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Review

Main Benefits and Applicability of Plant Extracts in Skin Care Products

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Abstract: Natural ingredients have been used for centuries for skin care purposes. Nowadays, they are becoming more prevalent in formulations, due to consumers' concerns about synthetic ingredients/chemical substances. The main benefits reported for plant extracts, used in skin care, include antioxidant and antimicrobial activities and tyrosinase inhibition effect. In this review, some examples of plants from Portuguese flora, whose extracts have shown good properties for skin care are presented. However, despite the known properties of plant extracts, few studies reported the development of formulations with them. More work in this field can be accomplished to meet consumer demand.

Keywords: plant extracts; antioxidant activity; tyrosinase inhibition; antimicrobial activity; cosmetics

1. Natural Ingredients in Cosmetics

Skin constitutes the largest living organ that protects the body from the external environment, helping to regulate temperature and fluid balance, keeping out harmful microbes and chemicals and offering some protection against sunlight. The outermost layer of the skin is the *stratum corneum*, a selectively permeable, heterogeneous layer of the epidermis, which protects against desiccation and environmental challenge and retains sufficient water to allow it to function. Impairment in skin barrier function is often demonstrated by an altered integrity of the *stratum corneum*, with a consequent increase in transepidermal water loss and decrease in skin hydration [1,2].

Despite having no legal value, the term cosmeceutical is commonly used to define cosmetic products with active ingredients promoting drug-like benefits. Thus, a cosmeceutical have in their composition ingredients with medicinal properties that manifest beneficial topical actions and provide protection against degenerative skin conditions. They improve appearance by delivering nutrients necessary for healthy skin. They are able to improve skin tone, texture and radiance while reduce wrinkles. Cosmeceuticals are the fast-growing segment of the natural personal care industry [3,4].

Although natural ingredients have been traditionally used for centuries for skin care purposes, they are becoming more prevalent in contemporary formulations [5]. The term "natural" is defined as something or an ingredient that is produced by the nature or found in nature and is directly extracted from plants or animal products [6]. Sources of natural ingredients can include herbs, fruits, flowers, leaves, minerals, water and land [5]. The effect of natural ingredients in skin care products depends on their *in vitro* and *in vivo* efficacy and the type of dermatological base where they are incorporated [5].

The use of plants for medicinal purposes is as old as humanity and, in the coming years, it is likely we will see the continuation of the emergence on the market of new products containing natural oils and herbs. Plants were the main source of all cosmetics before the use of synthetic substances with similar properties [7]. Natural plant molecules remain particularly interesting for new research. However, the use of extracts requires paying special attention to the extraction methods, plant-to-solvent ratios and the content of active ingredients [8].

Additionally, the use of plant extracts in skin care products is highlighted by consumer demand, who are increasingly concerned with buying ecologically friendly products [9]. However, consumers are often not aware of the fact that natural products are a complex mixture of many chemical compounds that can be responsible for the development of adverse reactions. To overcome this potential problem, researchers should chemically characterize their extracts in respect to composition. Additionally, the *in vitro* cytotoxic potential of extracts could be performed in several human cell lines, before the use in humans and irritant potential of cosmetic formulations can be screened. These procedures can be an asset to ensure the safety of consumers who choose to use natural products and, consequently, the acceptability of the marketed product.

2. Benefits of Plant Extracts

The use of bioactive extracts or phytochemicals from a variety of botanicals in cosmetics accomplishes two functions: care of the body and as ingredients to influence the biological functions of the skin, providing the nutrients for healthy skin [10]. Generally, botanical products are a rich source of

vitamins, antioxidants, essential oils and oils, hydrocolloids, proteins, terpenoids and other bioactive compounds [11]. According to their composition, these extracts can provide different properties.

2.1. Antioxidant Activity

The oxidative stress is one of the major mechanisms for skin aging and dermatological conditions [12]. Ultraviolet radiation from sunlight is the most common exogenous factor harmful to the skin. The continuous exposure to environmental factors leads to alterations in the connective tissue due to the formation of lipid peroxides and reactive oxygen species (ROS), as well as enzymes action, which results in several skin disorders [13].

