

A COMPREHENSIVE REVIEW ON THE ANTIOXIDATIVE AND ANTIAGING ENRICHED PROPERTIES OF WHITE TEA

ABSTRACT

The present study explored to extend the current knowledge by highlighting the antioxidative and antiaging profile of white tea. White tea, the least processed of the teas, is one of the least investigated and has the highest phenolic content. The white tea has a great potential on the skin for cosmetics and the for better skin physiology. Tea polyphenols, particularly catechin derivatives, are powerful antioxidants that benefit human health. Because of their potential to scavenge free radicals and thereby prevent oxidative stress, antioxidant components have piqued interest. In this context, several studies have revealed antiaging activity of white tea, as it involved in preventing aging and other age-related disorders. White tea delays the process of aging and improves the quality of life. This manuscript provides a summary of various bioactive components present in white tea along with the different alkaloids, enriched with (-)-epicatechin (EC), (-)-epigallocatechin (EGC) and (-)-epigallocatechin 3-gallate (EGCG) are responsible for their health-promoting and antiaging properties.

Keywords: White tea, Antioxidant, Antiaging, Green tea, Catechin, Cosmetics

1. INTRODUCTION

1.1 Tea

Tea is a popular refreshment infusion made from the young leaves of the *Camellia Sinensis* plant (L.) having the family Theaceae. Dias et. al. described that the fermentation categorized the tea form done through oxidation. Due to the fermentation process, tea is characterized as green, yellow, white, oolong, black, or Pu-erh. Among these, green tea and white tea are processed without fermentation. The producing conditions of this crop, harvesting processes and leaf preparation all contribute to significant variances in tea varieties [1].

Xing et. al. studied that fermentation causes the enzymatic oxidation by endogenous polyphenol oxidases and peroxidases of tea polyphenols partially converted into theaflavins and thearubigins responsible for black color. Unfermented teas are prepared by inactivating the endogenous enzymes through steaming or heating using different methods before the rolling and drying process to prevent the fermentation process. White tea, on either hand, is the fewest handled, as it merely begins the process of withering and then drying in the sunlight. For the production of white tea, the buds or one to two very young leaves covered with fine white hair are used. Xing et. al. also revealed in white tea, a non-fermented tea, is high phenolic contents. This can contribute to its several therapeutic activities like antioxidant, anti-inflammation, antibacterial. The tea polyphenols may help to reduce the risk of medical chronic disorders as anti-cancer, antihyperglycemic, anti-cardiovascular. The dietary supplement containing tea represents a compelling option for maintaining human health [2]. The different types of tea have different compositions of phenolic compounds and different uses. It is estimated that black tea accounts for 78 % of world production while green tea of 20 % and other tea account for 2% only. Black tea is consumed all over the world, whereas green and White tea is mainly consumed in Asia. White tea keeps a lot of its polyphenols, particularly catechins. White tea contains high antioxidant capabilities when catechin concentrations have been linked to antioxidant activity [3].

1.2 White tea

White tea is the basically buds of the tea plant. White tea unlike black or green tea is the least processed because it is not rolled and just slightly oxidized. White tea does not need to be panned, rolled, or shaken

before serving. Young tea leaves with a lot of fine hair can be plucked to make white tea as shown in figure 1. The tea leaves or buds are supposed to wither in sunlight to avoid oxidation or further processing. It is steam dried without oxidation as soon as the leaves are picked. It has the highest concentration of antioxidants and catechins, the least amount of caffeine, and a pale, dewy appearance due to the lack of oxidation. It has the most antioxidants and catechins, the least caffeine, and pale colour with a delicate, sweet taste due to the lack of oxidation the hue of this tea is pale yellow or green [4].

Aditya Rifqi et al studied that white tea drink significantly increases the struggling and swimming activity of rats which was studied the effect on body weight and endurance. So, nutritionists and sports scientists can use this information to investigate the health benefits of white tea [5]. The tea polyphenols may help to regulate the autophagic balance resulting in a variety of health advantages such as neuroprotective effects and antitumor and antihyperglycemic characteristics. Modulating canonical and non-canonical signaling pathways stimulates an antitumoral action. Polyphenols may also help reduce insulin resistance and prevent the loss of pancreatic islet-cell bulk and function while also acting as an antidiabetic. Polyphenols are often found in foods and may not have substantial negative effects, making them a viable option for preventing and treating various medical ailments [6].

Zhang et. al. described that Gastrointestinal microbiota has an impact on metabolic activities and indeed the bioavailability for total polyphenols in the body, which is crucial in neurodegenerative illnesses [7]. The somatic mutation and recombination test revealed that two separate antineoplastic cancer medications as streptozotocin and cyclophosphamide had genotoxic effects in somatic cells. It is thought that utilizing some supplementary nutrients during therapy could lessen the possible genotoxic effects of these medications, which increase the frequency of somatic mutation. The aqueous extracts of white tea plants made by brewing were discovered to provide supplementary nutritional sources that might be utilized in conjunction with these and comparable medications. This impact is attributed to the high levels of antioxidative polyphenols in their composition [8].



