cosmetics

MDPI

Review

From Traditional Knowledge to Modern Formulation: Potential and Prospects of *Pistacia atlantica* Desf. Essential and Fixed Oils Uses in Cosmetics

Asma El Zerey-Belaskri [1,2,*], Nabila Belyagoubi-Benhammou [3] and Hachemi Benhassaini [2]

1 Laboratoire de Recherche: Biotechnologie des Rhizobiums et Amélioration des Plantes, Faculté des Sciences de la Nature et de la Vie, Université Ahmed Ben Bella Oran 1, Oran 31100, Algeria
2 Laboratoire de Recherche: Biodiversité Végétale: Conservation et Valorisation, Université Djillali Liabes, Sidi Bel Abbes 22000, Algeria
3 Laboratory of Natural Products, Department of Biology, Faculty of Natural and Life Sciences, Earth and Universe, University Abou-Bekr Belkaïd, Tlemcen 13000, Algeria
* Correspondence: asma.elzerey.belaskri@gmail.com

Abstract: *Pistacia atlantica* Desf. (Atlas pistachio) is one of the most widely distributed wild species of the genus. It is an Irano–Touranian species with a large geographic area that extends from the Canary Islands to Pamir Mountains. Since ancient times, atlas pistachio gum-like resin and fruits, very rich in essential oils (EOs) and fixed oils (FOs), respectively, were used in traditional medicine and included in different traditional cosmetics and health and beauty products. Since then, Atlas pistachio fixed oil is incorporated into several soaps, creams and shampoos to benefit from its medicinal properties. Atlas pistachio fixed oils, resin and leaf essential oils are constituted by several bioactive compounds such as monoterpenes with α-pinene and β-pinene in the resin, terpinen-4-ol, elemol, sesquiterpenes with *D*-germacrene and *E*-caryophyllene in the leaves and oxygenated monoterpenes (bornyl acetate) in the fruits. The unsaturated fatty acids (oleic, linoleic, palmitic and stearic acid), sterols (β-sitostero) and tocopherols represented the principal compounds in fatty oil fruits. All these compounds exhibit great therapeutic and cosmetic virtues. Unlike lentisk oil uses in cosmetology, the cosmetic potentials of Atlas pistachio oils remain less valued. In the current review, we seek to highlight the characteristics and properties of Atlas pistachio oils in the prospects of the development of new and different cosmetic formulations as well as an innovative valuation of active ingredients and products inspired by indigenous knowledge and practices.

Keywords: *Pistacia atlantica* Desf.; essential oils; fixed oils; cosmetic formulation; indigenous knowledge

check for updates

Citation: El Zerey-Belaskri, A.; Belyagoubi-Benhammou, N.; Benhassaini, H. From Traditional Knowledge to Modern Formulation: Potential and Prospects of *Pistacia atlantica* Desf. Essential and Fixed Oils Uses in Cosmetics. *Cosmetics* **2022**, *9*, 109. https://doi.org/10.3390/cosmetics9060109

Academic Editor: Othmane Merah

Received: 30 December 2021
Accepted: 19 October 2022
Published: 25 October 2022

1. Introduction

When Aristotle gave the living creature's classification using 'the soul' as a 'principal', he put human beings in a unique class based on their 'rational soul'. Aristotle (De Anima, III,7431b, 14–17) considers that this soul enables the human to have a manner of perception of 'images'. He continues and cites that " ... whenever it affirms or denies that something is good or bad, it pursues or avoids. Consequently, the soul never thinks without an image ... ". So, man is that creature who thinks, describes, distinguishes, and gives values. Among these values, we cite 'beauty'. The 'beauty' is the one which has from ancient times interested and fascinated man leading him to continuously look for products and rituals to take care of external body appearance but also for his wellbeing and welfare. Five thousands years earlier, the Egyptians, Sumerians, Assyrians and Babylonians used mud, plasters, ointments and plants in their spiritual rituals and personal grooming. Many Artifacts from these civilisations attest to this such as mirrors, cosmetic jars, combs, hairbrushes, and toothbrushes [1].

In 7000 BC, beauty and health-care products such as pomades and oils based on animal and vegetable fats were already in use in Kish and Mesopotamia, although seed pressing and nut oils extraction had not yet begun [2]. Scented products and fragrances would have been elaborated using oil and fat bases. The fragrance industry was well developed in Egypt, Mesopotamia, Crete and mainland Greece [3]. Since then, this know-how has spread throughout the world, giving a great interest to the content and the container. In fact, the art of fragrance has always kept a great place. The containers were in glass, bronze, lead, or precious metals such as silver and gold. The flakes could be, therefore, decorated with precious gemstones (Figure 1).

Figure 1. Ancient perfume flasks witnessing the luxury of fragrance bottles: (**a**) perfume flask in gold, decorated with a bold geometric pattern; (**b**) perfume flask in rock crystal, decorated with gold, silver, and precious gemstones, rubies and emeralds. Conservation: Museum of Islamic Art, Doha, Qatar. Personal photos taken by the first author with permission. February 2019.

The fragrance was obtained by the maceration of flowers, spices, barks, woods, and resins in oils. One of the oldest species used in healthcare products belongs to the genus *Pistacia*. It is assumed that resin obtained from several *Pistacia* species primarily from *P. atlantica* and *P. lentiscus* (Anacardiaceae) was the first natural chewing gum of the ancient world. Pistachio resin was known for its distinguishing flavour and therapeutic properties and was used subsequently to clean the teeth and freshen the breath [4]. Since the ancient Egyptian dynasties, Pistachio resin was a key ingredient in body-care practices and the mummification process and rituals. Several scientific analyses of pigments from ancient Egyptian tomb walls and funerary items showed a predominant presence of pistachio resin [5–7]. Brettell et al. [8] showed that resinous substances obtained from pistachio species were highly prized in the ancient world for use in Roman mortuary practices in acting to disguise the odour of decomposition. Wherever pistachio species occur, their fruits are appreciated mainly by the rural population for human consumption because of their oleaginous exocarp while the fatty oils are used either for consumption or traditional cosmetic recipes. The leaves are used principally for their medicinal virtues while young and fresh ones could be added to some traditional culinary preparations such as salads and bread [9]. In Palestine and some regions in Algeria, the fruits are crushed and added to the bread dough to give it an exceptional flavour [9].

Pistacia is not the only Anacardiaceae member known for exhibiting substances with cosmetic potentials; *Anacardium* species, mainly *A. humile* (monkey nut), *A. occidentale* (cashew tree) and *A. nanum*, *Rhus* species, the Burmese lacquer tree (*Gluta usitata*), *Mangifera indica* and several other members present advanced active ingredients for the pharmaceutical and cosmetic industries [10]. Bennett [11] placed the *Anacardiaceae* within the top 25 plant families of high economic importance.

In the current review, we attempt to expose *Pistacia atlantica* essential and fixed oil potentials in modern cosmetics but also to highlight craft use and traditional practices of this species with high patrimonial values.

2. Botanical Description and Variability of *P. atlantica*

One of the most widely distributed wild species of the genus, *Pistacia atlantica* Desf. is an Irano–Touranian species which occurs from the Canary Islands to Pamir Mountains [12]. In this large area, *P. atlantica* is known under several local names. It is called in the Arabic area (El bottom, btom, bettam, battach or botma for an individual tree) [13–15]. It is called by the Amazighs of the Maghreb (iggt, iqq, idj, tismelelt and tesemhalt [13,14], while it is named (Baneh) in persian, (Wana, Gwan, and Kasore) in different local dialects in Pakistan, (melengiç or atlantik sakizi) in Turkish, (Treminthos) in Italian [16], (Almácigo de Canarias) or (Lengua de oveja) in Spanish [17]. Atlas pistachio trees are strong and vigorous (Figure 2), characterized mainly by their dense foliage although the leaves are deciduous. The leaves are used by rural populations for dyeing textiles and to give a durable colouration, principally in traditional medicine [9,15,18]. In fact, the leaves are a rich source of bioactive compounds which interested researchers in several studies in the field of pharmacology.

Figure 2. *Pistacia atlantica* trees in different countries: (**a**), a great *P. atlantica* tree (female) in the region of Sidi Bel abbes (Algeria), June 2016; (**b**) a vigorous *P. atlantica* within a dense wild population (here, in an ancient Christian graveyard) in the region of Marrakech, Morocco, March 2018; (**c**) a beautiful *P. atlantica* (male) in the town centre of Famagusta (Northern Cyprus), October 2017. Personal photos taken by the first author.

Pistacia atlantica is very variable, with three subspecies (*P. atlantica* subsp. *cabulica*, *P. atlantica* subsp. *mutica*, and *P. atlantica* subsp. *atlantica*) qualified as eco-geographical ecotypes [19,20]. We don't cite here (*P. atlantica* subsp. *kurdica*) since this subspecies was elevated to the species level and is considered a distinct species [21]. Additionally, the variability is not observed only at the subspecies level but also between the different populations of the same subspecies. Moreover, the variability doesn't concern only the morphological features [22] but also the chemical profile of leaf essential oils, oleoresin, fatty oils and their potential biological activities [23–31].

The morphological variability concerns the habitus, the leaves, the trunk and the fruits [12,22,32–36]. Furthermore, several studies on micro-morphological variability have been also undertaken [37–40] revealing an interesting micro-feature variability.

The leaves are spectacularly variable (Figure 3) [22,34,36] causing difficulties, principally to sometimes distinguish the three subspecies. In North Africa, this variability induced for a long time hypotheses [12,35,41] that more than one subspecies may occur in the region until the study undertaken by El Zerey-Belaskri [15] on the diversity of *P. atlantica* subsp. *atlantica* in Algeria, stating that the great morphological variability is mainly due to ecological, chemical and genetic factors and that *P.atlantica* is represented in Algeria by the only subspecies *P. atlantica* subsp. *atlantica*. The following botanical description can be found in the literature: the leaves are pinnate, oval glabrous almost sessile and dark green with seven to nine lance-shaped leaflets waxy impair-pinnate with petioles a little winged. While El Zerey-Belaskri and Benhassaini [36] updated the *P. atlantica* subsp. *atlantica* key describing more morphometric and morphological traits and new features; new leaf and leaflet shapes and new features have been observed (up to 18 leaflets, up to 24.5 cm leaf length, up to 21.9 cm leaf width). The terminal leaflet may be petiolulated [36]. According to this updated key, the leaves, reaching 24.5 cm long and 21.9 cm wide, are composed of one to nine leaflet pairs, imparipinnate, deciduous, leaf rachis winged. being sometimes paripinnate by losing the terminal or the pre-terminal leaflet. Leaflets (1–) 2–8 (−9) pairs; lanceolate, oval, elliptic, oblong, rhomboid, obovate, (falciform); obtuse, acute, acuminate, mucronated, emarginate, rounded, retuse, and attenuate apex leaflet. The terminal leaflet is sessile or petiolulated (0.1–3.4 cm long) [36].

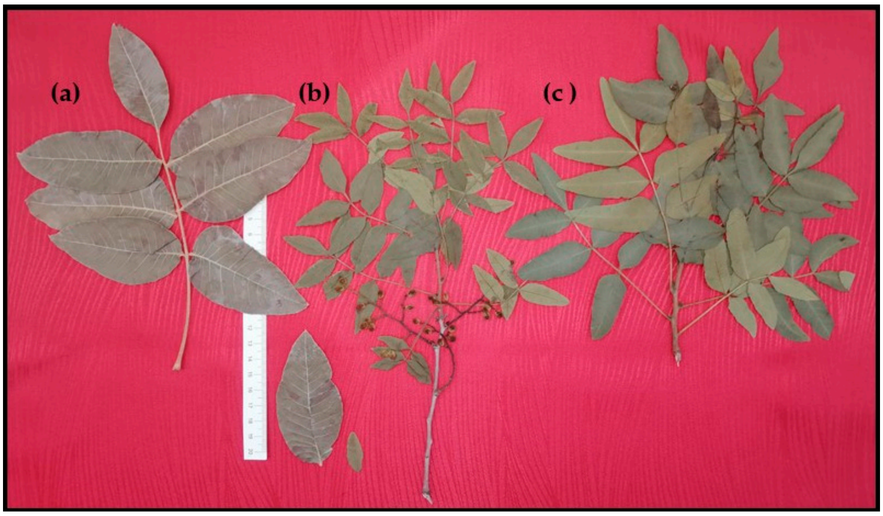

Figure 3. *Pistacia atlantica* leaves from different countries: (**a**) one of the largest *Pistacia atlantica* subsp. *atlantica* leaf, from Northwest Algeria, September 2014; (**b**) *Pistacia atlantica* subsp. *atlantica* branch with leaves and unripe fruits, from Marrakech, Morocco, March 2018; (**c**) branch with *Pistacia atlantica* leaves, in the town centre of Famagusta (Northern Cyprus), October 2017. Personal photo taken by the first author.

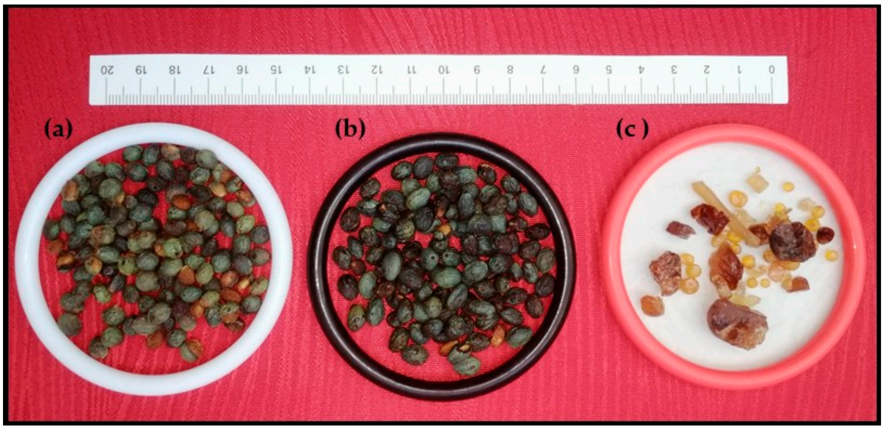

Figure 4. Atlas pistachio fruits from two countries and two different subspecies (**a** ≠ **b**) and resin: (**a**) *Pistacia atlantica* fruits from Iran. (**b**) *Pistacia atlantica* subsp. *atlantica* fruits from the region of El bayadh, Algeria; (**c**) *Pistacia atlantica* subsp. *atlantica* resin from the region of El bayadh, Algeria. Personal photo taken by the first author.

