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Table olives – A natural source of health-promoting bioactive nutrients and probiotics

C. Peres*, C.M. Peres, L. Moreira*, M. Alves**, J. Maricato** and F. Xavier Malcata**,*****

*Instituto Nacional de Investigação Agrária e Veterinária, IP
Quinta do Marquês, Av. da República, 2784-505 Oeiras (Portugal)
**Instituto de Tecnologia Quimica e Biológica/ITQB/UNL
Av. da República, Estação Agronómica Nacional, 2780-157 Oeiras (Portugal)
***Department of Chemical Engineering, University of Porto,
Rua Dr. Roberto Frias, 4200-465 Porto (Portugal)
E-mail: cperes@itqb.unl.pt

Abstract. A new generation of natural and healthy foods has been on the rise – and fermented olives are part of that new trend. Concerted public health policies triggered by budgetary restrictions will require investment on prevention rather than bearing – especially as the human life expectancy is becoming longer and longer; and the aforementioned types of foods are nuclear vectors of this strategy as applied to the Mediterranean countries. Some of the components of the olive fruit may by itself function as prebiotics, viz. dietary fibers (with beneficial effects toward prevention of several pathologies), besides such nutraceuticals as essential fatty acids (with anti-cancer features) and antioxidant sterols, polyphenols and glycosides (with general anti-ageing activities). Moreover, some of the adventitious lactic acid bacteria of table olives apparently can survive passage through the gastrointestinal tract – and fully i.e. they resist digestion and even survive in the gut, so they have a chance to act against pathogens installed therein ward showing probiotic capacities. Production of fermented olives with selected (wild) probiotic bacteria therefore constitutes indeed a new avenue to enrichment of the existing olive-based product portfolio, by generating a new food containing probiotics aimed at improving consumers' health without hampering its original sensory characteristics of that have accounted for their success so far.

Keywords. Table olives – Bioactive compound – Probiotics –- Health-promoting.

Les olives de table – Une source naturelle de composés bioactifs et de probiotiques pour la promotion de la santé

Résumé. *Une nouvelle génération d'aliments naturels et sains est à la hausse - et les olives fermentées en font clairement partie. Suite aux politiques de santé publique concertées visant à faire face efficacement aux restrictions budgétaires, il faudra investir sur les approches de santé préventives - d'autant plus que l'espérance de vie humaine s'allonge ; et les types d'aliments mentionnés ci-dessus sont des vecteurs essentiels pour cette stratégie appliquée dans le bassin méditerranéen. Les olives de table traditionnelles semblent un produit cible ayant un bon potentiel pour la promotion de la santé ; les composants du fruit peuvent aussi agir comme prébiotiques, à savoir, les fibres alimentaires (ayant des effets bénéfiques en matière de prévention de pathologies humaines), outre les produits nutraceutiques tels que les acides gras essentiels (avec activité anticancéreuse) et les antioxydants tels que stérols, polyphénols et glucosides (avec activités antivieillissement). En outre, certaines bactéries lactiques indigènes des olives de table peuvent survivre au passage dans le tractus gastro-intestinal - résistant ainsi à la digestion, et pouvant en conséquence agir contre les agents pathogènes qui y sont installés, montrant ainsi un potentiel probiotique. La production d'olives fermentées par des bactéries probiotiques sélectionnées (indigènes) constitue en effet une nouvelle voie pour enrichir le portefeuille de produits à base d'olives et permettre d'obtenir un nouvel aliment contenant des probiotiques pour améliorer la santé des consommateurs, sans pour autant entraver les caractéristiques sensorielles des olives fermentées.*

Mots-clés. *Olives de table – Composés bioactifs – Probiotiques – Favorisant la santé.*

I – Introduction

Besides responding to nutritional needs and providing organoleptic pleasure, foods may play a third role following regular inclusion in a balanced diet (that is gaining worldwide interest): carrying extra protection against degenerative diseases, and delaying incidence (and severity) of chronic health conditions. As a consequence of the rising consumer awareness on the beneficial effects of functional foods, worldwide consumption of olives and olive products has significantly increased –especially in the USA, Europe, Japan, Canada and Australia; this has accordingly led development of complementing olive-based products. Meanwhile, the market share of traditional fermented food products is steadily growing in Europe, as consumer's value cultural heritage, and gastronomic quality– so proof of an extra functional status may reinforce this trend, especially with regard to olives (IOC, 2008).

