



OLEA EUROPAEA OIL ANTIMICROBIAL ACTION IN CONTRADICTION OF MICROBIAL CONTAGIONS : A REVIEW

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Abstract

Indeed, even nowadays, plants resources assume a significant job in essential human services as restorative cures in numerous nations. Plants still keep on being a significant wellspring of medications for lion's share of the total populace. In right now, sedate opposition in organisms is an intense issue. Consequently, plant beginning natural prescriptions are considered as sheltered choices of engineered drugs. There are fluctuated techniques for prescriptions like Aurveda, Homeopathy and Unani, which use plant materials for sedate creation. As of now, Aurveda considered as an imperative arrangement of medication and administered the overall acknowledgment and having non-lethal substances. Be that as it may, newfound non-anti-infection substances, for example, certain fundamental oils and their constituent synthetic concoctions. The treatment of bacterial contaminations depends essentially on the utilization of anti-toxins, including across the board solution and additionally some of the time unseemly for these antibacterial operators can bring about the choice of multiresistant bacterial strains from which the significance of coordinating examination towards therapeutic plants as a wellspring of new atoms with antibacterial action to restrict the development of the wonder of multidrug opposition. *Olea europaea* oil and *Olea europaea* concentrates require remained utilized popular people medication as old occasions. Romans & Greeks utilized *Olea europaea* concentrates to treat numerous sicknesses and a concentrate of bubbled *Olea europaea* plants remained regulated by way of beverage to intestinal sickness patient throughout nineteenth century.

Key words : *Olea europaea*, antimicrobial action, multidrug, bacterial strains.

Introduction

is local to the Mediterranean bowl and parts of Asia Minor. References to the *Olea europaea* tree go back toward Theological besides Roman occasions besides on road to Greek folklore. foods grown from the ground separated oil have a wide scope of restorative and culinary applications and has a place the *O. europaea* to realm green plants, division magnoliophyta (blossoming plants), family oleaceae *Olea europaea* oil remains unique from a generous by way of great oleic corrosive element on grounds the most of seed oils remain prepared essentially obtainable for polyunsaturated unsaturated fats, counting important (omega-6 unsaturated fat), linoleic corrosive. Contrasted with polyunsaturated unsaturated fats, oleic corrosive is monounsaturated, which means it has one twofold security, manufacture significantly fewer helpless to oxidation then adding for cell reinforcement activity, in height strength and extended timeframe of realistic usability of *Olea europaea* oil (Ahmed *et al.*, 2014;

Balouiri *et al.*, 2016). *Olea europaea* oil additionally establishes a significant part of the "Mediterranean eating regimen". The central dynamic segments of *Olea europaea* oil incorporate oleic corrosive phenol constituents and squalene. The fundamental phenolics incorporate hydroxytyrosol tyrosol and oleuropein, which happen in most elevated levels in virgin *Olea europaea* oil and have shown cancer prevention agent action (Calo *et al.*, 2015). The substance of minor segments of an Among palatable vegetable oils, *Olea europaea* oil is one of only a handful few devoured grungy, which implies that just by way of triglyceride structure has additional slight bioactive parts, for example, Sterols, Nutrients, Escualene, Polyphenols. This compound, having an extraordinary aggravation impact on the throat, has shown restraint of cyclooxygenase proteins and calming action (Carraro *et al.*, 2014). Antioxidants are accepted to be liable for various *Olea europaea* oil's natural exercises. Oleic corrosive, a monounsaturated unsaturated fat, has indicated action in malignant growth aversion, while