Likewise, the fruits are slightly variable. They (Figure 4a,b) are small (≤0.8/0.7 cm) with thin and oleaginous exocarp, and with a syncarp drupe, ovoid or ovoid-globose with an osseous endocarp of a green to dark green–blue or black colour when ripe [22,35,42,43]. The fruits are called by several vernacular names. In Algeria, they are called "Goddim" because of the hardness of their endocarp requiring strength to break them with teeth [15] and also "el khodiri" [35] because of their colour (from akhdar, green in Arabic). In other regions in Algeria, when the fruits are present in two colours (green and black), the rural people call the green ones "el khoddir" (from akhdar, in Arabic) and the black ones "el ko'hhil" (from ak'hal), black in Arabic [15]. Yaaqobi et al. [44] reported that the Atlas pistachio fruit is called 'Tikouaoueche' (an Amazigh noun) in Morocco. The fruit is edible and used traditionally in many recipes bringing power mainly because of its energetic fatty oil [45–47]. Belyagoubi-Benhammou et al. [48], evaluated the antioxidant activity of the flavonoid fractions of *Pistacia atlantica* fruit, stating that the fruits could be used as a source of natural antioxidants in food and pharmaceutical industries.

3. Potential Use of *Pistacia atlantica* Essential Oils (EOs) in Cosmetics

Essential oil, also defined as essence, volatile oil, etheric oil or aetheroleum, is a complex mixture of volatile constituents biosynthesised by living organisms [49]. If higher plants are the best-known and most important source of essential oils, some mosses, liverworts, seaweeds and some terrestrial and marine animals (sponges), insects, fungi, and microorganisms are also known to biosynthesise volatile compounds [50–52]. Interestingly, essential oils are added to cosmetics formulations for their pleasant aroma but principally for their valuable biological activities including anti-pathophysiological activity.

3.1. Chemical Composition and Variability

The volatile compounds of *P. atlantica* were investigated in the large area where the Atlas pistachio occurs, showing great variability in the chemical composition. Although the essential oil yield (Figure 5a) is quantitatively less important, regarding other aromatic plants, several chemical analyses were interested in this secondary compound present in mostly all the plant organs. In fact, *P. atlantica* EOs were found in ripe and unripe fruits [23], leaf-buds [24], twigs, flower galls [53,54] and in the resin, called consequently oleresin [23,55,56] (Figure 4c), nevertheless, the leaf essential oils remain the most targeted. Moreover, the leaf EO composition is characterized by high variability.

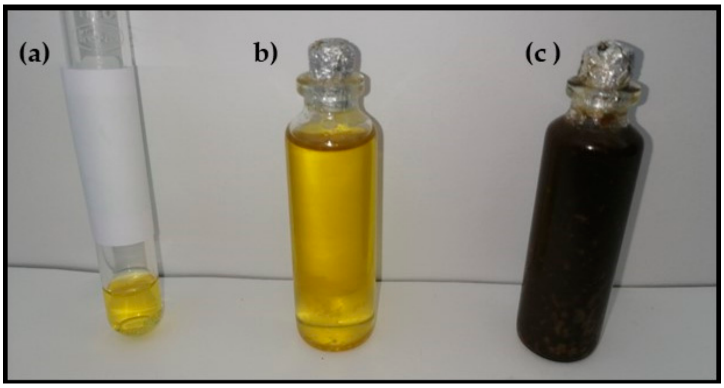

Figure 5. *Pistacia atlantica* subsp. *atlantica* oils: (**a**) essential oil obtained by hydrodistillation; (**b**) solvent fixed oil obtained by using a Soxhlet; (**c**) fixed oil obtained by using the traditional method; kindly provided by a friend from the region of El bayadh (Algeria). Personal photo taken by the first author.

Pistacia atlantica subsp. *atlantica*, is the only representative subspecies in the Maghreb, however, it occurs from the Canary Islands to Palestine, Syria, Jordan, Lebanon and Turkey in the Asian area [57]. It is "a characteristic tree" of the Saharan desert landscape in Algeria [58], and possesses a special consideration for people of all its distribution area [9]. This subspecies is the most studied regarding the essential oil compositions and biological activities, followed by *Pistacia atlantica* subsp. *mutica* (from Crimea, Turkey, Iran and the Caucus). *Pistacia atlantica* subsp. *cabulica* (from Afghanistan, Pakistan, and Iran) is not clearly mentioned in the chemical studies, nevertheless, it may be studied but cited as *Pistacia atlantica* without any precision of the subspecies. *Pistacia atlantica* subsp. *Kurdica* is not considered in the current review since, as noted below, it is elevated at the species level for *P. eurycarpa* as a specific name [21].

Pistacia atlantica subsp. *atlantica* leaf EOs from Algeria and Morocco have been deeply analysed, recording differently in α-pinene, terpinen-4-ol, germacrene D, E-caryophyllene, δ-3-carene, α-terpineol, γ-gurjunene/spathulenol/α-phellandrene as major compounds in several studies investigating seasonal, tree-sex and ecological variability factors [23,25,26,28–30,54,59]. Benhassaini et al. [56] analysed the chemical composition of the oleoresin, which was found to be dominated by α-pinene, β-pinene and carvacrol. Bornyl acetate was recorded as the major compound in fruit EO of *Pistacia atlantica* subsp. *atlantica*, in Morocco by Barrero et al. [23], while α-pinene, β-pinene and camphene dominated the chemical composition in Algerian *P. atlantica* [25].

From *Pistacia atlantica* subsp. *mutica* (in the Greek East Aegean islands, Kalimnos and Lesvos), leaf, bud-leaf and fruit essential oils were analysed. It was, therefore, reported that myrcene and terpinen-4-ol were found to be the predominant compounds in leaf EOs from female trees and terpinen-4-ol and *p*-mentha-1(7),8-diene in leaf EOs from male trees; terpinen-4-ol, myrcene and sabinene in unripe fruit EOs and *p*-mentha-1(7),8-diene, sabinene and α-pinene in leaf-buds EOs, while, sabinene, *p*-mentha-1(7),8-diene, germacrene D, terpinen-4-ol were found to be the major compounds in bud-leaf EOs [24]. In the same subspecies, widely distributed in Iran, the oleoresin was dominated by α-pinene [60] and by α-pinene followed by limonene oxide [61], while the fruit EOs showed α-pinene and camphene/β-myrcene/limonene as major compounds [53]. Eghbali-Feriz et al. [62] revealed that β-E-ocimene, myrcene, β-Z-ocimene, α-pinene, and E-caryophyllene composed principally the unripe fruit essential oil collected from *Pistacia atlantica* subsp. *mutica* from the Northeast of Iran.

On the other hand, Didehvar et al. [63] analysed oleoresin from Iranian *P. atlantica* (without any precision of the subspecies) and reported α-pinene, trans-pinocarveol, cis-limonene oxide, sabinene, and β-pinene as major compounds.

3.2. Potential of Pistacia atlantica EO Compounds in Cosmetics

Several conventional methods are used for essential oil extraction such as hydrodistillation, steam distillation, Soxhlet extraction, and solvent extraction while other advanced methods (microwave or SPME-based methods) are currently used to enhance oil yield with less sample amount. For *P. atlantica* EOs, hydrodistillation is still the most commonly used method although the efficiency of microwave techniques has been shown by using magnetic nanoparticle-assisted microwave (MW) distillation for *Pistacia vera* [64].

Essential oils are one of the most important natural products valorized for their organoleptic properties in the fragrance industry but principally for their various biological properties in cosmetics. They are composed of monoterpene and sesquiterpene hydrocarbons and their oxygenated derivatives, aldehydes, ketones, esters, ethers, oxides, lactones and coumarins, phenols [65]. The bioactivity of EOs is the sum of their constituents which act either in a synergistic or in an antagonistic way [66]. In addition to the smell and fragrance, essential oils are added to cosmetics products as preservatives particularly to prevent their oxidation. Their antioxidant potential acts as a protective agent in various products like moisturizers, lotions and cleaners, skin care cosmetics, conditioners, masks for anti-dandruff products, hair care products lipsticks, or fragrances in perfumery [67]. Preservatives are additionally, added to cosmetics to prevent microbial spoilage, as well as for the protection of consumers from potential infections.

3.2.1. Monoterpene Potentials

Monoterpenes are important fragrant molecules and suitable starting materials in the perfumery industry and cosmetic industries [65]. The monoterpenes in *P. atlantica* EOs are essentially represented by (α-pinene β-pinene α-thujene, camphene, terpinen-4-ol, δ-3-carene, *p*-cymene, limonene).

α and β-pinene are typically the most representative compounds of *P. atlantica* EOs although there is great chemical variability. These compounds are the most abundant bicyclic monoterpenes and are used as a fragrance substance to improve the odour of industrial products but also as precursors of important flavour and aroma compounds [68]. Additionally, monoterpenes are used in cosmetic products for their biological activities, α-Pinene is widely used as a fragrance in the cosmetics and household industry. *P. atlantica* leaf and resin EOs, being mostly an important source of α–pinene, were always evaluated for their microbial activities. Oleoresins, obtained from *P. atlantica* (from Iran) and *P. atlantica* subsp. *atlantica* (from Algeria), both dominated by α–pinene were tested, respectively, for their activity against *Helicobacter pylori* by Memariani et al. [60] and against *Candida albicans* by Benabdallah et al. [59]. According to Memariani et al. [60], all the tested *H. pylori* strains were susceptible to the essential oil. Furthermore, in a microscopic examination, *P. atlantica* oleoresin attenuated the destruction and necrosis of gastric tissue. On the other hand, Benabdallah et al. [59] revealed that the tested oleoresin showed bactericidal activity against *C. albicans*.

Helicobacter pylori is a common bacterium described first in the digestive tract as being the responsible agent for most ulcers in the stomach and small intestine. However, it is established that it also actually occurs in the oral cavity independently of stomach colonization [69]. Besides, *C. albicans* is considered to be the most common fungal pathogen of humans, manifesting itself in the oral cavity, causing oral candidiasis or thrush, female reproductive tract (commonly referred to as a yeast infection), and less commonly in the digestive tract. The bactericidal effect of pistachio EOs against buccal and stomachic flora remains the traditional use of pistachio resin and other organ plants.

Interestingly, it is known that the rural populations in the distribution area of Atlas pistachio used to chew the leaves and the resin of Atlas pistachio. This health and care practice is inherited from the ancient world where pistachio resin was used to clean the teeth and freshen the breath. Most compelling evidence shows that the indigenous knowledge regarding the medical use of Atlas pistachio corroborates the scientific findings.

Additionally, anti-Leishmania effects of *Syzygium cumini* leaf EOs and its major compound (α-pinene) were assessed by Rodrigues et al. [70] using MTT methods and macrophage cytotoxicity measurements. It has been shown that α-pinene exerts cytotoxic effects directly correlated with the different doses used against promastigotes of *Leishmania amazonensis* [70].

α-pinene and β-pinene showed cytotoxicity on tumour lymphocytes [71] while α–pinene revealed a positive antitumor activity in cell lines and in animal models of hepatocellular carcinoma [72], and a noticeable ability to induce, in vivo, apoptosis and antimetastatic properties [73]. In contrast, Buriani et al. [74] assessed human adenocarcinoma cell line sensitivity to EOs extracted from five *Pistacia* taxa (*P. lentiscus*, *P. lentiscus* var. *chia*, *P. terebinthus*, *P. vera*, and *P. integerrima*). According to the obtained results, they assumed that anti-tumoral activity was principally the effect exerted by the phytocomplex as a whole, which cannot be attributed to a single component but, rather, is likely the result of a complex network of simultaneous biological signals which contribute to the global cytotoxic effect.

Moreover, α-pinene and 1,8-cineole have been shown to present a beneficial effect on the equilibration of oxidant/antioxidant to protect against H_2O_2-induced oxidative stress in rat PC12 (rat pheochromocytoma) cells [75]. Pre-treatment with these monoterpenes inhibited the intracellular reactive oxygen species production and markedly enhanced the expression of antioxidant enzymes including catalase (CAT), superoxide dismutase (SOD), glutathione peroxidase (GPx), glutathione reductase (GR) and heme-oxygenase 1 (HO-1) [75].

β-pinene is known for its antimicrobial properties either purified or as part of essential oils [76–78]. β-pinene was one of the two main active principles of essential oil showing antidepressant-like and sedative-like activity and a clear potential in the treatment of sadness [79,80]. In fact, several essential oils are currently researched and in use as aromatherapy agents and cosmetics to relieve anxiety, stress, and depression.

Resources rich in terpinen-4-ol are used as antiseptics and antifungals to treat cuts, burns, abrasions and acne in a range of cosmetic products such as antiseptics, deodorants, shampoo and soaps. Thus, Huynh et al. [81] evaluated the antibacterial effect of two terpinen-4-ol-based cosmetic formulations against *Escherichia coli* and *Staphylococcus aurueus.* They revealed, in fact, a higher antibacterial activity against *E. coli* than *S. aureus*. In addition, the formulated cosmetic products have been appreciated by 28 female customers and showed satisfactory microbial standards for the cosmetics field according to Ho Chi Minh City Pasteur Institute (Vietnam) [81].

Indeed, Benabdallah et al. [59] attempted to determine the antimicrobial activity of *Pistacia atlantica* subsp. *atlantica* leaf EO dominated by terpinen-4-ol against *S. aureus*, *E. coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *E. albicans* and revealed a bactericidal effect against *S. aureus*, *C. albicans* and, *E. coli*.