Free radical formation is naturally controlled by various beneficial compounds known as antioxidants. These are radical scavengers providing protection to the human body by inhibition of various oxidizing chain reactions. ROS generated exogenously react with various biomolecules present in the skin and play an important role in skin disorders [14,15]. In this regard, topical application of antioxidants provides an efficient strategy to enrich the endogenous cutaneous system, leading to a decrease in the UV-radiation mediated oxidative damage and prevent oxidative stress-mediated diseases [16–18].

Phenolic compounds are bioactive substances widely distributed in plants, being important constituents of the human diet. Plant phenolics comprise a great diversity of compounds, such as flavonoids (anthocyanins, flavonols, flavones, *etc.*) and several classes of non-flavonoids (phenolic acids, lignins, stilbenes) [19]. Natural antioxidants are effective in preventing free radical formation by scavenging them or promoting their decomposition and suppressing disorders. Some compounds inhibit the initiation or propagation of oxidative chain reactions, thus preventing or repairing oxidative damage done by body's cells promoted by oxygen [20].

Phenolic compounds are plants' secondary metabolites, and their concentration may be influenced by several factors including physiological differences, environmental and geographic conditions, genetic factors and evolution [21]. Antioxidant activity of phenolic compounds varies according to the molecular structures in presence [22]. The structure–activity relationship suggests the number of hydroxyl groups as the most important factor determining the antioxidant activity of the phenolic compounds [23].

The importance of phenolic antioxidants has remarkably increased in the last decade due to their high capacity to scavenge free radicals [24]. Phenolic rich plants could be used, for example, for prevention of skin harmful effects of UV radiation [25].

Phenolic compounds can be delivered to the organism in the form of plant extracts as medicines, dietary supplements and cosmetics. The extract composition in phenolic compounds is strongly influenced by the extractive method as well as the solvent use [26].

2.2. Tyrosinase Inhibition Effect

Melanin is a human pigment responsible for the colour of eyes, hair and skin. It is produced and secreted, through a physiological process called melanogenesis, by the melanocytes, which are distributed in the basal layer of the dermis. There are two types of melanin pigments produced by the melanocytes: eumelanin, black or brown, and pheomelanin, red or yellow. The colour of human skin and hair is determined by the type and distribution of melanin pigment. Each individual of the different racial groups have, in general, the same number of melanocytes; thus, the type of melanin produced depends

on their functioning, *i.e*., people with darker skin are genetically programmed to constantly produce higher levels of melanin [27]. Upon exposure of the skin to sun radiation, melanogenesis is enhanced by the activation of thyrosinase, a melanogenesis key enzyme [28].

Tyrosinase, a polyphenol oxidase, can catalyze two distinct reactions (Figure 1): the oxidation of L-tyrosine to L-dihydroxyphenylalanine (L-DOPA) (first reaction) and the oxidation of L-DOPA to dopaquinone (second reaction). Then, dopaquinone, through a non-enzyme-catalysed process, is transformed into leukodopachrome (third reaction). This compound is oxidized into dopachrome (fourth reaction), which is an extremely fast and non-enzyme-catalyzed process. Then, dopachrome is transformed to melanin through a series of chemical- and enzyme-catalyzed reactions. Thus, the referred process shows that dopachrome synthesis can be suppressed when any of the steps are inhibited. However, not all substances that can inhibit the formation of dopachrome are tyrosinase inhibitors, such as for example, thymol [29,30].

