

The Emerging Health Attributes of the Mediterranean Diet and Olive Oil



INTRODUCTION

Eating a Mediterranean diet (MD)¹ is a tasty way to promote health and wellness. The first caveat that many health and nutrition researchers will make when discussing and presenting their research is that further research is needed to make absolute conclusions. The qualification also applies to the research summarized in the following narrative. Acknowledging that, a significant body of science supports that the MD and olive oil as a key ingredient in this diet offer significant health benefits. Along with other lifestyle factors, including exercise and weight loss and/or management, dietary patterns can promote healthy aging, all of which can prevent, manage and delay the onslaught of symptoms associated with age-related chronic diseases.

Compared to many other fat sources, olive oil is a good fat that protects human health through many different mechanisms, including anti-inflammatory action. Chronic inflammation is implicated in a wide range of health conditions, ranging from cardiovascular disease, cancer, diabetes, metabolic syndrome and neurological disorders. In addition to potent anti-inflammatory properties, the MD is emerging as a powerful weapon to improve several brain functions, early brain development, neurodegenerative disorders and some psychiatric diseases. Studies also maintain that the MD improves quality of life, most notably physical and mental health.

MAKING SENSE OF FATS – THE GOOD, THE BAD AND THE UGLY

Understanding nutrition and dietary recommendations can be challenging. Perhaps no area is more confusing than the knowledge about fats. Their effects on health are complex, and consumers are deluged with conflicting dietary information. In the United States and Canada, the widespread demonization of fats was interpreted by many as a call to eliminate all fats from the diet. This led to the production of many low-fat and fat-free foods, often loaded with heavily processed flours and sugars. Substituting all fats with highly refined carbohydrates didn't improve health and has, in fact, helped to fuel metabolic disorders as well as the rising obesity epidemic.

As nutrition science has become more developed, new information has emerged about fats and health. Not all fats are unhealthy; the quality and quantity of fats consumed are significant in determining their role in diet and overall health. While all fats are mixtures of saturated, monounsaturated and polyunsaturated fatty acids, it is the proportion of fatty acids in a given fat that matters. Fats are necessary for heart, brain and neurologic health and other functions of the body. They are critical to absorption of important fat-soluble vitamins E, D, A and K as well as carotenoids. Depending upon age, health status, level of activity and other factors, total fat should comprise 20 to 35 percent of daily caloric intake. All fats have roughly the same calories (9 kcal/gram), but there are good/healthy fats² (monounsaturated and polyunsaturated fats), bad fats (saturated fats) and “ugly fats” (trans fats). While many consumers don't understand the abundant information about monounsaturated (MUFA), polyunsaturated (PUFA) and saturated fatty acids (SFA), they do understand that trans fatty acids (TFA) have detrimental effects on human health.



Trans fats are found in small amounts in animal foods, but man-made trans fats are especially harmful. The latter are manufactured by adding hydrogen to some vegetable oils to make solid fats. Because this process (hydrogenation) increases the stability and shelf life of foods, the food industry liked it; however, scientific evidence underscores trans fats' similar deleterious health effects as saturated fats, including promoting chronic inflammation, raising LDL (bad) cholesterol and decreasing HDL (good) cholesterol and increasing triglycerides. Research shows that trans fats damage health, particularly with respect to cardiovascular disease. The food industry has responded by dramatically reducing and removing trans fatty acids in many foods, but content still varies in processed foods.

Recent research confirms the harmful effects of saturated fats. In fact, current recommendations are to limit saturated fat to less than seven percent of daily caloric intake.³ Solid at room temperature, saturated fats are found in animal sources like meat, dairy and eggs as well as plant sources: coconut, palm and palm kernel oil. For health promotion and disease prevention, consumers are urged to replace SFA with MUFA (olive oil).