Furthermore, Yang et al. [82] demonstrated that a solid-state terpinen-4-ol/β-CD inclusion complex, they prepared, clearly enhanced the antibacterial activity against *S. aurueus*, *P. aeruginosa* and, *E. coli*. Although terpinen-4-ol is known for its antimicrobial activities, this improvement could be attributed to that terpinen-4-ol being easily volatile and, especially, its low solubility in water limits its inhibitory effect. The enhancement also could be explained by the interactions of β-CD with terpinen-4-ol to form intermolecular hydrogen bonds, which improved its controlled release and water solubility [82].

Demodex mites (*Demodex folliculorum*) is the most common ectoparasite found in the human skin extending to the eye. Looking for a cosmetic formulation against these mites, Tighe et al. [83] assessed the killing effect of terpinen-4-ol on *D. folliculorum.* They stated that even though terpinen-4-ol exhibited a significant synergistic effect with terpinolene, deployment of terpinen-4-ol alone should enhance its potency in killing *Demodex* mites by reducing the adverse and antagonistic effects from other EO ingredients. They conclude that terpinen-4-ol could be adopted in future formulations of acaricides to treat a number of ocular and cutaneous diseases caused by demodicosis.

δ-3-carene was recorded as major constituent in *P. atlantica* in the Saharan region of Algeria by Gourine et al. [26]. This compound occurs principally in Cupressaceae exhibiting a high antifungal activity; proving to be a fundamental compound for this activity and an emergent alternative as an antifungal agent against dermatophyte strains [84]. Essential oils from other conifers with a high content of δ-3-carene and α-pinene possess important antibacterial and anti-inflammatory activities mostly against acne-causing pathogens and have therapeutic potential for diseases involving skin infections.

Plants and EOs with an important content of δ-3-carene could be targeted for cosmetic formulations for therapeutic potential, mainly in fungal diseases involving mucosal and cutaneous infections. However, the autoxidation of δ-3-carene to the hydroperoxide leading to eczematogenic and allergenic effects should be taken into consideration [85]. On the other hand, these oils, rich in δ-3-carene exhibit variable levels of antioxidant activities, evaluated in vitro in several studies. This variability was highly correlated with the quality and quantity of oil which is influenced by the harvest season, tree sex and the plant organs [26,27,53,54,86,87].

In *P. atlantica* EO chemical compositions, other monoterpenes with appreciable amounts were identified, such as *p*-cymene and camphene:

p-cymene is widely involved in the preparation and synthesis of dyes, medicines, fragrances and perfumes. *p*-cymene is known for its safety. This compound doesn't show genotoxicity, repeated dose toxicity, reproductive toxicity, local respiratory toxicity, phototoxicity/photoallergenicity, or skin sensitization [88,89]. Furthermore, this compound was shown to possess anti-tumoral activity [90].

Camphene is used as a fragrance and flavouring substance as well as in the production of cleaning agents produced that aim to eliminate or mask unpleasant smells (mainly as toilet fragrances, air fresheners and deodorizers). Camphene is converted to alkyl isobornyl ether, which is used in the formulation of cosmetics and perfumes [91]. In fact, acid-catalysed alkoxylation of terpenes is an important synthesis route to valuable terpenic ethers with many applications in the perfumery and pharmaceutical industry. Interestingly, for medical uses, camphene known for its antioxidant and anti-inflammatory activities was found to be able to significantly increase cell viability as indicated by MTT assay and LDH release assay [92]. Furthermore, it is used for renal and hepatobiliary disorders.

In addition, it is important to highlight that the antioxidant properties of essential oils are due to the synergetic effect of large amounts of monoterpenes and oxygenated sesquiterpenes which exhibited a significant ability to scavenge free radicals using 2,2′- diphenyl-1-picrylhydrazyl (DPPH) free radical-scavenging, ferric reducing antioxidant power (FRAP), β-carotene bleaching test, thiobarbituric acid reactive species (TBARS) and Rancimat assays [26,27,53,86]. The highest antioxidant effect was also demonstrated for seven predominant terpenoids (i.e., α-pinene, limonene, myrcene, geraniol, linalool, nerol, and terpineol) [93].

Essential oil also acts as an anti-inflammatory agent. This activity is assumed to be correlated to their antioxidant activities and their interactions with several key enzymes, signalling cascades involving cytokines, and regulatory transcription factors [86,94]. For *P. atlantica*, its essential oil possesses potent sedative and anti-inflammatory properties in different mice and rat based models using the carrageenan-induced hind paw edema test [95]. Another study revealed the therapeutic effects of applied doses of oral gum as well as volatile oil to reduce all indices of colitis and myeloperoxidase activity in an animal model of ulcerative colitis [96]. In addition, the essential oil of resin showed angiogenesis and skin burn wound healing in rats. The results of this study demonstrated a concentration-dependent effect on the healing of burn wounds by increasing the concentration of basic fibroblast growth factor (bFGF) and platelet-derived growth factor (PDGF) and by enhancing angiogenesis after 14 days of treatment by the plant [97]. The anti-inflammatory activity of *P. atlantica* has been proven by a cream formulated that contains oleoresin, alone and in combination with other systemic drugs [98]. In this work, the cream reduced pain, inflammation and restrictions of joint movement in patients with mild to moderate (grades 2 and 3) knee osteoarthritis. This effect is attributed to the high percentage of α-pinene which revealed the best analgesic effect by inhibiting some enzymes involved in inflammation caused by osteoarthritis.

3.2.2. Sesquiterpenes Potentials

El Zerey-Belaskri et al. [29] described for the first time two sesquiterpenes (Germacrene D and *E*-caryophyllene) as major compounds in *P. atlantica* leaf EOs, in particular natural populations. These populations were found to be in a distinctive group based on a molecular analysis [99]. Bicyclogermacrene was observed with a remarkable percentage in some *P. atlantica* EOs from Algeria by [26,29] while spathulenol was recorded as one of the main sesquiterpenes in *P. atlantica* EOs in the south region of Algeria [26].

Germacrene is known to be a bitter sesquiterpene olefin produced by several plants with antifeedant, antimicrobial and insecticidal properties [100]. Mosquitoes are the deadliest vectors of parasites that cause diseases mainly in Africa. In our opinion, this compound could be valorized for the cream formulation of cosmetic products with repellent activity.

Aloysia virgata EOs from Cuba and Brasil, dominated by germacrene-D, bicyclogermacrene, and *E*-caryophyllene were found to possess antifungal activity against *Candida albicans*, and antibacterial activity against *Escherichia coli*, *Bacillus cereus* and *Staphylococcus aureus* [101,102].

E-caryophyllene is a bicyclic-sesquiterpene, with a strong woody and spicy odour, widely used in cosmetology and perfumery as a fragrance chemical for its aroma quality since the 1930s [103,104]. Furthermore, it is incorporated into the ingredients of several non-cosmetic products such as household cleaners and detergents [105].

E-Caryophyllene is known for its anti-inflammatory effect [106–109], antibacterial [102] antiallergic effect [108] and local anaesthetic properties [106]. It is very used in medical and pharmacological fields, also for its analgesic activity and cytoprotective gastric effect [106]. EOs containing *E*-caryophyllene as one of the main constituents, evidently, showed antinociceptive and analgesic effects without inducing gastric damage [109]. *E*-caryophyllene in *P. atlantica* EOs is potentially an important element for dermo-cosmetic products.

In concordance with the traditional use of Atlas pistachio leaves, this organ is often used by the local population as an efficient treatment for stomach and gastric diseases. Moreover, Atlas pistachio leaf-boiled-water is used as a finishing bath lotion to treat skin problems [9].

Regarding its safety (GRAS-FDA 21 CFR 121.11.64) and distinctive smell and aroma, this compound is approved by the U.S. Food and Drug Administration as a food additive and a harmless element for the cosmetic compositions of face creams, hair care products, body lotions and shampoos.

Moreover, EOs rich in β-pinene, germacrene D, *trans*-β-caryophyllene, and α-pinene showed a clear antioxidant activity promising an interesting potential for the utilization of the oil in the prevention of oxidative damage in cosmetic creams [110]. Oxidation of unsaturated substances in cosmetic cream can affect its odour and colour and denature its quality, eventually leading to the formation of harmful compounds to health as well as to the product [110].

4. Potential Use of *P. atlantica* Fixed Oils (FOs) in Cosmetics

Pistacia atlantica, like the other members of the genus *Pistacia* has oleaginous fruits considered by several researchers. Fruit oil was considered a new source for the production of vegetable oils (Figure 5b,c) concerning the high amount of mono-unsaturated and omega-3 fatty acids. The oil content varied between 29.45% to 40% [46,111,112]. Several methods are used in oil extraction. Both traditional methods and modern extraction techniques (such as microwave assisted extraction (MAE), ultrasonic-assisted extraction (UAE) and supercritical fluid extraction (SFE) methods) are utilized.

4.1. Physical and Chemical Characteristics

The oil content variation has been shown to vary largely according to the genotype and climatic conditions [113]. It is noted that NO plays a highly complex role in the regulation of plant development. It plays a key function in seed oil accumulation and fatty acid composition [114]. Moreover, the oil extraction methods influence greatly the oil content [111]. Likewise, the chemical modifications which affect the quality of the vegetable oils are mainly due to several forms such as the esterification/transesterification by rearranging the acyl moieties to synthesize trimesters; estolide formation by modifying the acyl group after the hydrolysis of triglyceride and elimination of glycerol and formation of new ester bonds between the fatty acid chains and the epoxidation by modifying double bonds and subsequent ring opening to synthesize different diesters [112]. Compared to that extracted by pressure and by hexane, the supercritical carbon dioxide (CO_2) produced better oil quality with interesting physicochemical and a higher antioxidant activity with the existence of unsaturated fatty acids, sterols, tocopherols and polyphenols [115]. The physico-chemical proprieties of oil *P. atlantica* seeds obtained by Soxhlet extractor are shown in Table 1 [116].

Table 1. Physico-chemical proprieties of oil *P. atlantica* seeds: according to Achheb et al. [116].

Properties	Oil Extracted by Hexane
Density (20 °C)	0.917 ± 0.002
Refractive index (20 °C)	1.472 ± 0.001
Viscosity 20 °C (Cp)	85.000 ± 0.750
Acidic index (mg KOH/g)	8.350 ± 0.120
Peroxide index (meq O_2/Kg)	9.950 ± 0.950
Iodine index (g I_2 100 g)	88.000 ± 0.010
Saponification value (mg KOH/g)	204.490 ± 0.040
Unsaponifiable matter (%)	1.740 ± 0.010

Oils with lower values of viscosity and density are highly appreciated by consumers. These parameters increase with high saturation and polymerization [117]. For the refractive index of oils, its value depends on the molecular weight, fatty acid chain length, degree of unsaturation, and degree of conjugation [118]. The refractive index of *P. atlantica* seed oil was 1.472, which was slightly higher than the value observed for *P. lentiscus* (1.468), however, it is closely similar to the standard range reported by Firestone [119] for *Pistacia vera* (1.467–1.470). The iodine value is highly correlated with the refractive index. Its value measures the degree of unsaturation in fats, oils and waxes. In *P. atlantica* fruit oil, the high iodine value (88 of I_2/100 g) indicated a high nutritional value. The acid index with low value is very appreciated in the cosmetics industry and is associated with the amount of free acid formed from enzymatic hydrolysis reactions of triglycerides. It is considered to be more representative of oil quality during harvesting, handling or processing [120]. The acid value of the *P. atlantica* oil was high (8.350 ± 0.120 mg KOH/g oil). This value is close to that reported for *P. lentiscus* (7 ± 0.3 mg KOH/g oil) [121]. The peroxide index (9.950 ± 0.950 meq O_2/kg) of *P. atlantica* oil reported in this study is slightly lower than the one noted for *P. lentiscus*, (10 ± 0.04 meq O_2/kg) [121]. For saponification (204.490 ± 0.040 mg KOH/g) and unsaponifiable matter (1.740 ± 0.010%), their values were higher than that reported for the same plant [119].

4.2. Chemical Composition and Variability

4.2.1. Fatty Acid Composition

Fatty acids composition of Atlas pistachio fruits was reported in several studies, showing a quantitative variability due to the extraction methods, maturity stage of fruits, Atlas pistachio subspecies and geographical origins (Table 2).

Table 2. Fatty acids composition of *P. atlantica* samples obtained by CG (%).