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squalene has additionally been recognized as having anticancer impacts. The utilization of *Olea europaea* oil has as of late been viewed. Nourishment besides Medication Management based high substance trendy monounsaturate unsaturated fats (oleic corrosive), albeit various specialists and studies have demonstrated that the minor segments may likewise add to the advantageous impacts of *Olea europaea* oil to human wellbeing, specifically the phenolic mixes (Cavanna and Molinari, 1998). Information concerning the medical advantages of oleic corrosive are clashing. It has been accounted for that oleic corrosive assumes a job in disease avoidance. Regardless of whether this is an optional impact of the unsaturated fat on oil solidness (avoiding oxidative pressure) or a direct anticancer impact stays easy to refute (Covas, 2007) *in vivo*. A scope of phenols in *Olea europaea* oil gives a portion of its medical advantages. In spite of the fact that the revealed degrees of phenolic mixes in *Olea europaea* oil differ broadly, one steady end is that additional virgin *Olea europaea* oil has a higher phenolic content than refined virgin *Olea europaea* oil (Karakaya, 2009; Fleming *et al.*, 1973). Hydrolysis of oleuropein, which happens during *Olea europaea* oil stockpiling (Friedman *et al.*, 2013). Preference for the last hypothesis depends on the way that, in spite of the fact that oleic corrosive is found in high fixation in *Olea europaea* oil (Friedman *et al.*, 2009). *In vitro* examinations led by The investigation results are empowering and bolster the hypothesis that oleic corrosive is significant in chemoprotection. Higher convergences of tyrosol are expected to apply a cell reinforcement effect. One system related with the anticancer impacts of hydroxytyrosol and oleuropein is avoidance of DNA harm, which can anticipate mutagenesis and carcinogenesis (Hayes *et al.*, 2010). Hydroxytyrosol, be that as it may, has organic movement past its cancer prevention agent limit, as it can influence a scope of compounds, including cyclooxygenase and NADH oxidase (Juven and Henis, 1970) and decrease platelet total (Khayyal, 2002). The analysts announced oleic corrosive down-directs the over-articulation of (Her-2/neu), oncogene over-communicated in roughly percent from bosom an carcinomas. Just as being available in *Olea europaea* oil, hydroxytyrosol is endogenous to the mind as a catabolite of synapse breakdown (Tutour and Guedon, 1990; Lee and Lee, 2010). The catechol bunch can balance out free radicals through the arrangement of intramolecular hydrogen bonds. Of the three fundamental phenols in *Olea europaea* oil, hydroxytyrosol and oleuropein are catechols and tyrosol is a mono-phenol (Lemon *et al.*, 2007).

Organic exercises Enemy *Olea europaea* Oil

Olea europaea oil is accepted to apply its organic advantages fundamentally by means of constituent cell reinforcements. Fashionable meanness of statistic organization from *Olea europaea* oil is perplexing, significant gatherings of mixes thought to add to its watched medical advantages incorporate oleic corrosive, squalene & phenolics,, altogether from which must remained establish toward restrain oxidative pressure (Li *et al.*, 2016). Around 80% or a greater amount of the *Olea europaea* oil phenolic mixes are lost in the refinement procedure, along these lines, their substance is higher in virgin *Olea europaea* oil (around 230 mg/kg, normal range 130-350 mg/kg) than in other *Olea europaea* oils (Lim *et al.*, 2016). To production *Olea europaea* oil, *Olea europaea* are squashed to make a pomade, that standardized beforehand existence squeezed toward deliver oil. Main oil separated that great additional virgin *Olea europaea* oil-created utilizing centrifuged besides aquatic as it were. Pomade would before remain talented to be prepared once more in the direction of harvest lesser excellence advanced virgin *Olea europaea* oil. Additional abstraction through natural diluents can remain attempted towards distribute truncated excellence advanced covering oil (Liu *et al.*, 2011). The physical strategies used to deliver *Olea europaea* oil safeguard a significant number of its cancer prevention agent mixes. This isn't seen with other vegetable and seed oils, which will in general be increasingly refined. Variables influencing the ecological states of developing *Olea europaea* change the constituents of the oil, including its cancer prevention agent properties (Lim *et al.*, 2016).

Oil as Antioxidants *Olea europaea*

In connection in the direction of anthropological wellbeing, abundant anxiety takes remained centered around phenolic mixes as of plant besides nourishments that may eatable regulate macrobiotic by digestive system through specifically expanding development of bifid bacteria, lactobacilli that diminishing unsafe microscopic organisms, for example, clostridia (Malik and Bradford, 2006). The digestion phenolic mixes by *Olea europaea* oil might in this way add for well-adjusted macrobiotic from human digestive system. Nearby that motionless requirement aimed at newfangled techniques aimed at decreasing otherwise disposing of food borne pathogen, besides newfangled bio preservatives as of plant otherwise nourishments (Malik and Bradford, 2008), basic oil (Marco *et al.*, 2011) mentioned. *Olea europaea* oil might remain devoured legitimately happening bread besides fashionable newfangled plate of mixed greens, yet it is additionally utilized in numerous hand crafted