Polyunsaturated fats are found in fatty fish and oils, including safflower, corn and canola. Omega-6, linoleic acid (LA), and omega-3 are the main types of PUFA. Omega-3s are further broken down into three categories: Alpha-linolenic acid (ALA), Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA). ALA is found in plants, legumes, nuts, and seeds and their oils. Fatty fish are a rich source of EPA and DHA that are critical to heart health. DHA also is critical for prenatal and child brains, nerves and eyes. Omega-3 and omega-6 are considered essential fatty acids (EFA) because the body cannot produce them on their own, and they need to be consumed from dietary sources but in limited quantities (up to five percent of daily caloric intake).

Before people ate so much heavily processed food, many consumed almost equal amounts of omega-3 and -6; however, many North Americans now eat as much as 20 to 40 times more omega-6 than omega-3. Some experts contend that this dietary imbalance accounts for the increased rates of cardiovascular disease, some forms of cancer and neurological disease. Others believe that this imbalance is also partly responsible for obesity, depression and other

psychiatric illnesses. Those who are concerned with this imbalance argue that by consuming such a disproportionately high rate of omega-6 the body is more likely to be in a pro-inflammatory state and at higher risk for many chronic illnesses. More research is needed. While the science is conflicting, and there is disagreement about whether there is an ideal healthy ratio (1:4 omega-3:omega-6 is the most accepted), there is general agreement that North Americans need to consume more omega-3s and fewer omega-6s.

While not an EFA, omega-9 nevertheless plays a critical role in health. Omega-9, also known as oleic acid, is a MUFA. Oleic acid's positive effects on cardiovascular disease (CVD), diabetes and cancer have been the subjects of considerable research.⁴ Comprised of 55 to 85 percent oleic acid and very low in saturated fat, olive oil is one of the best dietary sources of omega-9. Emerging research points to oleic acid's role in reducing cognitive decline and neurological disease. Research has also suggested that olive oil MUFAs not only don't tip the balance of omega-3 to omega-6, they may even improve the ratio and help the body absorb more omega-3.⁵

Recently, more people have come to appreciate good fats and olive oil; however there is still widespread confusion about fats. The International Food Information Council (IFIC) recently released the findings of a survey on food and health. A large majority of the U.S. population understands that different fats can have different impacts on health; only 22 percent believe all fats are the same. Nevertheless, people are still confused about fats in their diets. Specifically, 49 percent of those surveyed said they avoid trans fats and 47 percent avoid saturated fats but 32 percent also limit or entirely avoid consumption of healthy mono- and polyunsaturated fats.⁶

While people may not fully comprehend MUFA benefits, there seems to be general awareness that olive oil is good for you, but some don't fully utilize its versatility. Olive oil can be used in salad dressings, dipping and even in sautéing, baking and deep-frying, although the smoke point should be considered (the smoke point is the temperature when an oil starts to break down and smoke). The smoke point for olive oil is about 468°F (242°C), which is higher than cottonseed oil, soybean oil, grape seed oil, canola oil, peanut oil, sunflower oil, refined corn oil, sesame seed oil, refined peanut oil, refined safflower oil, lard and

butter.⁷ The smoke point for extra virgin olive oil is 410°F (210°C). Because the temperature for pan-frying is normally between 350°–375°F (177–191°C) both olive oil and extra virgin olive oil are suitable for frying.⁸ Due to the content of antioxidants and high oleic acid content, olive oil is stable to the thermic degradation and can be used several times.⁹ Furthermore, Europeans have been using olive oil for deep-frying for centuries. Deep-frying in olive oil is healthier than in many other types of oil. Research published in the *British Medical Journal* analyzed eating patterns in Spain for more than 40,000 individuals for 11 years. People who regularly ate food deep-fried in olive oil or sunflower oil¹⁰ had no higher rates of heart disease than those who didn't consume fried food.¹¹ Fried food is high in calories and should be eaten in moderation, but if people choose to eat it, then preparing it in olive oil is a healthier alternative.