		Geographical Origins	Palmitic Acid	Palmitoleic Acid	Heptadecanoic Acid	Cis-10-Heptadecenoic Acid	Stearic Acid	Oleic Acid	Linoleic Acid	A-Linolenic Acid	Arachidic Acid	Cis-11-Eicosenoic Acid	Saturated Fatty Acids	Monounsaturated Fatty Acids	Poly-Unsaturated Fatty Acids
			C16:0	C16:1	C17:0	C17:1	C18:0	C18:1	C18:2	C18:3	C20:0	C20:1	SFA	MUFA	PUFA
Ziyad et al. [122]	Immature Fruits	Laghouat	18.8	0.35			0.84	55.4	21.9	0.74	ND		19.6	55.7	22.6
	Mature		14.7	0.39			2.6	53.5	24.9	0.71	0.26		17.5	53.8	25.6
	Immature fruits	Ain oussera	19.4	0.22			0.32	52.3	25.9	0.74	ND		19.7	52.5	26.6
	Mature fruits		12.7	1.1			1.6	51.6	29.4	0.61	0.22		14.7	52.7	30.0
Salhi et al. [115]	Fruits Pressure extraction	Elkharrouba (Tunisia)	11.32	0.12	0.07		2.36	56.80	28.83	0.32	0.18				
	Hexane extraction		11.30	0.23	0.07		2.41	56.67	28.82	0.35	0.15				
	Supercritical CO_2 extraction		11.42	0.15	0.05		2.33	56.12	29.45	0.33	0.15				
Hazrati et al. [123]	kernel	Kazerun (Iran)	20.20	2.97	0.06		2.02	53.15	20.41	0.71	0.15	0.32	22.59	56.44	21.12
Bentireche et al. [124]	Unripe	Laghouat (Algeria)	14.46	Tr			1.65	49.96	31.63	0.75	Tr	0.26	16.42	51.09	32.38
	Middle maturity		18.64	Tr			1.63	51.32	25.35	0.75	0.08	0.27	20.37	53.46	26.11
	Ripe		19.95	Tr			1.49	52.77	22.41	Tr	Tr	0.22	21.68	54.33	23.56
Labdelli et al. [111]	Seeds	Djelfa	26.7	1			2.1	40.9	26.8	1.1	0.1	0.2			27.9
Mohammadi et al. [125]	Hull	Shirez (Iran)	29.84	1.7			1.49	42.84	5.85	2.75			31.33	59.84	8.6
	Kernel		11.24	1.02			2.76	57.77	26.64	0.56			14	58.79	27.2
Gharsallaoui et al. [126]	Seeds	Tunisia	11.16	0.23	0.04	0.03	2.42	56.35	28.74	0.35	0.14	0.46			
Guenane et al. [127]	Fruits mature	Laghouat (Algeria)	25.1	0.5			1.9	49.6	22.0	0.8	Tr	Tr	27.1	50.1	22.8
	Intermediate maturity		17.5	0.7			2.2	53.1	25.6	0.7	Tr	Tr	19.7	53.8	26.3
	Immature		13.9	0.3			2.2	51.7	30.8	0.8	Tr	Tr	16.2	52.0	31.7
Saber-Tehrani et al. [128]	Seeds		13.12	2.04	0.07	0.09	2.78	50.65	29.76		0.17		16.51	53.10	30.39
Yousfi et al. [45]	Fruits	Algeria	24	1.2			1.8	46	27.4	-					
Ghalem et al. [129]		Sidi Bel Abbès (Algeria)	12.2	1.8			2.4	54.2	28.8	0.4	0.1				29.3
Benhassaini et al. [46]	Fruits	Tlemcen (Algeria)	12.2	1.8			2.4	54.2	28.8	0.4	0.1				29.3

Tr: Trace.

Numerous studies reported that the fatty acid composition of *P. atlantica* oils shows a high content of unsaturated fatty acid, notably oleic acid from 40.9% to 81% [111,130–134] and linoleic acid from 20.41% to 29.4% [46,122,123].

Linolenic (C18:3), stearic (C18:0), and palmitoleic (C16:1) acid were less present in the fruit oil, while myristic (C14:0) and arachidic (C20:0) acid were only present in trace amounts [122]. These values varied according to the harvest month, which is in turn correlated to the maturation stage [122,124,133]. The ratio of unsaturated/saturated fatty acids was significantly higher in immature fruit oil (3.43–5.19) compared with the mature ones [123,124,128].

4.2.2. Phytosterol Composition

Phytosterols are naturally occurring in plants and cannot be synthesized in humans. They play major functions in several fields like pharmaceuticals (production of therapeutic steroids), nutrition (anti-cholesterol additives in functional foods, anti-cancer properties), and cosmetics (creams, lipstick) [135,136].

In comparison to other seed oils, pistachio oil had a typical distribution of sterols, characterized by a high content of β-sitosterol, and by a low content of campesterol and stigmasterol. Δ^5-Avenasterol had an intermediate distribution [130].

The major sterol of the *P. atlantica* seed oil is β-sitosterol (85 to 87%) [45,46,128,137]. The next major components are campesterol (4 to 4.35%) and Δ^5-avenasterol (2 to 4.35%). Each of the $\Delta^{5,24}$-stigmastadienol, Δ^7-avenasterol and stigmasterol amounted to about 1% of the total amount of sterols. The level of stigmasterol was absent in fruits harvested from *P. atlantica* from the southern region of Algeria but was twofold higher in the north (11%) [46]. Cholesterol is present at low levels (0.4%). The total sterol content in wild pistachio was 2164.5 mg kg^{-1} oil [128,137].

4.2.3. Tocopherol Composition

It was noticed that the tocols (tocopherols and tocotrienols) had potential health benefits, they contribute to the prevention of certain types of cancer, heart disease, and other chronic ailments [138]. In edible oil, the high concentration of these phenolic antioxidants plays a major role in preserving mono- and polyunsaturated fatty acids [139]. For that, research of vegetable oil as a source of natural antioxidants is very encouraged in cosmetic and pharmaceutical applications as therapeutics and skincare active moieties against collagenase and elastase activities [140,141].

Tocopherols and tocotrienols are monophenols, and exist in four different isoforms (α, β, γ and δ), that differ from each other by the number and location of methyl groups in their chemical structures [142]. In *P. atlantica*, the fruit oil appears to be richer in tocopherols which vary depending on the developmental stage and the maturation degree of the fruits [124,143]. Their contents had a high value in immature fruit oil (50.7 ± 7.9 mg/100 g oil) compared to intermediate (44.3 ± 8.1 mg/100 g) and mature fruits (34.1 ± 10.9 mg/100 g) [143]. The predominant tocopherol in wild pistachio cold-press oil was α- tocopherol with 379.68 mg/kg. The amounts of (γ + β)-tocopherol and δ-tocopherol were 20.70 and 9.59 mg/kg of oil [128]. On the other hand, the tocopherols analysis performed for eleven samples of *P. atlantica* fruit oils extracted by n-hexane showed a dominance of α- and γ-tocopherols [143]. These compounds contribute the highest antioxidant propriety of oil with the participation of phenolic compounds [124]. It may be noted that the extraction method did not affect the content of tocophenols in fruit oil of *P. atlantica* obtained by three techniques i.e., supercritical CO_2, organic solvent (hexane) and cold pressing [126].

4.2.4. Pigment Composition

Besides, their use as antioxidants in dietary supplements and pharmacological agents, the carotenoids can be employed in cosmetics against photoaging effects on the skin, irritation, acne and cancer. They play the role of a filter to absorb ultraviolet radiation [144]. The chlorophylls represent not only the most abundant natural pigment molecules intervening in photosynthesis, but they have numerous therapeutic properties on inflammation, oxidation, wound healing and cancer prevention [145]. Moreover, these molecules have also been used as colouring agents and anti-ageing components in cosmetic products where they are added to creams and soaps [146].

In *Pistacia atlantica* fixed oils, it is shown that tocopherols and carotenoids were the major constituents of the unsaponifiable matter [133]. Pheophytin a (12.02 mg/kg), and luteoxanthin (10.41 mg/kg) represent the major carotenoid components, followed by lutein (5.2 mg/kg). The compounds neoxanthin, violaxanthin, lutein isomers and pheophytin a were also present with low contents, ranging between 0.15 to 1.46 mg/kg. For chlorophylls, their amounts were 0.92 and 1.19 mg/kg for chlorophyll a' and chlorophyll a, respectively [128]. As tocopherols, the carotenoids showed the highest level in ripe fruit oil compared to other stages of development [133].

4.2.5. Total Phenol and Flavonoid Contents

Total phenolic and flavonoid contents of *P. atlantica* fatty oil were 130.77 ± 3.11 mg gallic acid equivalent/100 g oil and 126.91 ± 4.41 mg quercetin/100 g oil, respectively [123]. These contents decrease with fruit maturation from 2.51 to 0.13 mg GAE/100 g oil and 1.64 to 0.09 mg quercetin/100 g for phenolic and flavonoid contents, respectively.

According to Farhoosh et al. [147], the greatest total phenolic concentrations have been recorded in fruit oils of *P. atlantica* subsp. *mutica* (81.12 mg gallic acid equivalent/kg) and *kurdica* (56.51 mg gallic acid equivalent/kg).

Additionally, Saber-Tehrani et al. [128] stated that caffeic acid (1.96 ± 0.04 mg/kg oil), cinnamic acid (0.67 ± 0.02 mg/kg oil) and pinoresinol (0.64 ± 0.01 mg/kg) were the predominant phenolic compounds in *P. atlantica* oil obtained by cold-press. Other compounds such as ferulic acid, o-coumaric acid, vanillin and ρ-coumaric acid were present at low levels.

4.3. Biological Activities

Some reports cited above studied the biochemical composition of fruit oil which contains interesting nutritional properties such as a high oleic acid content, phytosterols, carotenoids, phenolics and tocopherols. These essential compounds contribute to human health benefits for their antimicrobial, antioxidant, anti-inflammatory, immunity correction, hypocholeserolaemic, antiatherogenic, anticancer, digestive etc. Given these elements, Atlas pistachio fruit oil could be a promising component for cosmetics.

4.3.1. Antimicrobial Activity

The previous studies reported the highest contents of oleic and linoleic acids in *P. atlantica* fatty oil. These compounds have potential antibacterial properties which are partly attributed to their unsaturated long-chain lengths with 12–18 carbons [148]. This observation is consistent with previous work carried out with *P. lentiscus* fatty oil and its phenolic extract [149]. Additionally, it is noted that linoleic and oleic acids showed their growth inhibition against the Gram-positive bacteria but were inactive against the Gram-negative ones [150].

4.3.2. Antioxidant Activity

The antioxidant activity of *P. atlantica* crude oils might be attributed to the presence of tocopherols, carotenoids, and unsaturated fatty acids in particular omega-three fatty acids [133]. Another study, carried out on the stage of development of *P. atlantica* fruits showed positive correlations between flavonoid contents and total antioxidant capacity for unripe and red fruits [151].

4.3.3. Anti-Inflammatory Activity

Pistachio oil had been reported to possess anti-inflammatory activity. The fruit oil constituted of linoleic acid, oleic acid and stearic acid, as the major components, exhibited significant wound healing and anti-inflammatory effects of oil-absorbed bacterial cellulose in an in vivo burn wound model [152]. This oil can be used as a potential bio-safe dressing for wound management. In addition, *P. atlantica* fruit oil may be efficient for ulcerative colitis [153]. Tanideh et al. [153] stated that a high dose of oil reduces colonic injury by suppressing oxidative damage in rats when administered orally and rectally.

The oil of wild pistachio may modulate hypothyroidism and its effects on serum lipid profile and leptin concentration, modulate hypothyroidism and its effects on serum lipid profile and leptin concentration [154].

In 2017, Hamidi et al. [155] revealed the effects of topical application of a gel formulation prepared with 5%, and 10% of *P. atlantica* oil on cutaneous wound healing in an experimentally induced cutaneous wound model in rats. This study showed a re-epithelialization with continuous stratum basalis and mature granulation tissue and adnexa (hair follicles and sweat gland) with Atlas pistachio oil gels (especially Bene 10%) at 21 days post-injury.

Interestingly, the fixed oils traditionally extracted by the rural populations from Atlas pistachio fruits are widely used and recommended for rheumatoid arthritis and joint pain. The oil is directly applied over the painful area with a light massage to heat it and for greater adherence.

4.3.4. Antihyperlipidemic Effects

Unsaturated fatty acids in *P. atlantica* fruit oil modulated serum leptin, thyroid hormones, and lipid profile in female rats with experimentally induced hypothyroidism caused by propyl thiouracil (PTU) [154]. Jamshidi et al. [156] revealed the preventive effects of *P. atlantica* subsp. *mutica* oil, *P. atlantica* subsp. *mutica* resin and mixture oils in reducing metabolic syndrome risk. By measuring the lipid profiles, glycaemic indices, oxidative stress and inflammatory parameters, the results showed that consuming *P. atlantica* subsp. *mutica* oil was more effective than other oils (wild pistachio resin and mixture oils) in preventing hyperglycaemia, hypertriglyceridemia, hypercholesterolaemia, inflammation and pancreatic secretory disorders.

Phytosterols are important micronutrients in human diets, they form the unsaponifiable part of *P. atlantica* oil. They play an essential role in the reduction of cholesterol in the blood and therefore decrease cardiovascular morbidity [157]. β β-sitosterol ester with linoleic acids and β-sitosterol self-microemulsions have positive hypolipidaemic effects on hyperlipidaemic mice [157].

4.3.5. Antidiabetic Activity

It was shown that the resin oil of *P. atlantica* represents the best wound healing agent in STZ-induced diabetic experimental rats [158]. This oil improves blood flow and vascularization by elevation of vascular endothelial growth factor (VEGF) levels and reduces harmful effects of diabetic oxidative status, as well as burn damage in the wound area.

4.3.6. Cytotoxic Activity

Thanks to its chemical composition, *P. atlantica* fruit oil may be used for its anticancer potential. It is well noted that the fatty acids [159], unsaponifiable fraction [160], α-terpineol [161] and β-sitosterol [162] have the potential to reduce the proliferation of and induce apoptosis. It has been investigated whether the vitamin E and its tocopherol members (α-, β-, γ-, δ-) and tocotrienols (α-, β-, γ-, δ-) showed a strong association with the prevention of cancer and inhibition of tumour, both in vitro and in vivo [163].

The traditional extraction of oils (Figure 5c) had limited its utilization to domestic consumption and use. Whereas, with the availability of electric grinder–extractors, many artisans currently extract the fatty oils and sell them in herbalist shops or using electronic trade (e-Commerce). Therefore, Atlas pistachio fatty oil is increasingly experienced and appreciated. It is used to treat hair and skin damage as it is recommended since ancient times. Furthermore, it is incorporated into several handicraft cosmetics products such as soaps, shampoos, and protective repair and moisturizing creams.