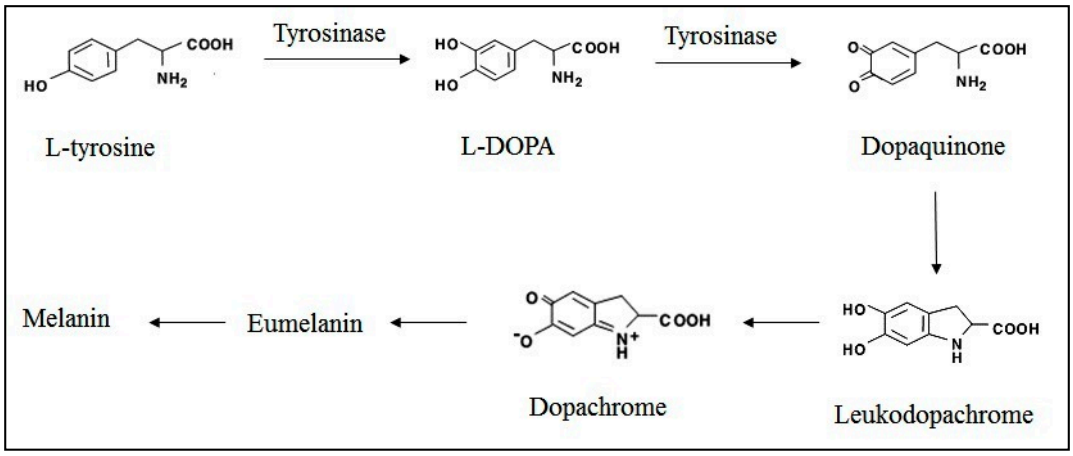

Figure 1. Representation of the melanin synthesis.

Melanin protects the skin against UV light damage by absorbing UV sunlight and removing the reactive oxygen species. Over-activity of tyrosinase leads to over-production of melanin [31]. Abnormal accumulation and biosynthesis of melanin pigments are responsible for skin disorders such as melasma, freckles and senile lentigo [32]. Numerous approaches have been attempted to find chemicals that inhibit the catalytic activity of tyrosinase, and disrupt the synthesis or release of melanin pigments. Many of these compounds have a tyrosinase inhibiting activity, leading to the decrease of melanin total production. Kojic acid, arbutin and different kinds of vegetal or herb extracts are some of the tyrosinase inhibitors used today [28].

The flavonoids, due to their ROS-scavenging activity and ability to chelate metals at the active site of metalloenzimes, present a pigment reducing action [33]. A number of flavonoids are frequently used in skin-lightening preparation such as aloesin, hydroxystilbene derivates and licorice extracts [28].

There are several tyrosinase inhibitors obtained from natural sources reported in literature which are used for depigmentation or for the disorder of hyperpigmentation of the skin [31].

2.3. Antimicrobial Activity

Cosmetic and pharmaceutical industries have an increasing interest in replacing synthetic antimicrobials in topical products. Besides the growing consumer interest for natural agents, microbial resistance to conventional antimicrobials is increasing [34].

Phenolic compounds are synthesized by plants for defense mechanisms [35]. They can act by interacting with the microorganism's cell membrane or cell wall, leading to changes in membrane permeability, and resulting in cell destruction [36,37]. Phenolics can also penetrate into bacterial cells and promote the coagulation of their content. In another way, phenolic compounds as natural antimicrobials could improve the shelf life of different products, inhibiting the growth of pathogenic microorganisms [38]. This is the case of pequi (*Caryocar brasiliense Camb*), a typical Brazilian fruit tree. The hydroethanolic extract of their leaves showed antibacterial activity against *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* [39].

3. Plant Extracts and Skin Care Products

The following sections are dedicated to common species whose antioxidant, tyrosinase inhibition and antimicrobial activities have been reported as positive for skin care products. The cited examples refer to extracts of plants that can be found in Portugal. Portuguese flora is rich in numerous plants that occur naturally and present potential applicability in health care, but are underexploited. The utilization of extracts from these plants could be an asset sustainable to the environment.

3.1. Castanea Sativa

Chestnut, particularly chestnut fruits and leaves are important sources of phenolic compounds [40,41]. However, Barreira *et al*. have also reported antioxidant properties in *C. sativa* flowers [42]. Portugal, particularly Trás-os-Montes, is one of the most important European producers of chestnut. The best growing conditions are found at altitudes exceeding 500 m and at low temperatures [41]. Several studies were conducted on chestnut by-products, namely, leaves and shells revealing to be a good source of phenolic compounds with marked biological activity, mainly antioxidant properties [43]. Rutin, hesperidin, quercetin, apigenin, morin, galangin, kaempferol and isoquercitin have been identified in *C. sativa* leaves [40,44].