Figure 1 Captured Picture of crude White tea

Process of preparation of white tea

White tea is prepared from the tea plant's bud. Unlike black or green tea, white tea is not rolled and only slightly oxidized making it the least processed tea. White tea is a type of tea that doesn't need to be panned, rolled, or shaken. White tea can be made by plucking young tea leaves with a lot of fine hair. To avoid oxidation and further tea preparation, the leaves, as well as buds, are left to wither in strong daylight before being lightly treated. After the leaves are plucked, they are steam left to dry fast to prevent oxidation. It also has the greatest antioxidants and catechins, the lowest caffeine, and pale colour with such a gentle and pleasant taste due to the lack of oxidation [4]. In short, the simplified steps of processing for white tea are summarized in figure 2.

Fresh tea leaves – Withering – Drying (air/ solar/ mechanical drying) – White tea

Figure 2 Steps in processing of white tea

1.3 The chemical composition of white tea (*Camellia sinensis*)

Proteins, polysaccharides, polyphenols, minerals and trace elements, amino and organic acids, lignins, and methylxanthines (caffeine, theophylline, and theobromine) are the primary components of tea. White tea has a caffeine content of 3.35-5.74 percent, 16.23-25.95 percent Polyphenols, 0.06-1.44 percent flavonol glycosides, and 7.94-16.56 percent catechins [6].

Catechins (also known as flavan-3-ol) and their derivatives are the most abundant phenolic chemicals in tea leaves, accounting for up to 30% of their dry weight. Figure 3 depicts the chemical structure of Catechin. The (-)-epicatechin (EC), (-)-epigallocatechin (EGC), which are flavanol monomers, (-)-epicatechin 3-gallate (ECG), and (-)-epigallocatechin 3-gallate (EGCG), which are flavanolgallates as depicted in figure 4. White tea contains especially different Phenolic acids as benzoic acid, gallic acid, caffeic acid, chlorogenic acid, cinnamic acid. White tea has three types of flavonoids which are catechin,

quercetin, and theaflavin. It also aids in the prevention of acne. By raising cecal lipids and oxidative stress in the liver and adipose tissue, white tea lowers blood triacylglycerols [9].

Fresh young shoots are also well-known for containing useful functional compounds like L-theanine, which is a biosynthetic precursor to catechins. Flavanols, flavonols, flavones, proanthocyanins, and phenolic acids (account for roughly 20–35 percent of the tea's dry weight, of which 60–80 percent are catechins) are among the total phenols (flavan-3-ols). Epicatechin derivatives are the most important category, accounting for over 90% of total catechin content. Caffeine, which makes up about 2–5% of the dry weight of tea, is another major functional metabolite [10].

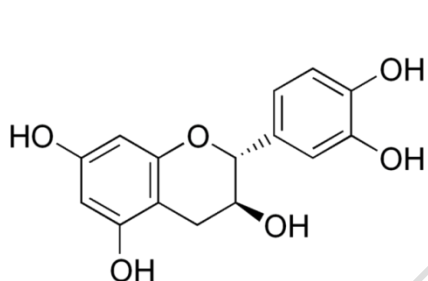


Figure 3 Chemical structure of Catechin

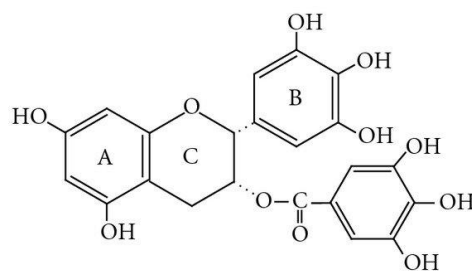


Figure 4 Chemical structure of (-)-epigallocatechin 3-gallate (EGCG)

1.4 Application of White tea in skin aging

1.4.1 Antioxidant activity of White tea

Phenolic and flavonoids molecules are significant antioxidant components that deactivate free radicals because of their capacity to donate hydrogen atoms to free radicals. They also have the right structural properties for scavenging free radicals. Phenolic chemicals are significant plant ingredients having antioxidants activity due to their redox characteristics [11].

The catechins are the main polyphenolic compounds rich in antioxidant properties. The different catechin present in *camellia sinensis* extract is epicatechin, catechins, epigallocatechin, epicatechingallate, and epigallocatechin-3-gallate which are primarily responsible for white tea's anti-oxidant properties. Catechin is found to be the most abundant source in the various plant extract. A higher percentage of catechin is present in *c. sinensis* species. Catechin is proven for the maintaining skin health [12].