5. Innovation and Modern Formulations for the Cosmetics Industry

Nanotechnology is a burgeoning scientific approach in research and presents potential applications in diverse fields, including biomedical, pharmaceutical and cosmetics industries [164]. Among the various nanoparticles used since the development of nanotechnology applications, silver nanoparticles (AgNPs) have attracted the attention of researchers in the last two decades [165] due to their useful characteristics in several fields, principally in cosmetics and care products. *Pistacia atlantica* leaf extract from Iran was used to synthesize pure crystalline and spherical green AgNPs with a high surface area of about 27 nm average size [165]. The results suggest that the synthesized AgNPs act as an effective antibacterial agent (e.g., against *Staphylococcus aureus*) and are capable of rendering high antibacterial efficacy and so possess a great potential in the preparation of drugs used against bacterial diseases, but mostly in cosmetic products [165]. The authors state that *Pistacia atlantica* is a very good eco-friendly and nontoxic source for the synthesis of Ag-NPs as compared to conventional chemical/physical methods [165].

P. atlantica fruit oil is one of the most nutritious vegetable oils which can be used as a carrier in lipid formulations. The use of vegetable oils in lipid nanoparticle preparation constitutes a promising field to treat diverse pathologies. These therapeutic activities are a result of synergistic effects by interactions of vegetable oil lipid carriers and active compounds [166].

The nanoformulations based on unsaturated fatty acids, carotenoids, retinoids, and tocopherols are employed as excipients in cosmetics and personal care products to alleviate skin disorders like irritation and inflammation [167]. Among the major fatty acids with potential applications, linoleic acid (omega-6) and α-linolenic acid (omega-3) were used in the prevention and treatment of inflammatory skin diseases such as atopic dermatitis, psoriasis and acne [168].

6. Challenges of the Use of EOs and FOs of *Pistacia atlantica* in the Cosmetics Industry

Although essential oils are used for their biological activities (antibacterial, antifungal, anti-inflammatory, antioxidant) and preservative properties against contamination, the safety issues regarding the use of EOs should not be neglected. EOs may induce allergenic and chronic toxicity risks if they are not added based on an accurate assessment. Nevertheless, the essential oil of *Pistacia atlantica* is known for its low toxicity [169]. Indeed, EOs with α-pinene as a major constituent have very low toxicity and would be a good candidate for use in health products [170]. The chemical variability also constitutes a great challenge for the use of *P. atlantica* EOs in the cosmetics industry, mainly when the plant material is brought from natural populations or populations under different environmental conditions. In addition, regarding the use of *P. atlantica* VOs in the cosmetics industry, the principal challenge is how to provide sufficient plant material (the fruit) without over-exploitation. In this sense, one of the main challenges is that fruit over-exploitation may induce a conflict between socio–economic and industrial needs. However, the valuation of Atlas pistachio EOs and VOs remains a major opportunity for dynamic rural development.

At the end of this paper, we believe that natural resource utilization should receive all our consideration. Atlas pistachio regarding its spiritual, social and economic value, but also its alarming situation as a threatened species, needs to be given particular consideration. The species should be intensively and broadly included in reforestation schemes and programs in the whole of its wide area to ensure sustainable valorization and to provide sufficient production.

7. Conclusions

Because of their health problems, toxicity and carcinogenicity, the use of synthetic compounds in several fields such as the food industry, drug industry, and cosmetics is currently being limited. Consequently, the search for new natural sources and novel natural bioactive compounds has been very accentuated in recent years.

Pistacia atlantica essential and fixed oils have been valorized and used in traditional medicine for the treatment of various diseases. Fruits and fatty oils are widely consumed as a nutrient by the local populations. They constitute a major source of beneficial compounds such as fatty acids with a predominance of oleic and linoleic acids, phenolic compounds, and unsaponifiable matter with their active molecules (tocopherols, phytosterols and carotenoids) which exhibited a large panel of health benefits. Both *Pistacia atlantica* essential and fruit oils have not been widely used for industrial applications. Nevertheless, the traditional uses and the indigenous knowledge have recently inspired modern cosmetic formulations but also cosmetic handicraft products which currently represent an emergent market in natural-based beauty and care products.

To the best of our knowledge, the current paper is the first review focusing principally on the potential of the use of EOs and FOs of *P. atlantica* in cosmetics. The chemical compositions of Atlas pistachio essential and fixed oils present a promising source for potential applications in pharmaceuticals and cosmetics as a single product or nanoformulation in the form of moisturizers, anti-ageing serums, makeup removers and massage oil. Thus, further field investigations and ethnobotanical surveys will provide useful information about the valorization of Atlas Pistachio EOs and VOs. This data may help to draw several perspectives in using *Pistacia atlantica* EO and VO components in modern cosmetic products principally for their biological activities and therapeutic potential.

Author Contributions: Conceptualization, A.E.Z.-B.; validation, A.E.Z.-B., N.B.-B. and H.B.; writing—original draft preparation, A.E.Z.-B., N.B.-B. and H.B.; writing—review and editing, A.E.Z.-B., N.B.-B. and H.B.; supervision, A.E.Z.-B.; All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Dalley, S.S. Ancient mesopotamian gardens and the identification of the hanging gardens of babylon resolved. *Garden Hist* **1993**, *21*, 1–13. [CrossRef]
2. DeNavarre, M.G. Oils and fats, the historical cosmetics. *J. Am. Oil Chem. Soc* **1978**, *55*, 435–437. [CrossRef]
3. Nicholson, P.T.; Shaw, I. *Ancient Egyptian Materials and Technology*; Cambridge University Press: Cambridge, UK, 2000; p. 461.
4. EMA (European Medicines Agency). Assessment report on *Pistacia lentiscus* L., resin (mastix). EMA/HMPC/46756/2015. 2015. Available online: https://www.ema.europa.eu/en/documents/herbal-report/draft-assessment-report-pistacia-lentiscus-l-resin-mastic_en.pdf (accessed on 25 November 2021).
5. Serpico, M.; White, R. The use and identification of varnish on New Kingdom funerary equipment. In *Colour and painting in ancient Egypt*; The British Museum Press: London, UK, 2001; pp. 33–42.
6. Stern, B.; Heron, C.; Corr, L.; Serpico, M.; Bourriau, J. Compositional variations in aged and heated pistacia resin found in late bronze age canaanite amphorae and bowls from Amarna Egypt. *Archaeo* **2003**, *45*, 457–469. [CrossRef]
7. Fulcher, K.; Budka, J. Pigments, incense, and bitumen from the New Kingdom town and cemetery on Sai Island in Nubia. *J. Archaeol. Sci. Rep.* **2020**, *33*, 102550. [CrossRef]
8. Brettell, R.C.; Stern, B.; Reifarth, N.; Heron, C. The 'semblance of immortality'? Resinous materials and mortuary rites in Roman Britain. *Archaeo* **2014**, *56*, 444–459. [CrossRef]
9. El Zerey-Belaskri, A.; Benhassaini, H. 'El bottom' à travers l'existence des Homo: Récit entre altruisme et ingratitude. In Proceedings of the 1ere Journée d'Etude sur la Conservation et la Valorisation de la Biodiversité Végétale en Algérie, Sidi Bel Abbes, Algeria, 21 February 2017.
10. Lima, S.N.R.; Lima, R.J.; de Salis, C.; de Azevedo Moreira, R. Cashew-tree (*Anacardium occidentale* L.) exudate gum: A novel bioligand tool. *Biotech. Appl. Biochem.* **2002**, *35*, 45–53.
11. Bennett, B.C. Twenty-five Important Plant Families. In *UNESCO Encyclopedia of Life Support Systems*; Bennett, B.C., Ed.; Florida International University: Miami, FL, USA, 2007. Available online: https://www.eolss.net/Sample-Chapters/C09/E6-118-03.pdf (accessed on 20 December 2021).
12. Zohary, M. A monographical study of the genus *Pistacia*. Palestine. *J. Bot.* **1952**, *5*, 187–228.

13. Benhassaini, H. Contribution à L'étude de L'autoécologie de *Pistacia atlantica* Desf. ssp. *atlantica* et Valorisation. Ph.D. Thesis, University of Sidi Bel Abbes, Sidi Bel Abbes, Algeria, 2004.
14. Quezel, P.; Santa, S. *Nouvelle Flore de l'Algérie et Des Régions Désertiques Méridionales*; Centre National de la Recherche Scientifique: Paris, France, 1963; pp. 611–612.
15. El Zerey-Belaskri, A. A Multidisciplinary Approach for the Characterization of *Pistacia atlantica* Desf. subsp. *atlantica* Diversity in Northwest Algeria. Ph.D. Thesis, University of Sidi Bel Abbes, Sidi Bel Abbes, Algeria, 2016; 143p.
16. Gregoriou, C. Collection, conservation and utilization of Pistacia genetic resources in Cyprus. In *Project on Underutilized Mediterranean Species. Pistacia: Towards a Comprehensive Documentation of Distribution and Use of Its Genetic Diversity in Central & West Asia, North Africa and Mediterranean Europe*; Padulosi, S., Hadj-Hassan, A., Eds.; Report of the IPGRI Workshop: Irbid, Jordan, 2001.
17. Mansf Ency. *Mansfeld's Encyclopedia of Agricultural and Horticultural Crops*; Hanelt, P., Ed.; 2001; Volume 1–6. Available online: http://mansfeld.ipk-gatersleben.de/pls/htmldb (accessed on 19 November 2021).
18. Daoudi, A.; Boutou, H.; Ibijbijen, J.; Zair, T.; Nassiri, L. Etude éthnobotanique du pistachier de L'Atlas, *Pistacia atlantica*, dans la ville de Meknes—Maroc. *Sci. Lib* **2013**, *5*, 131113.
19. Rechinger, K.H. *Flora Des Iranischen Hochlandes und der Umrahmenden Gebirge*; Akademische Druck-u.: Graz, Austria, 1969.
20. Browicz, K. *Chorology of Trees and Shrubs in South-West Asia and Adjacent Regions*; Polish Scientific Publications: Poznan, Poland, 1988; Volume 6.
21. Yaltirik, F. Anacardiaceae. In *Flora of Turkey*; Davis, P.H., Ed.; Edinburgh University Press: Edinburgh, UK, 1967; Volume 2, pp. 544–548.
22. El Zerey-Belaskri, A. Taxonomic and botanical retrospective review of *Pistacia atlantica* Desf. (Anacardiaceae). *Arab. J. Arom. Med. Plants* **2019**, *5*, 47–77.
23. Barrero, A.F.; Herrador, M.M.; Arteaga, J.F.; Akssira, M.; Mellouki, F.; Belgarrabe, A.; Blàzquez, M. Chemical composition of the essential oils of *Pistacia atlantica* Desf. *J. Essent. Oil Res.* **2005**, *17*, 52–54. [CrossRef]
24. Tzakou, O.; Bazos, I.; Yannitsaros, A. Volatile metabolites of *Pistacia atlantica* Desf. from Greece. *Flavour Fragr. J.* **2007**, *22*, 358–362. [CrossRef]
25. Mecherara-Idjeri, S.; Hassani, A.; Casanova, J. Composition of leaf, fruit and gall essential oils of Algerian *Pistacia atlantica* Desf. *J. Essent. Oil Res.* **2008**, *20*, 215–219. [CrossRef]
26. Gourine, N.; Bombarda, I.; Nadjemi, B.; Yousfi, M.; Gaydou, E.M. Chemotypes of *Pistacia atlantica* leaf essential oils from Algeria. *Nat. Prod. Commun.* **2010**, *5*, 115–120. [CrossRef]
27. Gourine, N.; Yousfi, M.; Bombarda, I.; Nadjemi, B.; Stocker, P.; Gaydou, E.M. Antioxidant activities and chemical composition of essential oil of *Pistacia atlantica* from Algeria. *Ind. Crops Prod.* **2010**, *31*, 203–208. [CrossRef]
28. Ait Said, S.; Fernandez, C.; Greff, S.; Torre, F.; Derridj, A.; Gauquelin, T.; Mevy, J.P. Inter-population variability of terpenoid composition in leaves of *Pistacia lentiscus* L. from Algeria: A chemoecological approach. *Molecules* **2011**, *16*, 2646–2657. [CrossRef]
29. El Zerey-Belaskri, A.; Cavaleiro, C.; Romane, A.; Benhassaini, H.; Salgueiro, L. Intraspecific chemical variability of *Pistacia atlantica* Desf. subsp. *atlantica* essential oil from Northwest Algeria. *J. Essent. Oil Res.* **2017**, *29*, 32–41. [CrossRef]
30. Khiya, Z.; Oualcadi, Y.; Zerkani, H.; Gamar, A.; Amine, S.; Hamzaoui, N.E.; Berrekhis, F.; Zair, T.; Hilali, F.E. Chemical Composition and Biological Activities of *Pistacia atlantica* Desf. Essential Oil From Morocco. *J. Essent. Oil-Bear. Plants* **2021**, *24*, 254–265. [CrossRef]
31. Benguechoua, M.I.; Benguechoua, M.; Gourine, N.; Silva, A.M.S.; Saidi, M.; Yousfi, M. Harvest date and variability in lipid bioactive compounds in *Pistacia atlantica* Mediterranean. *J. Nutr. Metab.* **2021**, *14*, 173–190.
32. Al Yafi, J. New characters differentiating *Pistacia atlantica* subspecies. *Candollea* **1978**, *33*, 201–208.
33. Al Yafi, J. Approches Systématique et Ecologique du Genre *Pistacia* L. dans la région méditerranéenne. Ph.D. Thesis, Univ. D'Aix-Marseille St Jérome France, Marseille, France, 1979.
34. Behboodi, B.S. Ecological distribution study of wild pistachios for selection of roostock. In *XIII GREMPA Meeting on Almonds and Pistachios*; Oliveira, M.M., Cordeiro, V., Eds.; CIHEAM: Zaragoza, Spain, 2005; Volume 63, pp. 61–67.
35. Belhadj, S.; Derridj, A.; Auda, Y.; Gers, C.; Gauquelin, T. Analyse de la variabilité morphologique chez huit populations spontanées de *Pistacia atlantica* en Algérie. *Botany* **2008**, *86*, 520–532. [CrossRef]
36. El Zerey-Belaskri, A.; Benhassaini, H. Morphological leaf variability in natural populations of *Pistacia atlantica* Desf. subsp. *atlantica* along climatic gradient: New features to update *Pistacia atlantica* subsp. *atlantica* key. *Int. J. Biometeorol.* **2016**, *60*, 577–589. [CrossRef]
37. Behboodi, B.S.; Ghaffari, M. Pollen morphology and analysis of Iranian wild pistachio. In *XIII GREMPA Meeting on Almonds and Pistachios*; Oliveira, M.M., Cordeiro, V., Eds.; Série A. Séminaires Méditerranéens; CIHEAM: Zaragoza, Spain, 2005; Volume 63, pp. 123–127.
38. Belhadj, S.; Derridj, A.; Aigouy, T.; Gers, C.; Gauquelin, T.; Mevy, J.-P. Comparative morphology of leaf epidermis in eight populations of Atlas Pistachio (*Pistacia atlantica* Desf., Anacardiaceae). *Microsc. Res. Tech.* **2007**, *70*, 837–846. [CrossRef]
39. Belhadj, S.; Derridj, A.; Civeyrel, L.; Gers, C.; Aigouy, T.; Otto, T.; Gauquelin, T. Pollen morphology and fertility of wild Atlas pistachio (*Pistacia atlantica* Desf., Anacardiaceae). *Grana* **2007**, *46*, 148–156. [CrossRef]
40. Tirse, M.; Benhassaini, H.; Sail, K.; Bassou, G. Leaflets Epidermal Micro-Characters of *Pistacia atlantica* Desf. subsp. *atlantica* (Anacardiaceae) under Semi-Arid Environmental Factors. *Environ. Res. J.* **2014**, *7*, 433–447.
41. Monjauze, A. Le pays des dayas et *Pistacia atlantica* Desf. dans le Sahara algérien. *Rev. Forest. Franç.* **1982**, *34*, 277–289. [CrossRef]