Basile *et al.* have tested and verified the antimicrobial activity of a *C. sativa* leaves aqueous extract against *Escherichia coli*, *Klebsiella pneumoniae*, *Enterobacter aerogenes*, *Staphylococcus aureus*, *Proteus vulgaris*, *Pseudomonas aeruginosa* and *Enterobacter cloacae* [44].

In a study developed by Almeida *et al.*, a surfactant-free topical formulation containing an ethanolic *C. sativa* leaf extract was characterized. No changes in pH and 1,1-diphenyl-2-picrylhydrazyl (DPPH)-scavenging activity were observed after a 6 months storage period at 20 °C and *in vivo* moisturizing effect was demonstrated that, lasted at least 4 h after products application [45]. The safety and stability of this formulation for topical use was verified. It could be relevant in the prevention and treatment of oxidative stress-mediated diseases and photo-ageing [45].

3.2. Prunus Dulcis

Almonds (*Prunus dulcis*) belong to the *Rosaceae* family and consist of an outer hull with an intermediate shell that contains a kernel or edible seed covered by a brown skin. Portugal is an important producer of almonds, especially in Algarve and Trás-os-Montes [46,47]. Almonds are useful in the treatment of many disorders, including skin conditions like eczema and pimples [48]. Almond hulls, skins and shells are rich in phenolic compounds [49–52]. When the almonds maturity is reached, the hull splits open and it is obtained the shelled almonds. Normally, in industrial process, the skin (seed coat) is removed from the kern and then discarded. Therefore, in the last few years several research works have been conducted to evaluate the potential use of these by-products derived from almond industrial processing (skins, shells and hulls), as a source of compounds with antioxidant properties [50–56].

Keser and co-workers have determined antioxidant activities and phenolic, flavonoid, phytosterol, lipid soluble vitamin and fatty acids contents of almond kernel extract. The results obtained indicate that almond extract is a good natural source of these compounds [57].

Barreira *et al.*, have evaluated the antioxidant properties of almond green husks, demonstrating good antioxidant properties with very low Median Effective Concentration (EC_{50}) values, particularly for lipid peroxidation inhibition. Therefore, according to the authors, this by-product proved to have a high potential for application in new antioxidant formulations [58].

3.3. Juglans Regia L.

Walnut (*Juglans regia L.*) is a valuable crop that produces a nut that is very popular and largely consumed. Not only dry fruits (nuts) but also green walnuts, shells, kernels, barks, green walnut husks (epicarp) and leaves have been used in both cosmetic and pharmaceutical industries [59]. *Juglans regia L*. originates from the Near East, but nowadays it is widely cultivated in Europe, North-Africa and North-America [60]. Walnut's green husk is a by-product of walnut production, a rich source of phytochemicals, but with scarce use. Their valorization will increase the incomes of the walnut chain production, beyond decreasing a waste produced in large amounts. Different works demonstrated the antioxidant potential of walnut products, especially fruits, leaves and liqueurs produced by green fruits [59,61]. Results further support the fact that skins of walnuts, a rich source of phenolics, are responsible for effective scavenging of free radicals [62]. The extracts and pure phenolic compounds from *Juglans regia* L. might also be used as natural antioxidants and alternatives to synthetic antioxidants such as BHT (2,6-ditert-butyl-4-methylphenol) [23].

Walnut leaf has been widely used in folk medicine for the treatment of skin inflammations, hyperhidrosis and ulcers and for its antiseptic and astringent properties [63]. An ethanol:water leaf extract of *J. regia* presented good effectiveness against pro-oxidant species, and the scavenging effects have been described for some polyphenols. As suggested by the authors of the study, the walnut leaf can be used as a source of natural antioxidants, whose extracts can be used in dermatological bases preventing oxidative damage [64].

Walnut green husks can be used as an easily accessible source of compounds with health protective potential and antimicrobial activity [65].

3.4. Olea Europaea

Olea europaea fruits (olive) are an important crop in Mediterranean Basin, which produces about 98% of the total world production [66].