Olive oil makes its greatest contribution as an ingredient of a healthy plant-based diet. The synergistic effect of complex mixtures of phytonutrients in whole foods is responsible for their most potent bioactive properties. New research has found that MUFA in the MD are particularly effective in facilitating the absorption of nutrients in salads. Scientists investigated how different salad dressings affect fat-soluble vitamin compounds, especially carotenoids associated with reduced risk of several chronic and degenerative diseases such as cardiovascular disease and cancer. The study was carried out by giving 29 people salad dressing with either saturated, polyunsaturated or monounsaturated fat. The subjects' blood was then tested for absorption of fat-soluble compounds. All of the fats facilitated carotenoid absorption, but the monounsaturated fat required the least amount of fat for the most absorption. Subjects had to consume a larger quantity of saturated or polyunsaturated fat to match the carotenoid absorption mediated by MUFA.¹²

Olive oil in the MD helps promote healthy aging and is increasingly emerging as a powerful weapon against inflammation, cognitive and motor function decline, as well as protection against several neurological illnesses. Scientific evidence is growing that the positive attributes of olive oil in the MD are not only due to oleic acid but also phenolic compounds in olive oil and other foods, especially vegetables, fruit and nuts. The main polyphenol in olive oil, hydroxytyrosol, has been associated with anti-inflammatory, antioxidant, antiviral and antibacterial properties.

Olive Oil and Inflammation

Inflammation is the body's first response to an illness or injury and is a process whereby the body's white blood cells and chemicals help prevent infection, bacteria and viruses. Acute inflammation is the basis of a healthy immune system and the crucial first step in fighting infection and healing wounds. However, when inflammation is continuously activated, otherwise known as chronic inflammation, people are more susceptible to chronic disease and illness. Chronic inflammation disrupts normal functions of cells and is usually silent, invisible and persistent. Many diseases are associated with chronic low-grade inflammation triggered and sustained by oxidative stress.

Some causes of chronic inflammation are environmental pollutants, genetic predisposition and lifestyle factors. Poor diet, chronic stress, lack of sleep and smoking promote inflammation. All age-related diseases, including cardiovascular disease, diabetes and cancer, have their roots in inflammation. Vascular disease begins as an inflammatory process and Alzheimer's disease results from inflammation of the brain. A traditional Mediterranean dietary pattern typically has a high ratio of oleic acid to SFA and omega-3 to omega-6. The MD is also characterized by consuming an abundance of fish, fruits, vegetables, legumes and nuts. This diet has shown anti-inflammatory properties. Conversely, a typical Western diet high in saturated and trans fats, low in fruit and vegetables, and high in refined grains and sugar is pro-inflammatory.

Diet can help in preventing or managing illnesses related to inflammation, particularly with respect to cardiovascular health. Researchers in Italy studied the diets of 131 healthy adults, and rated each person's diet for overall adherence to a MD. Using a MD score, they tested subjects' blood for cholesterol and triglycerides, antioxidant levels, immune system function and oxidative stress. They found that those who had a higher MD score had less inflammation, reduced oxidative stress, and higher circulating levels of antioxidants, all factors associated with reduced risk of disease.¹³

The mechanisms by which olive oil affects inflammation are not fully understood, but research supports that phenolic compounds in the oil modify genes involved in the inflammatory response. One of the studies that confirmed the nutrigenomic¹⁴

effects of olive oil analyzed 20 people with metabolic syndrome. The subjects ate breakfast food that included either extra virgin olive oil (high in polyphenols) or virgin olive oil (low in polyphenols). The expression of 79 pro-inflammatory genes was much lower in those who ate the extra virgin olive oil. In those who ate the extra virgin olive oil, the expression of 19 anti-inflammatory genes was also much higher. Many of the 98 genes that were affected positively by extra virgin olive oil are closely associated with an increased risk of cardiovascular disease and diabetes.¹⁵ This particular study was noteworthy because it offers a molecular explanation for diseases linked to inflammation. More recently published research provides additional evidence of the positive effects of the MD on atherosclerosis. The researchers studied the long-term effects (1 year) of a MD on vascular risk factors in 516 high-risk subjects. They concluded that the MD has an anti-inflammatory effect on the cardiovascular system since it lowers the cellular and circulating inflammatory biomarkers related to atherosclerosis.¹⁶ There are many additional studies on MDs having a positive effect on heart health.^{17, 18} Olive oil and the Mediterranean diet have also been found to affect many other conditions and diseases associated with chronic inflammation: rheumatoid arthritis, inflammatory bowel disease and osteoporosis.¹⁹