42. Ozenda, P. *Flore du Sahara*; CNRS: Paris, France, 1983; 622.
43. Zohary, M. *Pistacia* L. Flora Palestine. Academy of Science and Humanities. *Jerusalem* **1972**, *2*, 297–300.
44. Yaaqobi, A.; El Hafid, L.; Haloui, B. Etude biologique de *Pistacia atlantica* Desf. de la région orientale du Maroc. *Biomatec. Echo.* **2009**, *6*, 39–49.
45. Yousfi, M.; Nedjmi, B.; Bellal, R.; Ben Bertal, D.; Palla, G. Fatty acids and sterols of *Pistacia atlantica* fruit oil. *J. Am. Oil Chem. Soc.* **2002**, *79*, 1049–1050. [CrossRef]
46. Benhassaini, H.; Bendahmane, M.; Benchalgo, N. The chemical composition of fruits of *Pistacia atlantica* desf. subsp. *atlantica* from Algeria. *Chem. Nat. Compd.* **2007**, *43*, 121–124. [CrossRef]
47. El Zerey-Belaskri, A.; Belyaagoubi-Benhammou, N.; Kendouli, I.; Gambaza, N.; Bennaoum, Z.; Lalout, J.; Oughilas, A.; Atik-Bekkara, F.; Benhassaini, H.; Rosa, A.; et al. Phenolic profile, physic-chemical properties, fatty acid composition and anti-oxydant activity of *Pistacia atlantica* Desf. subsp. *atlantica* fruit oil from Algeria. In Proceedings of the 6th International Congress of Aromatic and Medicinal Plants (CIPAM), Coimbra, Portugal, 29 May–1 June 2016.
48. Benhammou- Belyagoubi, N.; Belyagoubi, L.; El Zerey-Belaskri, A.; Atik-Bekkara, F. In vitro antioxidant properties of flavonoid fractions from *Pistacia atlantica* Desf. subsp. *atlantica* fruit using five techniques. *J. Mat. Environ. Sci.* **2014**, *6*, 1118–1125.
49. Hüsnü, K.; Başer, C.; Demirci, F. Chemistry of Essential Oils. In *Flavours and Fragrances*; Berger, R., Ed.; Springer: Hannover, Germany, 2007; pp. 43–86.
50. Katayama, T. Volatile constituents. In *Physiology and Biochemistry of Algae*; Lewln, R.A., Ed.; Academic: Cambridge, MA, USA, 1962; pp. 467–473.
51. Katayama, T. Chemical studies on volatile constituents of seaweeds VI. On volatile constituents of *Sargasswn* sp. *Bul. Jap. Soc. Sci. Fish.* **1955**, *21*, 425–428. [CrossRef]
52. Joshi, G.V.; Gowda, C.A. Seasonal variations in chemical composition of *Sargasswn ilicifolium* Grun, sea water. *Indian J. Mar. Sci.* **1975**, *4*, 165–168.
53. Rezaei, P.F.; Fouladdel, S.; Hassani, S.; Yousefbeyk, F.; Ghaffari, S.M.; Amin, G.; Azizi, E. Induction of apoptosis and cell cycle arrest by pericarp polyphenol-rich extract of Baneh in human colon carcinoma HT29 cells. *Food Chem. Toxicol.* **2012**, *50*, 1054–1059. [CrossRef]
54. Labed- Zouad, I.; Ferhat, M.; Öztürk, M.; Abaza, I.; Nadeem, S.; Kabouche, A.; Kabouche, Z. Essential Oils Composition, Anticholinesterase and Antioxidant Activities of *Pistacia atlantica* Desf. *Rec. Nat. Prod.* **2017**, *11*, 411–415.
55. Benha Ssaini, H.; Benabderrahmane, M.; Chikhi, K. Contribution à l'évaluation de l'activité antiseptique de l'oléorésine et des huiles essentielles du pistachier de l'Atlas sur certains souches microbiennes: *Candida albicans* (ATCC 20027), *Candida albican* (ATCC 20032) et *Saccbaromyces cerevisiae*. *Ethnopharamcologia* **2003**, *30*, 38–46.
56. Benhassaini, H.; Bendeddouche, F.Z.; Mehdadi, Z.; Romane, A. GC/MS analysis of the essential oil from the oleoresin of *Pistacia atlantica* Desf. subsp. *atlantica* from Algeria. *Nat. Prod. Com.* **2008**, *3*, 929–932. [CrossRef]
57. Karimi, H.R.; Kafkas, S. Genetic relationships among *Pistacia* species studied by SAMPL markers. *Plant Syst. Evol.* **2011**, *297*, 207–212. [CrossRef]
58. Benhassaini, H.; Mehdadi, Z.; Hamel, L.; Belkhodja, M. Phytoécologie de *Pistacia atlantica* Desf. subsp. *atlantica* dans le Nord-ouest algérien. *Sécheresse* **2007**, *18*, 199–205.
59. Benabdallah, F.Z.; Kouamé, R.O.; El Bentchikou, M.; Zellagui, A.; Gherraf, N. Études ethnobotanique, phytochimique et valorisation de l'activité antimicrobienne des feuilles et de l'oléorésine du pistachier de l'atlas (*Pistacia atlantica* Desf.). *Phytothérapie* **2015**, *15*, 222–229. [CrossRef]
60. Memariani, Z.; Sharifzadeh, M.; Bozorgi, M.; Hajimahmoodi, M.; Farzaei, M.H.; Gholami, M.; Siavoshi, F.; Saniee, P. Protective effect of essential oil of *Pistacia atlantica* Desf. on peptic ulcer: Role of α-pinene. *J. Trad. Chin. Med.* **2017**, *37*, 57–63. [CrossRef]
61. Delazar, A.; Reid, R.G.; Sarker, S.D. GC-MS analysis of the essential oil from the oleoresin of *Pistacia atlantica* var. *mutica*. *Chem. Nat. Comp.* **2004**, *40*, 24–27. [CrossRef]
62. Eghbali-Feriz, S.; Taleghani, A.; Al-Najjar, H.; Emami, S.A.; Rahimi, H.; Asili, J.; Hasanzadeh, S.; Tayarani-Najaran, Z. Anti-melanogenesis and anti-tyrosinase properties of *Pistacia atlantica* subsp. *mutica* extracts on B16F10 murine melanoma cells. *Res. Pharm. Sci.* **2018**, *13*, 533–545. [CrossRef] [PubMed]
63. Didehvar, M.; Ebadi, M.T.; Ayyari, M. Qualitative and Quantitative Evaluation of *Pistacia atlantica* Desf. Essential Oil from Thirteen Natural Habitats. *Iran. J. Horti. Sci.* **2021**, *52*, 419–428.
64. Hashemi-Moghaddam, H.; Mohammdhosseini, M.; Salar, M. Chemical composition of the essential oils from the hulls of *Pistacia vera* L. by using magnetic nanoparticle-assisted microwave (MW) distillation: Comparison with routine MW and conventional hydrodistillation. *Anal. Methods* **2014**, *6*, 2572–2579. [CrossRef]
65. Scott, R.P.W. Essential oils. *Encycl. Anal. Sci.* **2005**, 554–561. [CrossRef]
66. Elshafie, H.S.; Mancini, E.; Sakr, S.; De Martino, L.; Mattia, C.A.; De Feo, V.; Camele, I. Antifungal Activity of Some Constituents of *Origanum vulgare* L. Essential Oil Against Postharvest Disease of Peach Fruit. *J. Med. Food* **2015**, *18*, 929–934. [CrossRef] [PubMed]
67. Guzmán, E.; Lucia, A. Essential Oils and Their Individual Components in Cosmetic Products. *Cosmetics* **2021**, *8*, 114. [CrossRef]
68. Bicas, J.L.; Dionısio, A.P.; Pastore, G.M. Bio-oxidation of Terpenes: An Approach for the Flavor Industry. *Chem. Rev.* **2009**, *109*, 4518–4531. [CrossRef]
69. Bürgers, R.; Schneider-Brachert, W.; Reischl, U.; Behr, A.; Hiller, K.A.; Lehn, N.; Schmalz, G.; Ruhl, S. *Helicobacter pylori* in human oral cavity and stomach. *Eur. J. Oral. Sci.* **2008**, *116*, 297–304. [CrossRef]