Olive trees, fruits, olive oil and olive mill waste contain hydroxytyrosol (2-(3,4-di-hydroxyphenyl) ethanol) and tyrosol (2-(4-hydroxyphenyl)ethanol). These phenolic compounds present antimicrobial, anticarcinogenic, anti-inflammatory and antioxidant activities [67–75]. In addition to its application as food additive and active pharmaceutical ingredient, hydroxytyrosol has great potential as cosmetic ingredient [76]. Due to the beneficial properties of these compounds, the use of olive extracts as raw material in the manufacture of cosmetic products seems to be an interesting innovation approach for cosmetic industries. As a consequence of olive oil extraction, a wet solid waste is produced. This by-product from the olive oil extraction is so rich in hydroxytyrosol and tyrosol that it can be used to produce high content olive extracts [77]. In the subsequent steps to refine and concentrate this product, different by-products containing significant amounts of hydroxytyrosol and tyrosol are obtained, such as dry solid wastes and fat-soluble liquid extracts. The cosmetic raw material to be obtained is a water-soluble liquid extract used as an ingredient. Additionally, the water-soluble olive extracts can be treated to obtain solid extracts, where hydroxytyrosol and tyrosol have been purified and concentrated. Therefore, it is necessary to develop analytical procedures to control the industrial processes to obtain the required olive extracts and to assess the quality of cosmetic products containing them [76].

Olive leaf has gained interest due to the numerous benefits for health, which is mainly attributed to oleuropein, which can constitute up to 6%–9% of dry matter in leaves, and related derivatives. However, other secoiridoids and flavonoids should contribute to the overall antioxidant activity of the olive leaf polar extracts [78,79]. Goulas *et al.* have demonstrated that olive leaves are a robust source of flavonoids and the total flavonoids contribute to 13%–27% of the total radical scavenging activity. The main leaf constituent identified and found to act as the dominant radical scavenger was luteolin 7-*O*-glucoside. These authors have concluded that olive leaf is a stable source of bioactive flavonoids [78].

3.5. Helichrysum Stroechas (L.) Moench

Helichrysum genus (Asteraceae) includes more than 500 species that are widespread around the world [80]. A great number of biological activities are usually attributed to this genus, such as anti-inflammatory, anti-allergic, antioxidant, antimicrobial, cough relief and treatment of colds and wounds [81]. Its chemistry is complex, with a wide variety of chemical classes including flavonoids, chalcones, phloroglucinol derivatives, essential oils, α-pyrones and diterpenes [82].

Helichrysum stoechas (L.) Moench (Asteraceae) is a perennial species growing to 0.5 m, in dry, rocky and sandy habitats of the Natural Park of Montesinho territory, Trás-os-Montes, North-eastern Portugal. *H. stroechas* (L.) Moench decoctions have been used with medicinal purpose for cold, bronchitis and fever [83]. Moreover, the antioxidant potential of extracts of this plant could support the development of cosmetic/cosmeceutical products [81,84–86].

Barroso *et al.* have characterized phenolic compounds of the hydroalcoholic extract and decoction of *H. stroechas* flowering areal parts and have evaluated their antioxidant potential. Eighteen phenolic compounds were identified and, comparatively to decoction, form the hydroalcoholic extract that

presented the highest antioxidant activity, which can be correlated with its higher phenolic compounds content. Additionally, the same authors have developed microspheres containing the lyophilized extract and these were subsequently incorporated into a moisturizer [86].

3.6. Quercus Robur

Oak (*Quercus rubur*) is a native tree in Europe, western Asia and northern Africa. Several polyphenols have already been identified from different parts of these plant [87,88]. *Q. robur* bark extracts have shown free radical scavenging activity, and against superoxide anion, hydroxyl radical and singlet oxygen [89,90]. Almeida *et al*. prepared extracts from oak leaves and verified the presence of ellagic acid, rutin and hyperoside, and phenolic compounds along with two unidentified flavonols. The ethanol:water (4:6) leaf extract presented potent free radical scavenging activity and iron chelating activity, as well as strong absorption in the Ultraviolet Radiation B (UVB) range. Considering the well-established role of free radicals and iron on the UV photodamage, the studied extract presented interesting features for application as topical antioxidant. The authors have also performed a patch test to study the skin tolerance of the extract verifying a good skin tolerance after a single application under occlusion [91].