One common medical intervention for certain types of inflammation is the use of non-steroidal anti-inflammatory drugs (NSAIDS). These drugs work by blocking two enzymes, cyclooxygenase-1 (COX-1) and 2 (COX-2), produced by the body and associated with inflammation. As a result of treatment by NSAIDS, the body doesn't feel pain or become inflamed. NSAIDS may also play a protective role against Alzheimer's disease; however, this pharmacological intervention can have serious side effects, including gastrointestinal and cardiovascular disruptions. Researchers are increasingly interested in finding diets that help manage and/or prevent chronic inflammation. As the research continues to grow and reveals more evidence of the anti-inflammatory effects of diet, one future outcome may eventually be to reduce and/or replace the widespread use of NSAIDS with a healthy MD.

Olive Oil and Brain Function

Nutrition and dietary components also have pro- and anti-inflammatory effects associated with cognitive function. Low-grade chronic inflammation affects several brain functions ranging from early brain development to neurodegenerative disorders and some psychiatric diseases.²⁰ Even modest effects of diet on cognitive health could offer great benefits.

As discussed in this paper, there is substantial research relating the MD to improved cardiovascular health and reduced rates of some forms of cancer. Scientists are also finding that what may be good for the heart may also be good for the brain. More recent scientific evidence suggests that vascular and vascular-related functions can be important in the development of age-related cognitive decline, mild cognitive impairment, vascular dementia and Alzheimer's disease (AD).²¹ Worldwide, an estimated 36 million people are afflicted with AD or other forms of dementia.²² AD is an irreversible degeneration of the brain that causes disruptions in memory, cognition, personality and other functions that eventually leads to death from complete brain failure. There is currently no known cause or cure; there are pharmaceutical interventions that help to manage some of the symptoms. A growing body of research suggests that diet can play an important role in cognitive health and preventing AD as well as other neurological diseases. In 2006, the Northern Manhattan Study looked at the diet of 1,800 New Yorkers and found that the MD reduced the risk of cognitive decline and AD as well as decreased the risk of mortality in AD patients.²³ An updated analysis of this study also revealed that those who followed the MD more closely had a 40 percent lower risk of AD than those with the lowest adherence to the diet.²⁴ While part of Alzheimer's disease is genetic, it is possible that lifestyle factors, diet and exercise may also positively impact brain function and brain health.

Parkinson's disease (PD) and AD are age-related degenerative disorders with shared clinical, pathological and biochemical features. Dutch researchers evaluated the diets of 5,289 people over six years to see whether or not a high intake

of unsaturated fatty acids reduced the risk of PD. At the beginning of the study, the participants were free from dementia and PD. Each subject completed an extensive dietary assessment. Their medical records were tracked and, the participants repeatedly went through in-person exams to study whether they had symptoms of PD. After six years, researchers identified that 51 people had PD. Analysis of the results suggested that MUFA may provide protection against PD.²⁵ A more recent study published in 2012 also supports the role of the MD with respect to PD risk. The analysis of comprehensive dietary questionnaires completed by 257 people with Parkinson's and 198 controls (people without PD) revealed that patients with PD adhered less to a MD than controls.²⁶ These findings suggest that while more research is needed, the MD may be key to reducing the incidence of PD.