70. Rodrigues, K.A.; Amorim, L.V.; Dias, C.N.; Moraes, D.F.; Carneiro, S.M.; Carvalho, F.A. *Syzygium cumini* (L.) Skeels essential oil and its major constituent alpha-pinene exhibit anti-Leishmania activity through immunomodulation in vitro. *J. Ethnopharmacol.* **2015**, *160*, 32–40. [CrossRef]
71. Sonboli, A.M.A.; Esmaeili, A.; Gholipour, A.; Kanani, M.R. Composition, cytotoxicity and antioxidant activity of the essential oil of *Dracocephalum surmandinum* from Iran. *Nat. Prod. Commun.* **2010**, *5*, 341–344. [CrossRef] [PubMed]
72. Chen, W.; Liu, Y.; Li, M.; Mao, J.; Zhang, L.; Huang, R.; Jin, X.; Ye, L. Anti-tumor effect of α-pinene on human hepatoma cell lines through inducing G2/M cell cycle arrest. *J. Pharmacol. Sci.* **2015**, *127*, 332–338. [CrossRef] [PubMed]
73. Matsuo, A.L.; Figueiredo, C.R.; Arruda, D.C.; Pereira, F.V.; Scutti, J.A.B.; Massaoka, M.H.; Travassos, L.R.; Sartorelli, P.; Lago, J.H.G. α-Pinene isolated from *Schinus terebinthifolius* Raddi (Anacardiaceae) induces apoptosis and confers antimetastatic protection in a melanoma model. *Biochem. Biophys Res. Commun.* **2011**, *411*, 449–454. [CrossRef]
74. Buriani, A.; Fortinguerra, S.; Sorrenti, V.; Dall'Acqua, S.; Innocenti, G.; Montopoli, M.; Gabbia, D.; Carrara, M. Human adenocarcinoma cell line sensitivity to essential oil phytocomplexes from *Pistacia* species: A multivariate approach. *Molecules* **2017**, *22*, 1336. [CrossRef] [PubMed]
75. Porres-Martínez, M.; González-Burgos, E.; Carretero, M.E.; Gómez-Serranillos, M.P. *In vitro* neuroprotective potential of the monoterpenes α-pinene and 1,8-cineole against H2O2-induced oxidative stress in PC12 cells. *Z. Nat. C* **2016**, *71*, 191–199. [CrossRef] [PubMed]
76. Leite, A.M.; de Oliveira Lima, E.; de Souza, E.L.; Diniz, M.F.F.M.; Trajano, V.N.; de Medeiros, I.A. Inhibitory effect of β-pinene, α–pinene and eugenol on the growth of potential infectious endocarditis causin gram-positive bacteria. *Rev. Bras. Ciências Farm.* **2007**, *43*, 121–126. [CrossRef]
77. Gavrilov, V.V.; Startseva, V.A.; Nikitina, L.E.; Lodochnikova, O.A.; Gnezdilov, O.I.; Lisovskaya, S.A.; Clushko, N.I.; Klimovitskii, E.N. Synthesis and antifungal activity of sulfides, sulfoxides, and sulfones based on (1 s)-(−)-β-pinene. *Pharm. Chem. J.* **2010**, *44*, 126–129. [CrossRef]
78. Silva, A.C.R.; Lopes, P.M.; Azevedo, M.M.B.; Costa, D.C.M.; Alviano, C.S.; Alviano, D.S. Biological activities of α–pinene and β-pinene enantiomers. *Molecules* **2012**, *17*, 6305–6316. [CrossRef]
79. Guzman-Gutierrez, S.L.; Gomez-Cansino, R.; Garcia-Zebadua, J.C.; Jimenez-Perez, N.C.; Reyes-Chilpa, R. Antidepressant activity of *Litsea glaucescens* essential oil: Identification of beta-pinene and linalool as active principles. *J. Ethnopharmacol.* **2012**, *143*, 673–679. [CrossRef]
80. Guzman-Gutierrez, S.L.; Bollina-Jaime, H.; Gomez-Cansino, R.; Reyes-Chilpa, R. Linalool and β–pinene exert their antidepressant-like activity through the monoaminergic pathway. *Life Sci.* **2015**, *128*, 24–29. [CrossRef]
81. Huynh, Q.; Phan, T.D.; Thieu, V.Q.Q.; Tran, S.T.; Do, S.H. Extraction and refining of essential oil from Australian tea tree, Melaleuca alterfornia, and the antimicrobial activity in cosmetic products. *J. Phys. Conf. Ser.* **2012**, *352*, 012053. [CrossRef]
82. Yang, Z.; Xiao, Z.; Ji, H. Solid inclusion complex of terpinen-4-ol/β-cyclodextrin: Kinetic release, mechanism and its antibacterial activity. *Flavour Fragr. J.* **2014**, *30*, 179–187. [CrossRef]
83. Tighe, S.; Gao, Y.Y.; Tseng, S.C.G. Terpinen-4-ol is the Most Active Ingredient of Tea Tree Oil to KillDemodexMites. *Transl. Vis. Sci. Technol.* **2013**, *2*, 2. [CrossRef] [PubMed]
84. Cavaleiro, C.; Pinto, E.; Goncalves, M.J.; Salgueiro, L. Antifungal activity of *Juniperus* essential oils against dermatophyte, Aspergillus and Candida strains. *J. Appl. Microbiol.* **2006**, *100*, 1333–1338. [CrossRef]
85. Pirila, V.; Siltanen, E. On the Eczematous Agent in Oil of Turpentine. In Proceedings of the International Congress on Occupational Health, Helsinki, Finland, 6–7 January 1957; 3, p. 400.
86. Miguel, M.G. Antioxidant and Anti-Inflammatory Activities of Essential Oils: A Short Review. *Molecules* **2010**, *15*, 9252–9287. [CrossRef]
87. Moeini, R.; Memariani, Z.; Asadi, F.; Bozorgi, M.; Gorji, N. *Pistacia* Genus as a Potential Source of Neuroprotective Natural Products. *Planta Med.* **2019**, *85*, 1326–1350. [CrossRef]
88. Api, A.M.; Belsito, D.; Bruze, M.; Cadby, P.; Calow, P.; Dagli, M.L.; Dekant, W.; Ellis, G.; Fryer, A.D.; Fukayama, M.; et al. Criteria for the Research Institute for fragrance materials, Inc. (RIFM) safety evaluation process for fragrance ingredients. *Food Chem. Toxicol.* **2015**, *82*, S1–S19. [CrossRef]
89. Api, A.M.; Belsito, D.; Biserta, S.; Botelho, D.; Bruze, M.; Burton, G.A., Jr.; Buschmann, J.; Cancellieri, M.A.; Dagli, M.L.; Date, M.; et al. RIFM fragrance ingredient safety assessment, p-cymene, CAS Registry Number 99-87-6. *Food Chem. Toxicol.* **2021**, *149*, 112051. [CrossRef]
90. Kaneda, N.; Pezzuto, J.M.; Kinghorn, A.D.; Farnsworth, N.R.; Santisuk, T.; Tuchinda, P.; Udchachon, J.; Reutrakul, V. Plant anticancer agents, L. cytotoxic triterpenes from *Sandoricum koetjape* stems. *J. Nat. Prod.* **1992**, *55*, 654–659. [CrossRef]
91. Whittaker, A.A. *Newman. Chemistry of Terpenes and Terpenoids*; Academic Press: London, UK, 1972; p. 11.
92. Tiwari, M.; Kakkar, P. Plant derived antioxidants–geraniol and camphene protect rat alveolar macrophages against t-BHP induced oxidative stress. *Toxicol. Vitr.* **2009**, *23*, 295–301. [CrossRef]
93. Wang, C.Y.; Chen, Y.W.; Hou, C.Y. Antioxidant and antibacterial activity of seven predominant Terpenoids. *Int. J. Food. Prop.* **2019**, *22*, 229–237. [CrossRef]
94. Pandur, E.; Balatinácz, A.; Micalizzi, G.; Mondello, L.; Horváth, A.; Sipos, K.; Horváth, G. Anti-inflammatory effect of lavender (*Lavandula angustifolia* Mill.) essential oil prepared during different plant phenophases on THP-1 macrophages. *BMC Complement. Med. Ther.* **2021**, *21*, 287. [CrossRef] [PubMed]

95. Hajjaj, G.; Chakour, R.; Bahlouli, A.; Tajani, M.; Cherrah, Y.; Zellou, A. Evaluation of CNS activity and anti-inflammatory effect of *Pistacia atlantica* desf. essential oil from Morocco. *Pharm. Chem. J.* **2018**, *5*, 86–94.
96. Minaiyan, M.; Karimi, F.; Ghannadi, A. Anti-inflammatory effect of *Pistacia atlantica* subsp. *kurdica* volatile oil and gum on acetic acid-induced acute colitis in rat. *Res. J. Pharmacogn.* **2015**, *2*, 1–12.
97. Haghdoost, F.; Baradaran Mahdavi, M.M.; Zandifar, A.; Sanei, M.H.; Zolfaghari, B.; Javanmard, S.H. *Pistacia atlantica* Resin Has a Dose-Dependent Effect on Angiogenesis and Skin Burn Wound Healing in Rat. *Evid. Based Complement. Altern. Med.* **2013**, *2013*, 893425. [CrossRef]
98. Peivastegan, M.; Rajabi, M.; Zaferani Arani, H.; Olya, M.; Atashi, H.A.; Abolghasemi, S. Comparing the Effects of Oleoresin of *Pistacia atlantica* Tree and Diclofenac Gel on the Knee Osteoarthritis Improvement. *Shiraz E-Med. J.* **2020**, *21*, e98293. [CrossRef]
99. El Zerey-Belaskri, A.; Ribeiro, T.; Alcaraz, M.L.; El Zerey, W.; Castro, S.; Loureiro, J.; Benhassaini, H.; Hormaza, J.I. Molecular characterization of *Pistacia atlantica* Desf. subsp. *atlantica* (Anacardiaceae) in Algeria: Genome size determination, chromosome count and genetic diversity analysis using SSR markers. *Sci. Hortic.* **2018**, *227*, 278–287. [CrossRef]
100. Bichatildo, H.; Borg-Karlson, A.; Araújo, J.; Mustaparta, H. Five types of olfactory receptor neurons in the strawberry blossom weevil *Anthonomus rubi* selective responses to inducible host–plant volatiles. *Chem. Sens.* **2005**, *30*, 153–170.
101. Pino, J.A.; Marbot, R.; Fuentes, V. Essential Oil of *Aloysia virgata* Juss. from Cuba. *J. Essent. Oil Res.* **2004**, *16*, 44–45. [CrossRef]
102. Montanari, R.M.; Barbosa, L.C.A.; Demuner, A.J.; Silva, C.J.; Andrade, N.J.; Ismail, F.M.D.; Barbosa, M.C.A. Exposure to *Anacardiaceae* Volatile Oils and Their Constituents Induces Lipid Peroxidation within Food-Borne Bacteria Cells. *Molecules* **2012**, *17*, 9728–9740. [CrossRef]
103. Opdyke, D.L.J. Monographs on Fragrance Raw Materials. *Food Cosmet. Toxicol.* **1973**, *11*, 1059. [CrossRef]
104. Skold, M.; Karlberg, A.T.; Matura, M.; Borje, A. The fragrance chemical β- Caryophyllene-air oxidation and skin sensitization. *Food Chem. Toxicol.* **2006**, *44*, 538–545. [CrossRef] [PubMed]
105. Bhatia, S.P.; Letizia, C.S.; Api, A.M. Fragrance material review on β-caryophyllene alcohol. *Food Chem. Toxicol.* **2008**, *46*, S95–S96. [CrossRef] [PubMed]
106. Ghelardini, C.; Galeotti, N.; Di Cesare Mannelli, L.; Mazzanti, G.; Bartolini, A. Local anaesthetic activity of β-caryophyllene. *Farmaco* **2001**, *56*, 387–389. [CrossRef]
107. Fernandes, E.S.; Passos, G.F.; Medeiros, R.D.A.; Cunha, F.M.; Ferreira, J.; Campos, M.M.; Pianowski, L.F.; Calixto, J.B. Anti-inflammatory effects of compounds alpha-humulene and (−)-trans-caryophyllene isolated from the essential oil of Cordia verbenacea. *Eur. J. Pharm.* **2007**, *569*, 228–236. [CrossRef]
108. Michielin, E.; Rosso, S.; Franceschi, E.; Borges, G.; Corazza, M.; Oliveira, J.; Ferreira, S. High-pressure phase equilibrium data for systems with carbon dioxide, α-humulene and trans-caryophyllene. *J. Chem. Thermod.* **2009**, *41*, 130–137. [CrossRef]
109. Hernandez-Leon, A.; González-Trujano, M.E.; Narváez-González, F.; Pérez-Ortega, G.; Rivero-Cruz, F.; Aguilar, M.I. Role of β-caryophyllene in the antinociceptive and anti-inflammatory effects of Tagetes lucida Cav. Essential oil. *Molecules* **2020**, *25*, 675. [CrossRef]
110. Meffo, S.C.D.; Njateng, G.S.S.; Tamokou, J.D.D.; Tane, P.; Kuiate, J.R. Essential Oils from Seeds of *Aframomum citratum* (C. Pereira) K. Schum, *Aframomum daniellii* (Hook. F.) K. Schum, *Piper capense* (Lin. F) and *Monodora myristica* (Gaertn.) Dunal NL and their Antioxidant Capacity in a Cosmetic Cream. *J. Essent. Oil Bear. Plants* **2019**, *22*, 324–334. [CrossRef]
111. Labdelli, A.; Zemour, K.; Simon, V.; Cerny, M.; Adda, A.; Merah, O. *Pistacia atlantica* Desf., a Source of Healthy Vegetable Oil. *Appl. Sci.* **2019**, *9*, 2552. [CrossRef]
112. Mehdi, S.; Asghari, A.; Ghobadian, B.; Dehghani Soufi, M. Conversion of *Pistacia atlantica* mutica oil to trimethylolpropane fatty acid triester as a sustainable lubricant. *Biomass Convers Biorefinery* **2020**, *10*, 139–148. [CrossRef]
113. Zemour, K.; Adda, A.; Labdelli, A.; Dellal, A.; Cerny, M.; Merah, O. Effects of Genotype and Climatic Conditions on the Oil Content and Its Fatty Acids Composition of *Carthamus tinctorius* L. Seeds. *Agronomy* **2021**, *11*, 2048. [CrossRef]
114. Liu, J.; Zhu, X.Y.; Deng, L.B.; Liu, H.F.; Li, J.; Zhou, X.R.; Wang, H.Z.; Hua, W. Nitric oxide affects seed oil accumulation and fatty acid composition through protein S-nitrosation. *J. Exp. Bot.* **2021**, *72*, 385–397. [CrossRef] [PubMed]
115. Salhi, M.; Gharsallaoui, M.; Gabsi, S. Tunisian *Pistacia atlantica* Desf. Extraction Process: Impact on Chemical and Nutritional Characteristics. *Eur. J. Lipid. Sci. Technol.* **2021**, *123*, 2100013. [CrossRef]
116. Acheheb, H.; Aliouane, R.; Ferradji, A. Optimization of Oil Extraction from *Pistacia atlantica* Desf. Seeds Using Hydraulic Press. *Asian J. Agric. Res.* **2012**, *6*, 73–82. [CrossRef]
117. Kim, J.; Kim, D.N.; Lee, S.H.; Yoo, S.H.; Lee, S. Correlation of fatty acid composition of vegetable oils with rheological behavior and oil uptake. *Food Chem.* **2010**, *118*, 398–402. [CrossRef]
118. Ouily, J.T.; Bazongo, P.; Bougma, A.; Kaboré, N.; Lykke, A.M.; Ouédraogo, M.; Nestor Bassolé, I.H. Chemical Composition, Physicochemical Characteristics, and Nutritional Value of Lannea kerstingii Seeds and Seed Oil. *J. Anal. Methods Chem.* **2017**, *2017*, 2840718.
119. Firestone, D. (Ed.) *Official Methods Recommended Practices of the American Oil Chemistry Society*, 4th ed.; AOCS Press: Champaign, IL, USA, 2013.
120. Kandji, N. Etude de la Composition Chimique et de la Qualite D'huiles Vegetales Artisanales Consommees au Senegal. Ph.D. Thesis, Universite Cheik Anta Diop (UCAD) de Dakar, de Dakar, Senegal, 2001.
121. Djerrou, Z. Anti-hypercholesterolemic effect of *Pistacia lentiscus* fatty oil in egg yolk-fed rabbits: A comparative study with simvastatin. *Chin. J. Nat. Med.* **2014**, *12*, 561–566. [CrossRef]