3.7. Glycyrrhiza Glabra

Glycyrrhiza glabra, also known as Licorice or sweet wood, is native in Europe (Portugal, Spain, France, among others), Middle East (Syria, Turkey, Iran) and Asia (China) [88]. It is a perennial herb which possesses sweet taste. The main taproot, harvested for medicinal use, is soft, fibrous and has a bright yellow interior [91].

It was one of the most widely known medicines in ancient history. Licorice is good for skin eruptions, including dermatitis, eczema, pruritus and cysts. Anti-inflammatory, antiseptic and antibacterial properties were also described [88].

Some of the chemical constituents of *Glycyrrhiza glabra* have been identified as antioxidants, such as polyphenolic flavonoids [87]. Licorice contains glycyrrhizin, glycyrrhetinic acid, flavonoids, asparagine, *iso*-flavonoids and chalcones [91].

Glabridin is the main ingredient of the hydrophobic fraction of licorice extract and has been shown to inhibit tyrosinase activity in B16 murine melanoma cells [92,93].

Morteza-Semnani *et al.*, verified that licorice root extract were more effective than other commercial antioxidants in protecting hydroquinone from oxidative degradation, for three months [89].

Another interesting study was developed by Hara and co-workers, demonstrating that *Glycyrrhizia glabra* root extract effectively inhibit diacetyl formation, without bacterial effects. Diacetyl is a key contributor to unpleasant odors emanated from the axillae, feet and head regions, produced by resident skin bacteria. According to the authors, the results obtained in this study provide new insight that can contribute to the development of effective deodorant agents [94].

Upadhyay *et al.* have demonstrated that a petroleum extract of *Glycyrrhiza glabra* promotes hair grow since treated animals developed longer, denser, anagenic hair and took less time for hair cover the denuded skin of female rats, compared to control and minoxidil-treated groups [90].

3.8. Vitis Vinifera

Vitis vinifera is also known as wine grape, European grape and grapevine. Phenols are the third most abundant constituent in grapes. The total extractable phenolics in grapes are present at about 10% in the pulp, 60%–70% in the seeds and 28%–35% in the grape skin [95].

Vitis vinifera grape seed extract is reported to function as anti-caries agent, antidandruff, antifungal, antimicrobial, antioxidant, flavouring, light stabilizer and sunscreen agent [96]. Data obtained from Food and Drug Administration in 2012 reported the use of *Vitis vinifera* grape seed extract in 495 cosmetic formulations. Also, *Vitis vinifera* grape fruit extract and leaf extract have been used in 238 and 80 cosmetic formulations, respectively [97].

The grape seed hydroethanolic extract is rich in polyphenols (proanthocyanidins). The antioxidant and scavenging activities of proanthocyanidins had been reported by many authors. Proanthocyanidins potentially improve chloasma in a short period of administration. Yamakoshi *et al.* reported the oral administration of a proanthocyanidin rich extract from grape seeds for one year reduced effectively the hyperpigmentation of women with chloasma [98].

3.9. Crataegus Monogyna Jacq

The inflorescences of hawthorn (*Crataegus monogyna* Jacq.) have long been known in herbal medicine in Europe, Asia, North Africa and America. The flowers are white or rose and its fruits when matures are red [99]. *Crataegus monogyna* Jacq. is one of the species highly recommended in folk medicine and the "berries" are consumed by shepherds, hunters and children, because they are considered "healthy" and nutritious [100].

Hawthorn was first mentioned as a drug in the Tang-Ben-Cao (659A.D.), the world's earliest officially published pharmacopoeia [101]. In Portuguese, Pharmacopoeia 9 described the use of leaves, flowers and fruits (berries) [102]. Pharmacological and toxicological studies have demonstrated that the consumption of hawthorn fruits is associated with long-term medicinal benefits to cardiovascular function with little side effects [103]. During the nineteenth and early twentieth century, preparations containing the fruit, leaves and hawthorn flowers were available across Europe in single preparations or in combination with other plant extracts. The preparations can contain various constituents in different amounts, such as phenolic compounds, according to the harvest time, plant species and extraction method [104]. Furthermore, some studies also demonstrated hawthorn extract moderates antimicrobial activity [105].