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Rohadi et al studied the antioxidant activity of aqueous extract of white tea, green tea, oolong tea, and black tea and proved that white tea aqueous extract has the strongest antioxidant capacity against DPPH radical. Also, suggest that it has great potential as it has a lot of promise as a natural beverage and as a source of antioxidants as in the food system. *The antioxidant potential of the hot water white tea extract as a radical scavenger of DPPH was comparable to that of the green tea extract, but not to that of the others. Oolong and black tea extracts have a lower radical scavenging DPPH than green and white tea extracts. It's possible that using quercetin as a benchmark to determine the total flavonoids in leaf extracts isn't the best idea* [14].

1.4.2 Photoprotective activity of White tea

Photodynamic therapy is the noninvasive therapy used for the treatment of (pre) cancers and in macular degeneration regarding certain cases. The most useful photosensitizer is protoporphyrin IX. A catechin is a promising option for preventing normal tissue damage while Photodynamic therapy or radiation [15].

Catechins can increase the skin's photostability and defend it from UV rays. Lastly, catechin is employed to keep the skin looking young. According to Bae J. et al., catechins improve the stability of EGCG nanoethosomal suspensions, enhancing their effectiveness in reducing UVB-induced skin damage and potentiating anti-aging properties. In a variety of studies, including MTT and western blot assays, ECG has been demonstrated to be an effective therapy for UVB-induced harm to HaCaT keratinocytes [16].

Frasheri et al concluded that white tea is considered an effective photoprotective agent and suggest the possibility of practical use of white tea extract as an antiwrinkle agent. The application of white tea to UV-irradiated skin caused a 35% reduction in CD1a+ (epidermal Langerhans cells) staining relative to unirradiated skin. Also, the white tea extract significantly reduced oxidative DNA damage caused by UVR.

So, the photoprotective activity was characterized by SPF 1. Furthermore, the lighter hue of white tea was deemed more appropriate for use in external cosmetic formulations, especially for use on the face on a daily basis. Additionally, the comparative data indicated that the anti-wrinkle activity of white tea is greater than all types of tea. The findings of the white tea aqueous extract on the UV-irradiated skin layer indicated that extracts were effectively reducing dermal extracellular matrix damage. This will subsequently be helpful to the wrinkle improvement and alleviate inflammation and skin barrier damage. As a result, the anti-wrinkle activities are probably attributable to the high levels of (-)-epigallocatechin-3-gallate (EGCG) and polyphenols in white tea. Topically applied white tea extracts in a specifically developed cosmetic vehicle. UV-irradiated skin has a significant loss in cutaneous immunity. The 8-OHdG (8-hydroxy-2'-deoxyguanosine) is used to prevent UV-induced oxidative DNA damage [17]. White tea is thought to protect the skin from UV rays. In an in vivo hairless mouse photoaged model, the data showed that CSWEs produced from green, white, and black teas were helpful in wrinkle reduction by lowering dermal extracellular matrix degradation, as well as inflammation and skin barrier damage. The high quantities of EGCG and polyphenols in green and white teas, as well as the theaflavins and thearubigins generated during the oxidation of black tea, are thought to be responsible for these anti-wrinkle properties. Water extracts from white and black teas, in particular, were found to have a better effect on wrinkle reduction than green tea. Surprisingly, even though there are differences. Interestingly, despite differences in processing between white and black tea, their capacity to repair photoaged skin did not differ considerably. Finally, our research implies that white and black teas could be used as anti-wrinkle medicines in the future [18].

1.4.3 Antiaging activity of White tea

Elastase is a protein kinase enzyme that divides certain polypeptide links to decrease elastin. As a result, inhibiting elastase activities in the dermis layer could be employed to keep skin supple. Inhibitors of elastase activity can be used as a cosmetic element to combat skin ageing. After pretreatment with putative inhibitors, the quercetin-like antioxidant suppresses elastase, allowing elasticity to be restored. In 2009, Thring et al. studied the antiaging as well as antioxidant capabilities of 23 plant extracts (from 21 taxa), considering antielastase and anticollagenase activities into consideration [19].

White tea was found to have the strongest inhibitory activity against both elastase and collagenase, outperforming burdock root and angelica in antielastase activity and green tea, rose tincture, and lavender in anti-collagenase activity. White tea also had the best antioxidant activity in the Trolox equivalent antioxidant capacity testing. The anti-elastase activities were observed for white tea with inhibitory activity is ~89% and the anti-collagenase activities were exhibited by white tea is ~87%. In the superoxide dismutase (SOD) assay, white tea showed a high level of activity. It inhibits the reduction of nitro blue tetrazolium by 88 percent. Green tea was also found to have a lot of activity (86.41 percent) [20].