The brain's oxidative processes affect age-related cognitive decline. Scientific researchers wanted to explore whether eating antioxidant-rich food would have a positive impact on cognitive decline. The results of the study suggest that olive oil consumption in a MD may counteract age-related cognitive decline and reduce the occurrence of neurodegenerative illnesses. The study looked at 447 participants who were between the ages of 55 and 80 years old at high risk for cardiovascular disease. The researchers examined the intake of various foods, performed neuropsychological tests and analyzed urinary excretion of polyphenols as a biomarker of daily intake of antioxidants. Higher intake of olive oil was associated with better cognitive scores.²⁷ The study was a subsample of the larger PREDIMED study, a large multi-year clinical study on nutrition and CVD on 7,500 participants. Additional results of this study are forthcoming and expected to reveal more promising findings on the MD and its components reducing the incidence of neurodegenerative illnesses.

In addition to polyphenols in olive oil, oleic acid also seems to protect against age-related cognitive decline. As people age, the brain appears to need more MUFA to prevent degeneration.²⁸ After nine years of follow-up, the Italian Longitudinal Study on Aging revealed that a diet high in MUFA (oleic acid) was associated with better cognitive performance in elderly people following a MD.²⁹ Recently published research from Brigham and Women's Hospital provides more evidence that dietary fats affect cognitive function. Scientists evaluated data on more than 6,000 women

over the age of 65.³⁰ Before cognitive testing, study participants completed detailed food frequency questionnaires. Then, they completed three cognitive function tests that were spaced out every two years over an average span of four years. Analysis of the data determined that women who consumed the highest amount of animal fat (like those from butter and red meat) had the worst overall cognition and memory over the four-year testing period. Women who ate the most monounsaturated fats had better patterns of cognitive function over time.³¹ The researchers noted that strategies to prevent cognitive decline in older people are critical because even small declines in cognitive function are risk factors for developing more serious problems like dementia and AD. Simple dietary modifications like substituting olive oil for butter could help memory decline.

Animal studies also support olive oil's protective effects. Researchers used SAMP 8 mice to see if olive oil could reverse oxidative damage in their brains and improve learning and memory. (SAMP 8 mice develop early abnormalities in learning and memory; they are considered to be an excellent model for examining early defects like those in AD). Researchers concluded that olive oil has beneficial effects on learning and memory deficits associated with aging, as well as diseases associated with the overproduction of amyloid beta protein, like AD.³²

While scientists cannot fully explain how phenolic compounds are absorbed and metabolized, there is evidence that hydroxytyrosol (one of the key polyphenols in olive oil) is absorbed by humans and may be responsible for some of the powerful properties in the MD.³³ Researchers have been investigating whether hydroxytyrosol (HT) may play a role in brain health. Scientists used an HT extract to see how it protected against oxidative stress in mice brain cells. Mice feeding studies were used to assess the brain bioactivity of HT *ex vivo*. The researchers reported that HT and extra virgin olive oil do provide neuroprotection and may contribute to the lower incidence of neurodegenerative diseases in countries where the Mediterranean diet is widely consumed.³⁴ As with most studies, this study had limitations;³⁵ however, further research may discover that over time, regular consumption of food containing HT, especially olives and olive oil, contributes significantly to the neuroprotective effects of the MD.

Studies are accumulating to support the role of the MD and olive oil for a healthy brain and prevention of cognitive decline. Research recently published in the *Archives of Neurology* found that diets rich in vegetables, fruit, lean proteins, whole grains and olive oil can protect blood vessel damage in the brain. Small blood vessel damage contributes to “silent strokes,” a vascular event that doesn’t have immediate symptoms or dramatic damage but can affect brain performance over time. White matter hyperintensities (WMH) that are visible on magnetic resonance imaging (MRI) are markers of chronic small vessel damage. While they can be seen in people who are aging normally, WMH are associated with vascular risk factors like smoking, diabetes, high blood pressure, blood lipid levels, metabolic syndrome and history of heart disease. Researchers from the University of Miami and Columbia University evaluated the diets of 966 adults who completed food questionnaires. Each participant was given a MRI scan to measure WMH volume (WMHV). Participants who followed a MD had a lower burden of WMHV; those who consumed more MUFA (oleic acid in olive oil) had lower volumes of WMHV.³⁶ The results were independent of sociodemographic and vascular risk factors, including physical activity, smoking, blood lipid levels, hypertension, diabetes, history of cardiac disease and BMI. While the researchers acknowledged that higher consumption of MUFA is a factor, they emphasized that overall dietary patterns are more important to small vessel damage in the brain than any individual component.