The main applications described in cosmetic and dermatological field concern creams and lotions with glycolic extract of the flowers, with toning action on the skin tissue. These products have effect in aged skin and in combating wrinkles [99].

Many studies indicate that hawthorn fruits are a rich source of antioxidants (flavonoids, such as chlorogenic acid, epicatechin, hyperoside, isoquercitrin, protocatechuic acid, quercetin, rutin and ursolic acid) [100,103,106–109]. The structure of these hawthorn phenolic compounds is characterized by two adjacent hydroxyl groups. An antioxidant, in general, should be an excellent donor of electrons or protons, and the resulting free radical should be relatively stable. The two adjacent hydroxyl groups of hawthorn fruits are theoretically more vulnerable to loss a proton and the resulting free radical is stable

due to resonance delocalization. The thorn-apple is also rich in pigments such as anthocyanidins which also contribute to the antioxidant activity [103].

In our group, a thorn-apple hydroethanolic extract was developed, incorporated in a semisolid dermatological base and its efficacy on skin application evaluated, demonstrating promising abilities regarding skin hydration (unpublished work).

3.10. Pinus Pinaster

The bark of trees is a rich source of green chemicals. The accumulation of polyphenols in the bark results from plant evolution as a response to biotic and abiotic stresses [110]. Pycnogenol® is a nutritional supplement which represents a standardized bark extract from the French maritime pine (*Pinus pinaster* Ait.) in compliance with US pharmacopoeial requirements [111]. The extract is standardized to contain 70% ± 5% procyanidins, oligomers of catechin and epicatechin subunits, taxifolin and a range of phenolic acids, derivatives of benzoic and cinnamic acids [112]. Therefore, Pycnogenol® contains a variety of bio-active molecules known to exert beneficial effects on skin cells *in vitro* or in animal studies. Previous studies on Pycnogenol® effects on human skin indicate this supplement improves human skin conditions including chronic venous insufficiency and skin inflammation [113]. Furthermore, Pycnogenol® protects against oxidative stress in several cell systems by doubling the intracellular synthesis of anti-oxidative enzymes and by acting as a potent scavenger of free radicals [114]. Picnogenol® has attracted special attention in the field of Dermatology with regard to its application in cosmetic formulations. Some studies evidence that Pycnogenol® supplementation benefits human skin by increasing skin hydration and skin elasticity and show that these effects are most likely due to an increased synthesis of extracellular matrix molecules such as hyaluronic acid and possibly collagen [111,115].

In summary, it can be concluded that wood is also a promising source of natural antioxidants and in the future may have added value in the cosmetology industry.

4. Conclusions

Nowadays, consumers have an increasing interest in natural products, namely in the case of cosmetic products. On the other hand, several works refer to the advantages of plant extracts, such as antioxidant capacity, tyrosinase inhibition and antimicrobial activity, which can be beneficial for attenuation and prevention of various skin conditions.

The present review refers to some plant species whose extracts have been evaluated, and the potential advantages demonstrated. However, few works that focused on the development of formulations for skin application containing these extracts were reported. So, scientific studies aiming at the development, evaluation and application of such extracts in topical formulations and that simultaneously meet consumer concerns are a challenge.

Given the inherent economic potential in the exploitation of natural resources in ecosystems, plant extracts can be used in cosmetic science in order to beautify and maintain the physiological balance of the human skin. On the other hand, compared to synthetic cosmetic ingredients, herbal products are mild and biodegradable, exhibiting low toxicity. Furthermore, several by-products result from the plant processing industry (for example food industry) and represent a great disposal problem for industries. However, some of these by-products could also be a promising source of compounds with biological

properties favorable for cutaneous application. Nowadays, huge amounts of by-products are obtained without economic value but are potentially recoverable. Thus, natural plant extracts either from plants that occur in nature and wastes from plants processed industrially can be used to obtain new natural topical antioxidants, lighteners and preservatives, maximizing the utility of products currently underexploited or discarded.

In summary, many plant extracts, after being duly studied, can be a safe, efficacious and cost effective alternative to synthetic products.

Author Contributions

The authors have equally contributed for writing and revision of this article.

Conflicts of Interest

The authors declare no conflict of interest.

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