Table olives are probably the most popular fermented vegetable in the Western world, and cannot be told apart from the Mediterranean diet (together with olive oil). Its preservation process encompasses a spontaneous fermentation, and it produces a sensory profile that depends on the cultivar and the native microbiota – besides the degree of maturity at harvest and any postharvest steps. During fermentation, wild lactic acid bacteria (LAB) and yeasts (Marquina *et al.,* 1992; Garrido-Fernández *et al*., 1997; Oliveira *et al*., 2004; Tassou *et al*., 2002) eventually dominate over contaminating microbiota that would otherwise pose sensory and health hazards (Delgado *et al*., 2005; Silva *et al*., 2011); despite the spoilage related to yeast growth during storage and package, the presence of yeasts during olive fermentation is crucial because of the production of relevant compounds that determines special organoleptic attributes in final product (Arroyo-López *et al.,* 2008); enzymes indigenous to the raw materials may also play a role in enhancing taste and safety (Hammes, 1990).

Regarding the fruit itself, some of its components may play a prebiotic role: e.g., carbohydrate polymers as dietary fibers, essential fatty acids, and anti-oxidant sterols and polyphenols. Besides the intrinsic nutritional features of table olives derived from their original composition, the metabolites resulting from the phenomena associated with fermentation also being about nutritive and safety benefits. Addition and preferential promotion of growth of probiotic LAB isolates (among the complex native microbiota) may further improve the functional properties of table olives in the future.

II – Nutritional properties of table olives

Several advances have been made in recent years on the scientific understanding of how diet –and specific foods if included regularly in a balanced diet– promote human health and prevent chronic illnesses, such as cardiovascular diseases, cancers, and neurodegenerative disorders. Consumers are accordingly turning their attention toward foods with health-promoting properties as promising tools in disease prevention and health maintenance. A focus on the Mediterranean diet has been witnessed, and a few foods that are nuclear to this diet have grown significantly in demand olives and olive oil.

Nutritional benefits of table olives have been claimed to be associated with major and minor constituents, the concentration of which depend on the cultivar, the maturation state and the type of processing (Garrido-Fernández *et al*., 1997). The most abundant compounds in table olives are water, and lipids to a lesser extent. With regard to fatty acid profile, monounsaturated and polyunsaturated fatty acids represent 78.9% and 4.8%, respectively. Triglycerides (ca. 82%) are represented chiefly by monounsaturated residues (e.g. oleic acid), along with a small amount of saturated and a considerable fraction of polyunsaturated which are known as essential for human nutrition, e.g. linoleic and α-linolenic (Salas *et al*., 2000). Although indispensable for cell structure development and function, they cannot be synthesized by the human body (Garrido-Fernandéz and Lopez-Lopez, 2008). The sterolic fraction is mainly constituted by ß-sitosterol (94.0%), Δ-5-avenasterol (6.3%), erytrodiol plus uvaol (3.4%), campesterol (3.0%) and stigmasterol (1.1 %) (López-López *et al*., 2009). Fermented action does not affect the fatty acid profile, or the sterol and triterpenic dialcohol profile (EUC, 2003). Fatty acids and sterols in olives play an important role in human nutrition in prevention of several degenerative diseases (Awad *et al*., 2000; Escrich *et al*., 2006). The beneficial effects of consumption of these fatty acids with regard to cardiovascular diseases has been demonstrated in primary prevention, since it reduces the risk of occurring the disease; and in secondary prevention, since it reduces the probabilities of occurrence of a second coronary event (Covas *et al*., 2006).

Olives are also a good source of fibre; they contain all essential amino acids in their proteins and a high concentration of polyphenols (TDC Olive, 2006). The levels of vitamins in olive pulp are important; the dominant ones are (the water-soluble) ascorbic acid and thiamine; (the oil-soluble) tocopherols and carotenes are considered the most important lipid-soluble antioxidants in nature; they prevent lipid peroxidation, and α-tocopherol protects the body against free radical attacks, skin disorders, cancer and atherosclerosis (Lavelli and Bondesan, 2005).