dishes (mayonnaise, cakes, others), canned fish (Calo *et al.*, 2015), serving of mixed greens dressing (Lee and Lee, 2010) and meat nourishments (Covas, 2007), in the safeguarding of cheddar and fish (Guinda *et al.*, 2004) and in beautifying agents. Despite the fact that *Olea europaea* oil utilized to quite lengthy period as nourishment additive and in people medication, which parts of the oil are answerable for this bioactivity remains undiscovered. *In vitro* and *in vivo* models, *Olea europaea* oil phenolics have appeared to have cancer prevention agent properties, higher than that of nutrient E, on lipids and DNA oxidation. Likewise, *Olea europaea* oil phenolic mixes restrained platelet-initiated collection (Tabera *et al.*, 2004) and have been accounted for to improve the mRNA interpretation of the cancer prevention agent protein glutathione peroxidase. This last issue, in any case, is by all accounts subject to the tissue in which the quality articulation was assessed (25). Other potential exercises incorporate calming and chemopreventive movement. On pathogenic microorganisms the counter bacterial impact depends of the phenolic mixes and of the strains tried. Simopoulos, Colomer and Menendez revealed the counter bacteriological possessions to unadulterated polyphenols besides phenolic mixes of various wine in contradiction of (*Pseudomonas aeruginosa*, *Proteus mirabilis*, *Serratia marcescens*, *Staphylococcus aureus* besides *Klebsiella pneumoniae*) (Hansen *et al.*, 2006). nourishment sully by microbes pulled in expanded consideration since it is an issue that consumes brought below satisfactory controller in spite of conservation methods accessible. (*Listeria monocytogenes*) was perceived by way of developing food borne pathogens then consumes develop significant worry for nourishment preparing manufacturing besides wellbeing specialists in course of the most recent periods. That institute in top soil, aquatic, dairy items, counting delicate cheese, crude and half-cooked Meat, rooster, fish besides connected products (Paiva *et al.*, 2003). Significant that action from certain aldehyde, unpredictable taste parts from *Olea europaea* products of the soil, against various parasitic and bacterial strains. This movement is specifically compelling since a large portion of plant optional metabolites appear all in all more intense action against Gram positive microscopic organisms than against growths. In this way, new classes of hostile to microbial medications are desperately required. As of late, there has been developing enthusiasm for elective treatments and the remedial utilization of regular items, particularly those got from plants (García *et al.*, 2000). It is commonly acknowledged phytochemical remain fewer strong anti-infective from operators of microscopic starting point, for example anti-toxins. Be that as it may,

new fangled class of hostile to contagious medication that critically mandatory, phenolic mixes speak to a original arrangement from indications. Forthcoming advancement from mixes over and done with basic adjustment might permit improvement from pharmacological adequate enemy of bacterial specialist otherwise gathering from operators (Bouaziz and Sayadi, 2005). The outcomes acquired brought up unsaturate aldehyde must an expansive anti microbial range besides appearance comparative movement in contradiction of (Gram positive) and (Gram negative) microscopic organisms. speculated this phytochemical demonstration together in plasmatic films, by perturbation its lipoids part, then in intra cellular boards. Unsaturate aldehyde to anti microbial possessions were viewed as associated with the opposition of *Olea europaea* to organism then creepy crawly assault. Furthermore, unsaturated fats then mono glycerides that originate for wide range from micro bicidal action in contradiction of microscopic organisms and molds (Briante *et al.*, 2002).