Depression is an illness of the brain. In studying brain imaging like those from an MRI, researchers have noted that the brains of people with depression look different from those who don’t suffer from the disease. Some parts of the brain that are altered include those that regulate mood, thinking, appetite and behavior. One theory about depression is that neurotransmitters, chemicals that brain cells use to communicate, are out of balance. Chronic inflammation has also been implicated in depression. Studies of people with depression have shown elevated levels of several markers of inflammation, including C-reactive protein and interleukin-6.^{37, 38} According to the World Health Organization, depression afflicts about 121 million people worldwide. Depression is the leading cause of disability and the fourth leading contributor to the global burden of disease.³⁹ Some forms of depression affect cognitive function, and depression is a major risk factor for stroke, heart disease, AD and other

neurological disorders. Major illnesses can also cause depression. The relationship of diet to depression is increasingly of interest to health practitioners and is the subject of recent research. There is growing epidemiological evidence to support an association with nutrition and better mental health.⁴⁰

To investigate the effect of dietary fat intake and depression, researchers undertook a 10-year prospective cohort study of more than 12,000 university graduates—The SUN Project. They were all free of depression at the start of the study. The subjects took a food frequency questionnaire to estimate the intake of fatty acids (MUFA, PUFA, SFA, TFA) and culinary fats (olive oil, seed oils, butter and margarine).⁴¹ During the follow-up, subjects were considered to have depression if they were diagnosed by a physician and/or were using antidepressant medication. Questionnaires were completed after 2, 4, 6, 8 and 10 years. A total of 657 cases of depression were identified during the trial period. Butter consumption was associated with an increased risk of depression and olive oil was inversely associated with depression risk. Trans fats were found to have a directly harmful association with the risk of depression. The association was rigorously tested through several analyses.⁴² Reduced risk of depression from olive oil is attributed to oleic acid and bioactive polyphenols. Anti-inflammatory properties of olive oil may play a significant role in reducing the risk of depression. An earlier study analyzed severely depressed moods and links to oleic acid (omega-9) and linoleic acid (omega-6). The results revealed that women who ate the most oleic acid were 52 percent less likely to suffer from severe depression.^{43, 44} Both of these studies emphasize that olive oil plays an important role in brain health as it pertains to depression.

Quality of Life

Health-related quality of life (HRQL) studies are used to measure health interventions. A new HRQL study⁴⁵ has added more reasons to follow a Mediterranean dietary pattern; it is associated with better mental and physical health. Researchers studied 11,015 university graduates over 4 years. Dietary intake data was taken at the beginning of the study and self-perceived quality of life was measured at the end of the study. To measure adherence with a MD, consumption of vegetables, legumes, fruit, nuts, cereals and fish was



rated positively. The ratio of MUFA to SFA was used to assess the quality of fat intake. Consumption of excess meat, dairy products and alcohol was negatively valued. The results revealed that those who followed the MD most closely enjoyed better mental and physical health. The association was even stronger with physical well-being. Over the four-year period, even incremental dietary changes by the participants brought about significant increases in both their physical and emotional quality of life. The subjects reported more energy, better physical health, less pain and greater vitality and social functioning.⁴⁶ With aging populations on the rise in many developing countries, finding ways to improve quality of life takes on an even greater level of importance.