No changes on the cellular structure are observed during olive processing; the most important transformations related to fermentation are the loss of hydrosoluble compounds (Ekinci, 2005; TDC Olive, 2006). Due to the relative instability of hydrosoluble compounds despite their role in nutrition, they should be monitored throughout the food chain. On the other hand, vitamins of the complex B (e.g. thiamine, riboflavin, niacin, pantothenic acid, biotin, pyridoxine, folic acid and cyanocobalamin) are hydrosoluble, so they are more susceptible to fermentation; these compounds play specific and vital functions in all forms of life. They can be synthesized by bacteria, yeasts, moulds, algae and some even plant species. Human beings cannot store most of them (except B12 and folate that are stored in the liver), so they need a daily allowance to be ingested (FAO/WHO, 2002). The vitamin requirements of *Lactobacillus pentosus* DSM 16366 isolated from olive brines were determined – and the riboflavin level in the brines did not suffer significant changes, unlike pantothenic acid and biotin, conversely, observed adventitious strains *Pichia membranaefaciens* produce vitamins of the B complex, whereas strains of *Saccharomyces cerevisiae* produced only riboflavin, vitamin B6 and folic acid (Reto *et al.,* 2006).

The mineral composition of table olives depends significantly on the cultivars and the mode of preparation. As expected for a brined food product, Na is the most abundant element, but olives are also a good source of Ca, K, Mg and P. Levels of Fe are also high in ripe olives, but relatively low in green and directly brined ones, whereas such microelements as Cu, Zn, Se and Mn appear at levels similar to other plants (Fernández-Diez *et al.,* 1985).

The phenol components contribute to sensory characteristics of olive products, further to their pharmaceutical and physiological benefits (Covas *et al*., 2006); the main classes of phenols in olive oil are phenolic acids, phenolic alcohols, hydroxy-isocromans, flavonoids, secoiridoids and lignans (Bianchi, 2003). Phenols have been proven to play several biological properties; for instance, hydroxytyrosol inhibits platelet aggregation and is an anti-inflammatory agent, while oleuropein promotes formation of nitric acid which is a powerful vasodilator and exerts a strong anti-bacterial effect (Visioli *et al*., 1998; Andreadou *et al*., 2007). The antioxidant properties of olives are associated with their free phenols and corresponding glycosides. Oleuropein is responsible mainly for bitterness, but its content decreases along maturation. Lactobacilli have an important role in the (biological) debittering process of naturally ripened olives (Rozès and Peres, 1996; Ghabbour *et al*., 2011); their metabolism leads to accumulation of derivatives with even higher anti-oxidant capacity, e.g. hydroxytyrosol (Marsilio *et al.,* 1998). This trait is a result of β-glucosidase activity of those microorganisms (Silva *et al*., 2011). Hydroxytyrosol appears to be safe – and has even been recognized as GRAS. Additional support for of olive oil effect on cardio-health was apparent when EFSA approved a ‘heart health’ claim for hydroxytyrosol (EFSA, 2011). Tyrosol and hydroxytyrosol are absorbed by humans after ingestion (e.g. via olive matrices) in a dose-dependent manner, and they are excreted in the urine as glucuronide conjugates (Visioli *et al*., 2000). Other phenolic constituents of olives have been associated with potent biological activities *in vitro*, including (but not limited to) antioxidant action (Pereira *et al*., 2006; Landete *et al.,* 2007).

III – Probiotic attributes of native lactic acid bacteria

Lactic acid fermentation has been for centuries the dominant method of biological preservation of vegetables around the world. Demand for lactic acid fermented products has never ceased – and is expected to rise in the near future. It is generally agreed among food scientists that 'fermented plant products' are nuclear 'foods of the future', because of their unique properties. Of particular interest for food fermentation indeed olives which remain one of the most important food industries in the Mediterranean Basin, with Spain, Italy, Greece, Portugal and France sharing the market as leaders (Patterson and Josling, 2005).

Despite its local and overall economic impacts, most olive brining is still carried out following artisanal practices, with a moderate degree of technological innovation. However, the uniqueness of fermented olives has made them unavoidable ingredients for gourmet recipes and gastronomic excellence; nowadays health-aware consumers seek them also for their biological origin and functional features (Garrido-Fernandéz and Lopez-Lopez, 2008).