Diseases and *Olea europaea* Oil

The developing notoriety of the Mediterranean eating routine is because of an enormous assortment of epidemiological examinations demonstrating how the frequency of specific malignancies is the most minimal in the Mediterranean bowl. It has been proposed this is to a great extent because of the generally sheltered and even defensive dietary propensities for this territory (Hanahan *et al.*, 2011, Filomeno *et al.*, 2015) *Olea europaea* oil is an indispensable element of the conventional Mediterranean eating routine and a few investigations quality a significant number of the sound preferences of this eating regimen to *Olea europaea* oil's remarkable attributes. For sure, the connection between the admission of *Olea europaea* oil and malignant growth hazard has become a disputable issue that could have significant repercussions in human wellbeing as it might have a potential job in bringing down the danger of some human neoplasms (Schwingshackl, 2015; Ostan *et al.*, 2015). Therefore, various examinations have demonstrated that the utilization of *Olea europaea* oil have a potential defensive impact towards a few malignancies, particularly bosom disease (stomach, ovary, colon and endometrium malignancy too). There have been numerous reports on the lower occurrence of malignancy in creatures and people after utilization of *Olea europaea* oil. An audit, by Lipworth *et al.*, condenses the relationship of *Olea europaea* oil consumption with malignancy hazard in people (Marlow *et al.*, 2013). It was deduced in this audit *Olea europaea* oil doesn't have the malignancy advancing capability of other fat sorts. In

any case, extra examinations will be required to affirm this speculation. Various investigations have indicated that these phenols are strong inhibitors of LDL oxidation *in vitro* (Panunzio *et al.*, 2010; Serrano *et al.*, 2011). The *in vivo* oxidation of LDL is connected to the arrangement of atherosclerotic plaques, which are proposed to add to the improvement of coronary illness. *Olea europaea* oil phenol obligate likewise advantageously connected from forms add towards pathogens to coronary illness besides malignancy (Camargo *et al.*, 2012). Specifically ahydroxytyrosol, unique from significant phenolic constituent fashionable *Olea europaea* oil, accounted for unaided lessen danger from coronary illness besides atherosclerosis. that likewise proposed hydroxytyrosol hinders arachidonic corrosive (lipoxygenase) otherwise represses platelets conglomeration (Renna *et al.*, 2015). The assumed hydroxytyrosol infiltrates in cells films then thusly can hinder generation of (leukotriene B4) successfully as of endogenous arachidonic corrosive Oleuropein restrains androstenedione 6-hydroxylase action, a CYP3A marker in human liver microsomes and oleuropein, yet not the fundamentally comparative mixes hydroxytyrosol and secologanin, was seen as a system based inhibitor of androste). Nedione 6-hydroxylase movement (Schwingshackl and Hoffmann, 2014). Colonization by *Candida* sp. is essentially more successive in kids with diaper dermatitis than in those with solid skin, though colonization by *Staphylococcus aureus* doesn't contrast between these two gatherings. Corticosteroids, zinc glue and eosin are outstanding topical specialists for the treatment of diaper dermatitis. It has been recommended that topical antifungal operators are not shown for diaper dermatitis; surely, their security and viability have not been built up in newborn children (Portarena *et al.*, 2017). *Olea europaea* oil, beeswax and nectar are characteristic items, containing flavonoids and cancer prevention agent, antibacterial and antifungal exacerbates that influence the creation of cytokines by skin cells when applied topically (Farràs *et al.*, 2013). Thinking about the potential risks of topical corticosteroids, it appears that utilization of this topical treatment, alone or in mix with different operators, is a potential elective treatment for diaper dermatitis. This could bring about decreased utilization of physician endorsed drugs and an accompanying decrease in any related unfavorable impacts (Castañer *et al.*, 2013).

A similar arrangement came about additionally compelling inreducing the indications to diaper dermatitis besides annihilated *Candida albicans* as of half of culture affirmative patient through (7-days) preliminary (Schwingshackl, 2015). A few examinations manage the capacity from *Olea europaea* separates otherwise