Conclusion

Scientific research is continuously providing more evidence to support the benefits of dietary and lifestyle choices on health, including the Mediterranean diet and olive oil. Emerging research is finding the diet to have positive effects on inflammation, cognitive health, neurological disease, depression and overall quality of life. As a dietary pattern, the MD confers several health benefits augmented by including olive oil. The mechanisms are not fully understood, but are attributed in part to oleic acid and phenolic compounds in olive oil. Diet cannot completely prevent aging, but it can promote healthy aging. Furthermore, choosing a healthy diet, physical activity and maintaining a healthy weight are factors that people can control to help fight chronic disease and may help mitigate factors that are more difficult to control such as environmental factors and genetic predisposition.

- 1 There is no single Mediterranean diet (MD). For the purposes of discussion, the Mediterranean diet refers to several dietary patterns in the region with similar food intakes, including the prominence of olive oil as the primary source of fat. Fatty acids from fish are also key to the health benefits of the MD.
- 2 Because fats are high in calories, even fats with positive health attributes should be consumed in moderation.
- 3 The evidence currently supports that excess saturated fatty acids consumption adversely affects many health conditions.
- 4 International Olive Council *Health Benefits of Olives and Olive Oil*. 2012.
- 5 Haban P et al. Dietary supplementation with olive oil leads to improved lipoprotein spectrum and lower n-6 PUFA in elderly subjects. *Med Sci Monit* 2004; 10(4):49-54.
- 6 International Food Information Council. 2012 Food and Health Survey.
- 7 Andrikopoulos N K et al. Deterioration of natural antioxidant species of vegetable edible oils during the domestic deep-frying and pan-frying of potatoes. *International Journal of Food Sciences and Nutrition* 2002;53(4):351-363.
- 8 When olive oil is cooked repeatedly, the smoke point goes down, a consideration for cooks who are reusing oil multiple times.
- 9 According to a 2002 study as cited in footnote 7, "The performance of virgin olive oil and a commercial vegetable shortening was investigated during 10 successive pan-frying of potatoes at 180°C (356°F) for a total period of 60 min. According to the 2002 study cited in footnote 7, "The performance of virgin olive oil and a commercial vegetable shortening was investigated during 10 successive pan-frying of potatoes at 180°C (356°F) for a total period of 60 min and during 10 successive deep-frying at 170 °C (338 °F) for a total period of 120 min.... Both oils performed similarly during pan-frying, while virgin olive oil performed better during deep-frying."
- 10 The majority, 62%, used olive oil in frying. The rest used sunflower oil.
- 11 Guallar-Castillón P et al. Consumption of fried foods and risk of coronary heart disease: Spanish cohort of the European Prospective Investigation into Cancer and Nutrition Study. *BMJ* 2012; 344-363.
- 12 Goltz SR et al. Meal Triacylglycerol Profile Modulates Postprandial Absorption of Carotenoids in Humans. *Mol Nutr Food Res* 2012; 56:866-877.
- 13 Azzizi E et al. Mediterranean diet effect: An Italian Picture. *Nutr J* 2011;10:25-33.
- 14 Nutrigenomics studies how foods and specific nutrients affect the genes that direct the activity of cells.
- 15 Carmago A et al. Gene expression changes in molecular cells in patients with metabolic syndrome after acute intake of phenol-rich olive oil. *BMC Genomics* 2010;11:253
- 16 Urpi-Sarda et al. Virgin olive oil and nuts as key foods of the Mediterranean diet effects on inflammatory biomarkers related to atherosclerosis. *Pharmacological Research* 2012;65(6):577-83.
- 17 Giugliano D, et al. The Effects of Diet on Inflammation. *J Am Coll Cardiol* 2006;48:677-685.
