pm 1.12 ^a
Sauce 2	298 \pm 8 ^a	16,216 \pm 811 ^a	1,604 \pm 80 ^a	17,820 \pm 730 ^a	21.22 \pm 1.27 ^a
Sauce 3	250 \pm 12 ^b	13,800 \pm 690 ^b	1,200 \pm 110 ^b	15,000 \pm 403 ^b	17.92 \pm 1.43 ^a
Sauce 4	274 \pm 13 ^b	13,431 \pm 671 ^b	1,011 \pm 85 ^b	14,442 \pm 397 ^b	18.45 \pm 1.66 ^a
Commercial	134 \pm 18 ^d	6,595 \pm 330 ^d	573 \pm 29 ^d	7,168 \pm 353 ^d	13.70 \pm 1.20 ^b

^{a-d}Different letters indicate statistically significant differences among samples ($p \leq 0.05$; one-way ANOVA). Commercial values are the average of 8 commercial ready-to-eat sauces; H-ORAC, hydrophilic ORAC; L-ORAC, lipophilic ORAC; Total ORAC, given by the sum of H- and L-ORAC.

The addition of tomato puree to the sautéed vegetables confers to the sauces many powerful antioxidants, including flavonoids present in the tomato puree (VALLVERDÚ-QUERALT *et al.*, 2012), as well as lycopene, which largely contributes to the lipophilic antioxidant capacity (L-ORAC) (CANO *et al.*, 2003).

The H-ORAC, which correlates to the ascorbic acid content (CANO *et al.*, 2003), contributed to the highest antioxidant capacity (Table 3), representing more than 90% of total ORAC (WU *et al.*, 2004).

Regarding the lycopene content, no statistically significant difference was observed among the homemade sauces ($p > 0.05$) (Table 3).

All of the aromatic herbs, namely basil, oregano, and marjoram, increased the polyphenol and antioxidant capacity values of the tomato sauce, with the sauce 2, with basil, showing the highest polyphenol and total ORAC values (Table 3). Basil leaves were found to yield the highest increase, possibly due to the herb's high phenol and flavonoid contents (GUINE and GONCALVES, 2016; NINFALI *et al.*, 2005).

The commercial sauces had significantly lower polyphenol, ORAC and lycopene values than do homemade sauces (Table 3). Although only eight commercial samples were assessed, our data show that homemade sauces have greater nutritional value than do their store-bought counterparts. The lower nutritional value of commercial sauces may be due to the use of seed oil instead of EVOO, non homogeneously ripened fruits, concentrated ingredients stored for long periods, rough processing technologies in the sauce preparation (NINFALI and BACCHIOCCA, 2004).

Hence, the ability to make homemade tomato sauces using fresh vegetables and aromatic herbs is part of the cultural background and has important health implications (HOFFMAN and GERBER, 2015; PRIOR *et al.*, 2007; VALUSSI, 2012).

The experiences linked to the Food Literacy Project (<https://dining.harvard.edu/food-literacy-project>), promoted by the Harvard University and the Lifelong Learning by the European Union Commission, are focused on the increase of the consumers' consciousness in the culinary practices and sustainable nutrition. In this light, Table 4 summarizes the best ways to select, cook and store the vegetables to be used in the homemade sauce.

3.4. Antioxidants in pasta with tomato sauce

Fig. 2 shows the concentration of free and bound polyphenols (Fig. 2a) and ORAC (Fig. 2b) values in whole wheat pasta (WWP) and refined wheat pasta (RWP), under raw or cooked conditions.

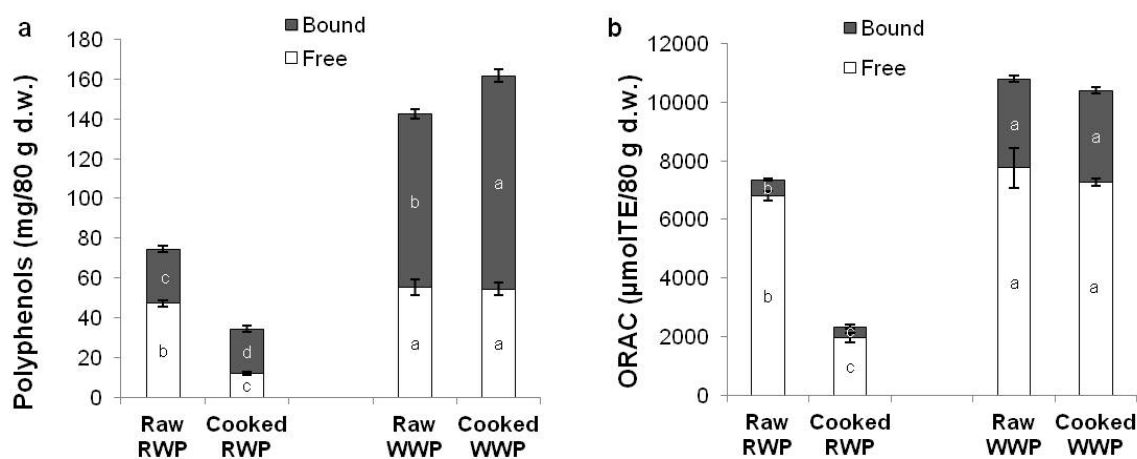


Figure 2. Free and bound polyphenols (a) and antioxidant capacity (b) in raw and cooked whole wheat pasta (WWP) and refined wheat pasta (RWP). Polyphenol values are expressed as mg/80 g of raw and cooked pasta, on dry weight (d.w.). ORAC values are expressed as µmol of Trolox equivalents (TE)/80 g of raw and cooked pasta, on d.w.

a,b Different letters indicate statistically significant differences among raw and cooked RWP and WWP ($p \leq 0.05$, Student's *t* test), for each component (free and bound).