unadulterated segments towards hinder otherwise defer microorganisms development. *Olea europaea* leaves aquatic separate remained tried in contradiction of microscopic organisms besides parasites, concentrate exterminated practically completely microorganisms, whereas (dermatophytes) remained hindered subsequent (3-days) introduction in addition *Candida albicans* remained exterminated next (24 h.) (Schwingshackl and Hoffmann, 2014). Moreover, oleuropein indicated movement against a few types of Mycoplasma (45). Essential is the action of certain aldehydes, unstable flavor parts of *Olea europaea* products of the soil, against various parasitic and bacterial strains. portrayed the antimicrobial movement of long chain soaked and unsaturated aldehydes from *Olea europaea* natural product against a wide range of nourishment borne microfungus and microscopic organisms strains, among the microorganisms tried, parasites were the most touchy. This movement is specifically compelling since the greater part of plant optional metabolites appear by and large more strong action against Gram-positive microorganisms than against growths. All the more as of late, depicted the movement of a portion of these mixes against various standard microbes strains that might be causal specialists of human contaminations. (Schwingshackl and Hoffmann, 2014; Castañer *et al.*, 2013). The outcomes got called attention to that unsaturated aldehydes have a wide antimicrobial range and show comparative action against Gram positive and Gram negative microscopic organisms. It has been conjectured that these phytochemicals demonstration both on the plasmatic layer, by perturbing its lipidic portion and on intracellular targets (Karakaya, 2009). At long last, a, b-unsaturated aldehydes for their antimicrobial properties are viewed as engaged with the obstruction of *Olea europaea* to organism and bug assault (Lockyer *et al.*, 2013). *Olea europaea* oil has been accounted for to support the mineralization and improvement of bones (Karakaya, 2009).

References

- Ahmed, A., N.S. Rabii, A.M. Garbaj and S.K. Abolghait (2014). Antibacterial effect of olive (*Olea europaea* L.) leaves extract in raw peeled undeveined shrimp *Penaeus semisulcatus*. *Int. J. Vet. Sci. Med.*, **2**: 53-56.
- Balouiri, M., M. Sadiki and S.K. Ibnsouda (2016). Methods for *in vitro* evaluating antimicrobial activity: a review. *J. Pharm. Anal.*, **6**: 71-79.
- Benavente-García, O., J. Castillo, J. Lorente, A. Ortuño and J.A. Del Rio (2000). Antioxidant activity of phenolics from *Olea europaea* L. leaves. *Food Chem.*, **68**: 457-462.
- Bouaziz, M. and S. Sayadi (2005). Isolation and evaluation of antioxidants from leaves of a Tunisian cultivar olive tree. *Eur. J. Lipid Sci. Technol.*, **107**: 497-504.