- 18 Carmago A et al. Expression of proinflammatory, proatherogenic genes is reduced by the Mediterranean diet in elderly people. *Br J Nutr* 2011;15:1-9.
- 19 International Olive Council, *Health Benefits of Olives and Olive Oil*. 2012.
- 20 Wamberg J et al. Nutrition, inflammation and cognitive function. *Ann N Y Acad Sci* 2009;1153:164-75.
- 21 There is strong evidence linking metabolic syndrome with increased risk of predementia, dementia and vascular dementia; however, the findings on metabolic syndrome and AD are not as consistent.
- 22 American Health Assistance Foundation <http://www.ahaf.org>.
- 23 Scarmeas N et al. Mediterranean diet and risk for Alzheimer's disease. *Ann Neurol* 2006;59:912-921.
- 24 Scarmeas N et al. Physical activity, diet and risk of Alzheimer's disease. *JAMA* 2009;302 (6):627-637.
- 25 de Lau LML et al. Dietary fatty acids and the risk of Parkinson disease, The Rotterdam Study. *Neurology* 2005; 64:2040-2045.
- 26 Alcalay RN et al. The Association between Mediterranean diet adherence and Parkinson's disease. *Mov Disord* 2012; 27(6):771-74.
- 27 Valls-Predet C et al. Polyphenol-rich foods in the Mediterranean diet are associated with better cognitive function in elderly subjects at high cardiovascular risk. *J Alzheimer's Dis* 2012; 29:773-782.
- 28 Solfrizzi V et al. High monounsaturated fatty acid intake protects against age-related cognitive decline. *Neurology* 1999;52:1563-1574.
- 29 Solfrizzi V, et al. Dietary intake of unsaturated fatty acids and age-related cognitive decline: a 8.5-year follow-up of the Italian Longitudinal Study on Aging. *Neurobiol Aging* 2006;27:1694-704.
- 30 The complete Women's Health Study is on 40,000 women 45 years and older.
- 31 Okereke, OI et al. Dietary fat types and 4-year cognitive change in community-dwelling older women. *Ann Neurol* 2012. doi:10.1002/ana.23593.
- 32 Farr SA et al. Extra virgin olive oil improves learning and memory in SAMP8 mice. *J Alzheimer's Dis* 2012;28:81-92.
- 33 Vissers MN et al. Olive phenols are absorbed in humans. *J Nutr* 2002; 132:409-17.
- 34 Schaffer S. Hydroxytyrosol-rich olive oil mill wastewater extract protects brain cells *in vitro* and *ex vivo*. *J Agric Food Chem* 2007;55(13):5043-49.
- 35 These limitations include that this was an animal study; an extract was used instead of a whole food and the quantity of hydroxytyrosol used in the research was dramatically higher than what a person would regularly consume in the context of a daily diet of whole foods.
- 36 Gardener H et al. Mediterranean diet and white matter hyperintensity volume in the Northern Manhattan Study. *Arch Neurol* 2012;69(2):251-56.
- 37 Gimeno D et al. Association of C-reactive protein and interleukin-6 with cognitive symptoms of depression: 12 year follow-up of the Whitehall II Study. *Psych Med* 2009;39:413-423.
- 38 Bremner MA et al. Inflammatory markers in late-life depression: results from a population-based study. *J Affect Disord* 2008;106:249-255.
- 39 <http://www.who.int>
- 40 Freeman M. Nutrition and Psychiatry. *Am J Psychiatry* 2010;167:244-247.
- 41 While omega 3 has been studied extensively for psychiatric conditions, there has been very little research on other types of fatty acids and depression.
- 42 Sanchez-Villegas A et al. Dietary fat intake and the risk of depression: The SUN Project *PLoS ONE* 2011;6(1): e16268. doi:10.1371.
- 43 Wolfe AR et al. Dietary linoleic and oleic fatty acids in relation to depressed mood: 10-year follow-up of a national cohort. *Prog Neuropsychopharmacol Biol* 2009;33(6):972-977.
- 44 The study also found a strong association between omega 6 consumption and increased depression in men (additional information on the damaging effects of excess consumption of omega 6 in soybean, corn and sunflower oils).
- 45 There are several other studies on quality of life that are referenced in the new SUN Project research paper.
- 46 Henriquez Sanchez. Adherence to the Mediterranean diet and quality of life in the SUN Project. *Eur J Clin Nutr* 2012;66:360-68.