Microorganisms bearing a health impact will likely remain important functional ingredients in the coming future; new strains will probably be identified, and foods will accordingly be developed to fulfil the needs of an ever increasing number of specific consumer groups. Increased understanding of the interactions prevailing between the gut microbiota, the diet and the physiological conditions in the host will open up new possibilities of producing new tailor-made ingredients and nutritionally optimised foods – both of which are expected to promote consumer health at large, namely via favourable microbial activities in the gut (Mattila-Sandholm *et al.,* 1999).

According to the FAO/WHO (2009), probiotics are live microorganisms which, when administered in adequate amount, confer a health benefit on the host; this implies passing through the gastrointestinal to sufficiently high viable numbers. Probiotic microorganisms alter favourably the intestinal microbial balance, promote intestinal integrity and mobility, inhibit the growth of harmful bacteria and increase resistance to infection. The effectiveness of probiotic microorganisms is considered to be population-specific –due to variations in gut microbiota, food habits and specific host-microbial interactions.

Most probiotic strains available in the market are of Western (or at least European) origin, so seeking for new indigenous probiotic organisms is in order. Fermented foods of plant origin have been increasingly considered as vectors for incorporation of probiotic cultures (Soccol *et al*., 2010), following the well-established worldwide know-how on manufacture of LAB-fermented vegetables. Native LAB can bring about health-promoting features (Kohajdová *et al.,* 2006).

Despite most probiotic strains employed commercially being originated on the gastrointestinal tract (Haller *et al*., 2001), plant matrices may be an alternative source. Unfortunately, only a few successful probiotic cultures in dairy products exhibit acceptable viabilities in plant matrices by the time of consumption; screening for LAB strains of plant origin for potential probiotic features may help overcome such technological challenges (Karasu *et al*., 2010).

The European olive production and export numbers are already impressive – but competition involving low-added value, traditional agricultural commodities developed by less developed countries in the Mediterranean basin and elsewhere has been on the rise. The production of probiotic olives fermented with (potential) probiotic bacteria isolated among their native microbiota and added so as become dominant raises new opportunities (Fernández-Diez *et al*., 1985; Oliveira *et al*., 2004); the selected bacteria may then be introduced into brines at the onset of fermentation so that thus can act as starters, and hence dominate the population and ensure proper fermentation while inhibiting undesirable microorganisms (Peres, 2011).

IV – Opportunity for product innovation

The primary role of diet is to provide enough nutrients to fulfil body building and energy requirements, yet pleasing the sensory organs and assuring convenience – while providing a feeling of social satisfaction and well-being, have also appeared as complementary roles. Recent scientific evidence has proven that diet may modulate several functions in the human body, as well as delay, or even decrease incidence of a few chronic diseases and health conditions (Newell-Mc Gloughlin, 2008).

A significant challenge for traditional food production is thus to improve its competitiveness by finding opportunities for innovation that may guarantee the safety of the products, while meeting general consumer demands and specific consumer expectations and attitudes (including towards traditional food). Integration of the rich history of European cuisine with the innovation-driven market is a particularly challenging task for food manufactures; and ensuring that the European food industry remains ahead in the value chain through use of appropriate advanced and innovative technologies in traditional food processing is a main priority for competitiveness (Peres *et al.,* 2012).

Over recent decades, consumption and development of probiotic foods has been increasing, as a result of the awareness of their beneficial effects towards gut health, as well as disease prevention and therapy. Food processes are now focusing on new non-dairy foods that can contribute to regular assumption of probiotics – e.g. by individuals with lactose intolerance, or subjected to diets lacking milk-derived products. Health-proactive ingredients – or nutraceuticals, and matrices that incorporate them – or functional foods, will accordingly be the major food trend of the 21st century. This may be accounted by a global population growing older and state health budgets increasing dramatically – besides realization that health-related items are sold at premium prices and have interesting profit margins. The food industry has thus been urged to design novel food matrices for use as vectors for delivery of probiotic strains – but claims can be used in labelling only after establishing their role beyond reasonable doubt (Peres *et al.,* 2012). Future studies are in great needs that collect data to definitely assess, by *in vivo* studies, whether the living bacteria, as well as the fruit beneficial components significantly improve health of consumers. If so, allegations can be proposed for certain types of table-olives be classified as functional foods, and thus develop a share in a much more interesting food market.

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