- Briante, R., M. Patumi, S. Terenziani, E. Bismuto, F. Febbraio and R. Nucci (2002). *Olea europaea* L. leaf extract and derivatives: antioxidant properties. *J. Agric. Food Chem.*, **50**: 4934-4940.
- Calo, J.R., P.G. Crandall, C.A. O'Bryan and S.C. Ricke (2015). Essential oils as antimicrobials in food systems-A review. *Food Control.*, **54**: 111-119.
- Camargo, A., J. Delgado-Lista, A. Garcia-Rios, C. Cruz-Teno, E.M. Yubero-Serrano, P. Perez-Martinez, F.M. Gutierrez-Mariscal, P. Lora-Aguilar, F. Rodriguez-Cantalejo and F. Fuentes-Jimenez *et al.*, (2012). Expression of proinflammatory, proatherogenic genes is reduced by the Mediterranean diet in elderly people. *Br. J. Nutr.*, **108**: 500-508.
- Carraro, L., L. Fasolato, F. Montemurro, M.E. Martino, S. Balzan and M. Servili *et al.*, (2014). Polyphenols from olive mill waste affect biofilm formation and motility in *Escherichia coli* K-12. *Microb Biotechnol.*, **7**: 265-275.
- Castañer, O., D. Corella, M.I. Covas, J.V. Sorlí, I. Subirana, G. Flores-Mateo, L. Nonell, M. Bulló, R. de la Torre and O. Portolés *et al.*, (2013). *In vivo* transcriptomic profile after a Mediterranean diet in high-cardiovascular risk patients: A randomized controlled trial. *Am. J. Clin. Nutr.*, **98**: 845-853.
- Cavanna S. and G.P. Molinari (1998). Residues of fenthion and trichloron in olives and olive oil after olive tree treatments. *Food Addit. Contam.*, **15**: 518-527.
- Covas, M.I. (2007). Olive oil and the cardiovascular system. *Pharmacol. Res.*, **55**: 175-186.
- El, S.N. and S. Karakaya (2009). Olive tree (*Olea europaea*) leaves: potential beneficial effects on human health. *Nutr. Rev.*, **67**: 632-638.
- Farràs, M., R.M. Valls, S. Fernández-Castillejo, M. Giralt, R. Solà, I. Subirana, M.J. Motilva, V. Konstantinidou, M.I. Covas and M. Fitó (2013). Olive oil polyphenols enhance the expression of cholesterol efflux related genes *in vivo* in humans. A randomized controlled trial. *J. Nutr. Biochem.*, **24**: 1334-1339.
- Filomeno, M., C. Bosetti, E. Bidoli, F. Levi, D. Serraino, M. Montella, C. La Vecchia and A. Tavani (2015). Mediterranean diet and risk of endometrial cancer: A pooled analysis of three Italian case-control studies. *Br. J. Cancer.*, **112**: 1816-1821.
- Fleming, H.P., W.M. Walter Jr. and J.L. Etchells (1973). Antimicrobial properties of oleuropein and products of its hydrolysis from green olives. *Appl. Microbiol.*, **26**: 777-782.
- Friedman, M., P.R. Henika and C.E. Levin (2013). Bactericidal activities of health-promoting, food-derived powders against the foodborne pathogens *Escherichia coli*, *Listeria monocytogenes*, *Salmonella enterica* and *Staphylococcus aureus*. *J. Food Sci.*, **78**: 270-275.
- Friedman, M., C.E. Levin, S.U. Lee and N. Kozukue (2009). Stability of green tea catechins in commercial tea leaves during storage for 6 months. *J. Food Sci.*, **74**: 47-51.
- Gonzalez, M., A. Zarzuelo, M.J. Gamez, M.P. Utrilla, J. Jimenez and I. Osuna (1992). Hypoglycemic activity of olive leaf. *Planta. Med.*, **58**: 513-515.
- Guinda, A., T. Albi, M.C.P. Camino and A. Lanzón (2004). Supplementation of oils with oleanolic acid from the olive leaf (*Olea europaea*) *Eur. J. Lipid Sci. Technol.*, **106**: 22-26.
- Hanahan, D., R.A. Hallmarks of cancer: (2011). The next generation. *Cell.* **144**: 646-674.
- Hansen, K., A. Adersen, B.S. Broeogger, J.S. Rosendal, U. Nyman and U. Wagner Smitt (2006). Isolation of an angiotensin converting enzyme (ACE) inhibitor from *Olea europaea* and *Olea lancea*. *Phytomedicine.*, **2**: 319-324
- Hayes, J.E., V. Stepanyan, P. Allen, M.N. O'Grady and J.P. Kerry (2010). Effect of lutein, sesamol, ellagic acid and olive leaf extract on the quality and shelf-life stability of packaged raw minced beef patties. *Meat Sci.*, **84**: 613-620.
- Juven, B. and Y. Henis (1970). Studies on the antimicrobial activity of olive phenolic compounds. *J. Appl. Bacteriol.*, **33**: 721-732.
- Khayyal, M.T., M.A. el-Ghazaly, D.M. Abdallah and N.N. Nassar (2002). Okpanyi SN, Kreuter MH. Blood pressure lowering effect of an olive leaf extract (*Olea europaea*) in L-NAME induced hypertension in rats. *Arzneimittelforschung.*, **52**: 797-802.
- Le Tutour, B. and D. Guedon (1992). Antioxidative activities of *Olea europea* leaves and related phenolic compounds. *Phytochemistry.*, **31**: 1173-1178.
- Lee, O.H., B.Y. Lee (2010). Antioxidant and antimicrobial activities of individual and combined phenolics in *Olea europaea* leaf extract. *Bioresour. Technol.*, **101**: 3751-3754.
- Lemon, K.P., D.E. Higgins, R. Kolter (2007). Flagellar motility is critical for *Listeria monocytogenes* biofilm formation. *J. Bacteriol.*, **189**: 4418-4424.
- Li, X., Y. Liu, Q. Jia, V. Lamacchia, K. O'Donoghue and Z. Huang (2016). A system biology approach to investigate the antimicrobial activity of oleuropein. *J. Ind. Microbiol. Biotechnol.*, **43**: 1705-1717.
- Lim, A., N. Subhan, J.A. Jazayeri, G. John, T. Vanniasinkam and H.K. Obied (2016). Plant phenols as antibiotic boosters: *in vitro* interaction of olive leaf phenols with ampicillin. *Phytother. Res.*, **30**: 503-509.
- Liu, Y., A. Ream, R.D. Joerger, J. Liu and Y. Wang (2011). Gene expression profiling of a pressure-tolerant *Listeria monocytogenes* scott A ctsR Deletion Mutant. *J. Ind. Microbiol. Biotechnol.*, **38**: 1523-1533.
- Lockyer S., P. Yaqoob, J.P.E. Spencer and I. Rowland (2012). Olive leaf phenolics and cardiovascular risk reduction: Physiological effects and mechanisms of action. *Nutr. Aging.*, **1**: 125-140.
- Malik, N.S.A. and J.M. Bradford (2006). Changes in oleuropein levels during differentiation and development of floral