122. Ziyad, B.E.; Yousfi, M.; Vander Heyden, Y. Effects of growing region and maturity stages on oil yield, fatty acid profile and tocopherols of *Pistacia atlantica* Desf. fruit and their implications on resulting biodiesel. *Renew. Energy* **2022**, *181*, 167–181. [CrossRef]
123. Hazrati, S.; Govahi, M.; Ebadi, M.T.; Habibzadeh, F. Comparison and Evaluation of Oil Content, Composition and Antioxidant Properties of *Pistacia atlantica* and *Pistacia khinjuk* Grown as Wild. *Int. J. Hortic. Sci. Technol.* **2020**, *7*, 165–174.
124. Bentireche, F.; Guenane, H.; Yousfi, M. Fatty Acids, the Unsaponifiable Matter, and Polyphenols as Criteria to Distinguish *Pistacia atlantica* Unripe Fruit Oil. *J. Am. Oil Chem. Soc.* **2019**, *96*, 903–910. [CrossRef]
125. Mohammadi, B.; Maboud, H.E.; Seyedi, S.M. Nutritional value and antioxidant properties of hull and kernel in *Pistacia atlantica* and *Pistacia khinjuk* fruits. *J. Food Sci. Technol.* **2019**, *56*, 3571–3578. [CrossRef] [PubMed]
126. Gharsallaoui, M.; Azouzi, H.; Chelli-Chaabouni, A.; Ghrab, M.; Condoret, J.S.; Ayadi, M.; Gabsi, S. Extraction methods of seed oil and oil quality of *Pistacia atlantica* grown in dry land. In *XVI GREMPA Meeting on Almonds and Pistachios*; Options Méditerranéennes. Series A: Mediterranean Seminars; CIHEAM-IAMZ: Zaragoza, Spain, 2016.
127. Guenane, H.; Bombarda, I.; Bombarda, I.; Didi OuldElhadj, M.; Yousfi, M. Effect of Maturation Degree on Composition of Fatty acids and Tocopherols of Fruit Oil from *Pistacia atlantica* Growing Wild in Algeria. *Nat. Prod. Commun.* **2015**, *10*, 1723–1728. [CrossRef] [PubMed]
128. Saber-Tehrani, M.; Givianrad, M.H.; Aberoomand-Azar, P.; Waqif-Husain, S.; Jafari Mohammadi, S.A. Chemical Composition of Iran's *Pistacia atlantica* Cold-Pressed Oil. *J. Chem.* **2013**, *2013*, 1–6. [CrossRef]
129. Ghalem, B.R.; Benhassaini, H. Etude des phytosterols et des acides gras de *Pistacia atlantica*. *Afr. Sci.* **2007**, *3*, 405–412.
130. Arena, E.; Campisi, S.; Fallico, B.; Maccarone, E. Distribution of fatty acids and phytosterols as a criterion to discriminate geographic origin of pistachio seeds. *Food Chem.* **2007**, *104*, 403–408. [CrossRef]
131. Sena-Moreno, E.; Pardo, J.E.; Catalán, L.; Alvarez-Orti, M. Drying temperature and extraction method influence physicochemical and sensory characteristics of pistachio oils: Influence of drying temperature of pistachio nuts. *Eur. J. Lipid Sci. Technol.* **2015**, *117*, 684–691. [CrossRef]
132. Esteki, M.; Ahmadi, P.; Heyden, Y.V.; Simal-Gandara, J. Fatty Acids-Based Quality Index to Differentiate Worldwide Commercial Pistachio Cultivars. *Molecules* **2019**, *24*, 58. [CrossRef]
133. Chelghoum, M.; Guenane, H.; Harrat, M.; Yousfi, M. Total Tocopherols, Carotenoids, and Fatty acids Contents Variation of *Pistacia atlantica* Desf. Different Organs Crude Oils and their Antioxidant Activity during Development Stages. *Chem. Biodivers* **2020**, *17*, 1–16.
134. Zarei Jelyani, A.; Tavakoli, J.; Lashkari, H.; Aminlari, M. Different effect of chemical refining process on Baneh (*Pistacia atlantica* var. *mutica*) kernel oil: Regeneration of tocopherols. *Food Sci. Nutr.* **2021**, *9*, 5557–5566. [CrossRef] [PubMed]
135. Fernandes, P.; Cabral, J.M.S. Phytosterols: Applications and recovery methods. *Bioresour. Technol.* **2007**, *98*, 2335–2350. [CrossRef]
136. Bai, G.; Ma, C.; Chen, X. Phytosterols in edible oil: Distribution, analysis and variation during processing. *Grain Oil Sci. Technol.* **2021**, *4*, 33–44. [CrossRef]
137. Givianrad, M.H.; Saber-Tehrani, M.; Jafari Mohammadi, S.A. Chemical composition of oils from wild almond (*Prunus scoparia*) and wild pistachio (*Pistacia atlantica*). *Grasas Y Aceites* **2013**, *64*, 77–84. [CrossRef]
138. Shahidi, F.; Costa de Camargo, A. Tocopherols and Tocotrienols in Common and Emerging Dietary Sources: Occurrence, Applications, and Health Benefits. *Int. J. Mol. Sci.* **2016**, *17*, 1745. [CrossRef] [PubMed]
139. Shahidi, F.; Shukla, V.K.S. Non-Triacylglycerol constituents of fats, oils. *Inf. Int. News Fats. Oils Relat. Mater.* **1996**, *7*, 1227–1232.
140. Zemour, K.; Labdelli, A.; Adda, A.; Dellal, A.; Talou, T.; Merah, O. Phenol Content and Antioxidant and Antiaging Activity of Safflower Seed Oil (*Carthamus Tinctorius* L.). *Cosmetics* **2019**, *6*, 55. [CrossRef]
141. Ahmad, J. Lipid Nanoparticles Based Cosmetics with Potential Application in Alleviating Skin Disorders. *Cosmetics* **2021**, *8*, 84. [CrossRef]
142. Azzi, A. Tocopherols, tocotrienols and tocomonoenols: Many similar molecules but only one vitamin E. *Redox Biol.* **2019**, *26*, 101259. [CrossRef]
143. Guenane, H. Activités biologiques des extraits lipidiques des fruits du Pistachier de l'Atlas (*Pistacia atlantica* Desf.). Ph.D. Thesis, Université Kasdi Merbah, Ouargla, Algérie, 2017.
144. Baran, M.; Miziak, P.; Bonio, K. Characteristics of carotenoids and their use in the cosmetics industry. *J. Educ. Health Sport* **2020**, *10*, 192–196. [CrossRef]
145. İnanç, A.L. Chlorophyll: Structural Properties, Health Benefits and Its Occurrence in Virgin Olive Oils. *Akad. Gıda* **2011**, *9*, 26–32.
146. Pucci, C.; Martinelli, C.; Degl'Innocenti, A.; Desii, A.; De Pasquale, D.; Ciofan, G. Light-Activated Biomedical Applications of Chlrophyll Derivatives. *Macromol. Biosci.* **2021**, *21*, 2100181. [CrossRef]
147. Farhoosh, R.; Tavakoli, J.; Hossein, M.; Khodaparast, H. Chemical Composition and Oxidative Stability of Kernel Oils from Two Current Subspecies of *Pistacia atlantica* in Iran. *J. Am. Oil Chem. Soc.* **2008**, *85*, 723–729. [CrossRef]
148. Petropoulos, S.A.; Fernandes, Â.; Calhelha, R.C.; Rouphael, Y.; Petrovi´c, J.; Sokovi´c, M.; Ferreira, I.C.F.R.; Barros, L. Antimicrobial Properties, Cytotoxic Effects, and Fatty Acids Composition of Vegetable Oils from Purslane, Linseed, Luffa, and Pumpkin Seeds. *Appl. Sci.* **2021**, *11*, 5738. [CrossRef]
149. Mezni, F.; Aouadhi, C.; Khouja, M.L.; Khaldi, A.; Maaroufi, A. In vitro antimicrobial activity of *Pistacia lentiscus* L.edible oil and phenolic extract. *Nat. Prod. Res.* **2015**, *29*, 565–570. [CrossRef] [PubMed]
150. Dilika, F.; Bremner, P.D.; MMeyer, J.J. Antibacterial activity of linoleic and oleic acids isolated from *Helichrysum pedunculatum*: A plant used during circumcision rites. *Fitoterapia* **2000**, *71*, 450–452. [CrossRef]

151. Benmahieddine, A.; Belyagoubi-Benhammou, N.; Belyagoubi, L.; El Zerey-Belaskri, A.; Gismondi, A.; Di Marco, G.; Canini, A.; Bechlaghem, N.; Atik Bekkara, F.; Djebli, N. Influence of plant and environment parameters on phytochemical composition and biological properties of *Pistacia atlantica* Desf. *Biochem. Syst. Ecol.* **2021**, *95*, 104231. [CrossRef]
152. Mirmohammadsadegh, N.; Shakoori, M.; Moghaddam, H.N.; Farhadi, R.; Reza Shahverdi, A.; Amin, M. Wound healing and anti-inflammatory effects of bacterial cellulose coated with *Pistacia atlantica* fruit oil. *Daru J. Pharm. Sci.* **2021**, *30*, 1–10. [CrossRef]
153. Tanideh, N.; Masoumi, S.; Hosseinzadeh, M.; Reza Safarpour, A.; Erjaee, H.; Koohi-Hosseinabadi, O.; Rahimikazerooni, S. Healing Effect of *Pistacia atlantica* Fruit Oil Extract in Acetic Acid-Induced Colitis in Rats. *Iran. J. Med. Sci.* **2014**, *39*, 522–528.
154. Nazifi, S.; Saeb, M.; Sepehrimanesh, M.; Poorgonabadi, S. The effects of wild pistachio oil on serum leptin, thyroid hormones, and lipid profile in female rats with experimental hypothyroidism. *Comp. Clin. Pathol.* **2012**, *21*, 851–857. [CrossRef]
155. Hamidi, S.A.; Tabatabaei Naeini, A.; Oryan, A.; Tabandeh, M.R.; Tanideh, N.; Nazifi, S. Cutaneous Wound Healing after Topical Application of Pistacia atlantica Gel Formulation in Rats. *Turk. J. Pharm. Sci.* **2017**, *14*, 65–74. [CrossRef]
156. Jamshidi, S.; Hejazi, N.; Golmakani, M.T.; Tanideh, N. Wild pistachio (*Pistacia atlantica mutica*) oil improve metabolic syndrome features in rats with high fructose ingestion. *Iran. J. Basic Med. Sci.* **2018**, *2*, 1255–1261.
157. Yuan, C.; Zhang, X.; Long, X.; Jin, J.; Jin, R. Effect of β-sitosterol self-microemulsion and β-sitosterol ester with linoleic acid on lipid-lowering in hyperlipidemic mice. *Lipids Health Dis.* **2019**, *18*, 157. [CrossRef] [PubMed]
158. Shahouzehi, B.; Shabani, M.; Shahrokhi, N.; Sadeghiyan, S.; Masoumi –Ardakani, Y. Effects of *Pistacia atlantica* resin oil on the level of VEGF, hydroxyproline, antioxidant and wound healing activity in STZ-induced diabetic rats. *Ukr. Biochem. J.* **2018**, *90*, 34–41. [CrossRef]
159. Pacheco, B.; dos Santos, M.D.; Schultze, E.; Martins, R.M.; Lund, R.; Seixas, F.; Colepicolo, P.; Collares, T.; Paula, F.R.; De Pereira Claudio, M.P. Cytotoxic activity of fatty acids from antarctic macroalgae on the growth of human breast cancer cells. *Front. Bioeng. Biotechnol.* **2018**, *6*, 185. [CrossRef] [PubMed]
160. Elaasser, M.M.; Morsi, M.K.S.; Galal, S.M.; Abd El-Rahman, M.K.; Katry, M.A. Antioxidant, anti-inflammatory and cytotoxic activities of the unsaponifiable fraction of extra virgin olive oil. *Grasas Aceites* **2020**, *71*, e386. [CrossRef]
161. Hassan, S.B.; Gali-Muhtasib, H.; Göransson, H.; Larsson, R. Alpha terpineol: A potential anticancer agent which acts through suppressing NF-kappaB signalling. *Anticancer Res* **2010**, *30*, 1911–1919.
162. Novotny, L.; Abdel-Hamid, M.E.; Hunakova, L. Anticancer potential of β-Sitosterol. *Int. J. Clin. Pharmacol. Pharmacother.* **2017**, *2*, 129. [CrossRef]
163. Zarogoulidis, P.; Cheva, A.; Zarampouka, K.; Huang, H.; Li, C.; Huang, Y.; Katsikogiannis, N.; Zarogoulidis, K. Tocopherols and tocotrienols as anticancer treatment for lung cancer: Future nutrition. *J. Thorac. Dis.* **2013**, *5*, 349–352.
164. Naqvi, S.A.R.; Sherazi, T.A.; Zahid, M.; Mansha, A.; El Zerey-Belaskri, A. Nanotechnology: A smart translation of ingredients in the agriculture industry. In *Micro and Nano Technologies, Aquananotechnology*; Abd-Elsalam, A., Zahid, M., Eds.; Elsevier: Amsterdam, The Netherlands, 2021; pp. 47–65.
165. Sadeghi, B.; Rostami, A.; Momeni, S.S. Facile green synthesis of silver nanoparticles using seed aqueous extract of *Pistacia atlantica* and its antibacterial activity. *Spectrochim. Acta Part A Mol. Biomol. Spectrosc.* **2015**, *134*, 326–332. [CrossRef]
166. Fagionato Masiero, J.; Barbosa, E.J.; de Oliveira Macedo, L.; de Souza, A.; Yukuyama, M.N.; Arantes, G.J.; Bou-Chacra, N.A. Vegetable oils in pharmaceutical and cosmetic lipid-based nanocarriers preparations. *Ind. Crops Prod.* **2021**, *170*, 113838. [CrossRef]
167. Ahmad, A.; Ahsan, H. Lipid-based formulations in cosmeceuticals and biopharmaceuticals. *Biomed. Dermatol.* **2020**, *4*, 12. [CrossRef]
168. Balić, A.; Vlašić, D.; Žužul, K.; Marinović, B.; Bukvić Mokos, Z. Omega-3 Versus Omega-6 Polyunsaturated Fatty Acids in the Prevention and Treatment of Inflammatory Skin Diseases. *Int. J. Mol. Sci.* **2020**, *21*, 741. [CrossRef] [PubMed]
169. Sifi, I.; Dzoyem, J.P.; Ouinten, M.; Yousfi, M.; McGaw, L.J.; Eloff, J.N. Antimycobacterial, antioxidant and cytotoxic activities of essential oil of gall of *Pistacia atlantica* Desf. From Algeria. *Afr. J. Tradit. Complement. Altern. Med.* **2015**, *12*, 150–155. [CrossRef]
170. Koppel, C.; Tenczer, J.; Tonnesmann, U.; Schirop, T.; Ibe, K. Acute poisoning with pine oil-metabolism of monoterpenes. *Arch. Toxicol.* **1981**, *49*, 73–78. [CrossRef] [PubMed]