Given that the average portion per meal, for a healthy adult, is 80 g of pasta (http://www.sinu.it/public/20141111_LARN_Porzioni.pdf), the values are reported per serving of raw and cooked pasta, on dry weight.

Concerning the raw pasta, WWP showed significantly higher total polyphenol (Fig. 2a) and ORAC (Fig. 2b) values than RWP. When the free and bound polyphenols were compared, the bound were predominant in WWP with respect to RWP, due to the loss of polyphenols in the refining process (ANTONINI *et al.*, 2017; PANATO *et al.*, 2017).

After cooking, total polyphenols and ORAC values remained almost unchanged in the WWP, whereas they were reduced by 50 and 70%, respectively, in the RWP. In the cooked RWP, the free polyphenols and ORAC were markedly reduced, as compared to the bound ones (Fig. 2). This aspect is linked to the presence of the fiber which preserve the polyphenols during cooking (LIU, 2007).

Table 4. Nutritional values of sauce ingredients with guidelines regarding their selection, storage and cooking.

Vegetable/ Aromatic herb	Main antioxidants	Heat resistance	Freshness index	Seasonality	Storage	References
Carrot	Carotenoids, hydroxycinnamic acids, anthocyanidins, vitamin C	β -carotene is heat resistant and becomes more bioavailable through cooking in oil	Roots should be firm, smooth, bright in color	All year	Up to two weeks if stored without leaves in the refrigerator	(LEMMENS <i>et al.</i> , 2011) (SELJÅSEN <i>et al.</i> , 2013)
Celery	Phenolic acids, flavonoids, stilbenoids, furanocoumarins, phytosterols, vitamin C, β -carotene	Heat for as little time as possible (5-15 min)	Crisp, tight and compact, stalks with pale bright green leaves	All year	Fresh for 5-7 days in the refrigerator	(YAO <i>et al.</i> , 2011) (OVODOVA <i>et al.</i> , 2009)
Garlic	Allicin (thiosulfinate)	Heat for as little time as possible (5-15 min)	Plump with unbroken skin	All year	Fresh for 1 month stored in a cool, dark place	(MARTINS <i>et al.</i> , 2016)
Onion	Quercetin, vitamin C	Heat for as little time as possible (5-15 min)	Well shaped, no opening at the neck, with crisp, dry outer layer of skin	All year	Fresh for four weeks in a dark ventilated space at room temperature	(BYSTRICKÁ <i>et al.</i> , 2013)
Tomato	Lycopene, β -carotene, hydroxycinnamic acids, flavonoids, vitamin C and E, folate	Lycopene is heat resistant and-becomes more bioavailable through cooking in oil	Red, well shaped and smooth skinned	From May to September	Up to two weeks at room temperature and out of direct exposure to sunlight, depending on ripeness	(GÓMEZ <i>et al.</i> , 2016) (VALLVERDÚ-QUERALT <i>et al.</i> , 2012)
Basil	Phenolic acids, flavonoids, β -carotene, vitamins (A,C,E,K) essential oils	Add near the end of the cooking to retain its maximum essence and flavor	The leaves should be deep green in color	In the summer	Fresh, wrapped in a paper towel in the refrigerator; dried, in a sealed glass container in a cool, dark place	(GHASEMZADEH <i>et al.</i> , 2016; LEE <i>et al.</i> , 2005)
Oregano	Carvacrol, cinnamaldehyde, essential oil	Add fresh near the end of the cooking; at the beginning if dried	Firm stems with fresh leaves, green in color	All year	Fresh, wrapped in a paper towel in the refrigerator; dried, in a sealed glass container in a cool, dark place	(TEIXEIRA <i>et al.</i> , 2013) (GUINE and GONCALVES, 2016)
Marjoram				See oregano		

4. CONCLUSIONS

This study focuses on the contribution in terms of phenols, antioxidant capacity and lycopene of homemade tomato sauce, a staple of the Med Diet.

For the sake of transparency, the food industry, which produces ready-made sauces, should rank the quality of the ingredients used in their sauces, as well as the impact of industrial processing technologies, used in their production by measuring polyphenols and antioxidant capacity before and after processing.

The main nutritional suggestions of this study are the followings:

- a) Use EVOO instead of seed oil to increase the phenol contribute;
- b) Use short cooking time: about 10 min are sufficient to allow the oil to make free the phenols of vegetables;
- c) Add fresh vegetables and brilliant red tomato sauce with high lycopene concentration;
- d) Add aromatic herbs near to the end of cooking to increase the antioxidant capacity of the basic tomato sauce;
- e) Use whole wheat pasta, which has greater polyphenols and antioxidant capacity than refined wheat pasta and dress it with a 1:2 ratio of sauce/pasta.

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