- buds in 'Arbequina' olives. *Sci. Hortic.*, **110**: 274-278.
- Malik, N.S.A. and J.M. Bradford (2008). Recovery and stability of oleuropein and other phenolic compounds during extraction and processing of olive (*Olea europaea*) leaves. *J. Food Agric. Environ.*, **6**: 8-13.
- Marco, A., C. Ferrer, L.M. Velasco, D. Rodrigo, B. Muguerza and A. Martínez (2011). Effect of olive powder and high hydrostatic pressure on the inactivation of *Bacillus cereus* spores in a reference medium. *Foodborne Pathog. Dis.*, **8**: 681-685.
- Marlow, G., S. Ellett, I.R. Ferguson, S. Zhu, N. Karunasinghe, A.C. Jesuthasan, D. Han, A.G. Fraser and L.R. Ferguson (2013). Transcriptomics to study the effect of a Mediterranean-inspired diet on inflammation in Crohn's disease patients. *Hum. Genom.*, **7**: 24.
- Ostan, R., C. Lanzarini, E. Pini, M. Scurti, D. Vianello, C. Bertarelli, C. Fabbri, M. Izzi, G. Palmas and F. Biondi *et al.*, (2015). Inflammaging and cancer: A challenge for the Mediterranean diet. *Nutrients.*, **7**: 2589-2621.
- Paiva-Martins, F., M.H. Gordon and P. Gameiro (2003) Activity and location of olive oil phenolic antioxidants in liposomes. *Chem. Phys. Lipids.*, **124**: 23-36
- Panunzio, M.F., R. Caporizzi, A. Antoniciello, E.P. Cela, L.R. Ferguson and P. D'Ambrosio (2010). Randomized, controlled nutrition education trial promotes a Mediterranean diet and improves anthropometric, dietary and metabolic parameters in adults. *Ann. Ig. Med. Prev. Comunità.*, **23**: 13-25.
- Portarena, S., C. Baldacchini and E. Brugnoli (2017). Geographical discrimination of extra-virgin olive oils from the Italian coasts by combining stable isotope data and carotenoid content within a multivariate analysis. *Food Chem.*, **215**: 1-6.
- Renna, M., V.A. Rinaldi and M. Gonnella (2015). The Mediterranean Diet between traditional foods and human health: The culinary example of Puglia (Southern Italy) *Int. J. Gastron. Food Sci.*, **2**: 63-71.
- Schwingshackl, L., (2015). Hoffmann G. Does a Mediterranean-Type Diet Reduce Cancer Risk? *Curr. Nutr. Rep.*, **5**: 9-17.
- Schwingshackl, L. and G. Hoffmann (2014). Monounsaturated fatty acids, olive oil and health status: A systematic review and meta-analysis of cohort studies. *Lipids Health Dis.*, **13**: 154.
- Tabera, J., A. Guinda, A. Ruiz-Rodriguez, J.F. Senorans, E. Ibanez, T. Albi and G. Reglero (2004). Countercurrent supercritical fluid extraction and fractionation of high-added-value compounds from a hexane extract of olive leaves. *J. Agric. Food Chem.*, **52**: 4774-4779.]
- Yubero-Serrano, E.M., N. Delgado-Casado, J. Delgado-Lista, P. Perez-Martinez, I. Tasset-Cuevas, M. Santos-Gonzalez, J. Caballero, A. Garcia-Rios, C. Marin, F.M. Gutierrez-Mariscal *et al.*, (2011). Postprandial antioxidant effect of the Mediterranean diet supplemented with coenzyme Q10 in elderly men and women. *Age (Dordr.)*, **33**: 579-590.