Yang-Hee et al. studied that the formulation with 5% tannase-converted white tea extract potentially inhibits the elastase and tyrosinase activity match up to with 5% ordinary white tea extract. So, the aqueous white tea extract can use for cosmetic purposes. And simultaneously also studied for antiaging properties which protect the skin. Collagenase and elastase inhibitors have been discovered in isolated white tea (*Camellia sinensis*) polyphenols such as catechin and epigallocatechingallate (EGCG). At a very low final concentration of 25 g, white tea whole extract exhibits comparable anti-elastase activity to EGCG, as well as very high collagenase inhibition, implying additive or the catechins in tea-leaf extracts have synergistic effects, especially when it comes to inhibiting collagenase. Also, because collagenase is a zinc-containing metalloproteinase, the catechins in the tea extract may bind to the Zn²⁺ ion within the enzyme, preventing it from binding to the substrate [21]. The antioxidative and antiaging properties of white tea illustrated in Table 1.

Table 1 Antioxidative and Antiaging properties of white tea [11-16]

Activity	Mechanism of action / effects
Antioxidant properties	<ul style="list-style-type: none"> • ROS and RNS quenching • Reduction in trace elements chelation • Regeneration of antioxidants
Photoprotective properties	<ul style="list-style-type: none"> • Inhibit the DNA damage • Reduce erythema formation

	<ul style="list-style-type: none"> • Reduce p53 expression in keratinocytes • Decrease thymidine dimer formation
Antiaging properties	<ul style="list-style-type: none"> • Inhibition of enzymes (hyaluronidase, collagenase, Elastase, metalloproteinases)
	<p>Slimming properties</p> <ul style="list-style-type: none"> • Microcirculation in the skin • Better cell oxygenation • Increase the fat burning in skin cells
	<p>Skin microcirculation</p> <ul style="list-style-type: none"> • Anticoagulant effect – protection toward prostacyclines • Reduce thromboxane A2 synthesis
Other properties	<ul style="list-style-type: none"> • Prevention of Vitamin C oxidation • Greater oxygen delivery to the skin
	<p>Skin and Hair condition</p> <ul style="list-style-type: none"> • Smoothness • Moisture content (immediate and long term) • Micro relief • Decreased sebum production • Decrease roughness • Reduce the dandruff

1.5 Skincare Products Containing Tea Extracts

Polyphenols can be used as depigmenting agents since they have a molecular resemblance to tyrosine, a forerunner of tyrosinase. Antioxidants also reduce pigmentation by scavenging reactive oxygen and nitrogen atoms, among other mechanisms. Also this slowing the oxidative polymerization by reducing o-quinones or other intermediates in melanin production. By blocking phenylalanine oxidative

polymerization, the antioxidant alpha-tocopherol has been shown to reduce melanin formation. As a consequence, polyphenolic chemicals play a role in the effectiveness of skin-whitening agents [21].

Skin care products increasingly appearing in the interest of researchers. The tea extract establishes an important role in dietary supplements and cosmetics. The rich strong antioxidants present in tea extract follow the different applications for the treatment of dermatological diseases and disorders. Also, the other peculiar attention to the use of tea extract is anti-hyaluronidase, photoprotective and sealing blood vessel properties [22].

The study found that the tea extract is not only found to be for young and premature aging skin but also inhibits the excess sebum formation, reducing the skin sensitivity and allergic conditions. The polyphenols present in tea extract have chelation action on the trace elements which are involved in free radical generation. After the discovery of free radical theory, the *camellia sinensis* extract is the one that diminishes the reactive oxygen species which are generated in the human body [23].

The flavonoids are polyhydroxylated natural compounds found in most plant sources and extracts. They have the ability to inhibit radicals including hydroxyl, oxide, superoxide, peroxy radicals. The antioxidants are having different categories as primary antioxidant, secondary antioxidant, and metal deactivator (complex-forming agents). The extractor natural source containing antioxidant principles having the action as a primary and secondary antioxidant will be the good and potential antioxidant [24].

2. CONCLUSION

Tea is one of the world's most popular beverages, and it's known for its antioxidant and anticancer effects. While the polyphenols in white tea have sparked a flurry of recent research, nothing is known about the possible health advantages of white tea, which is even less processed. Some evidence suggests that white tea is more effective than green tea in terms of overall efficacy and dermatologic efficacy. More research is something I'm looking forward to seeing. The white tea extract has been demonstrated to offer significant health advantages in studies. Although much research had done on the effects of white tea on skin aging, a thorough understanding of the mechanisms through which tea components may affect the process of aging is required.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

3. REFERENCES

1. Dias TR, Carrageta DF, Alves MG, Oliveira PF, Silva BM. White tea, Nonvitamin and Nonmineral Nutritional Supplements, Academic Press, Elsevier. 2018, (1), 437-445. DOI: 10.1016/B978-0-12-812491-8.00058-8.
2. Xing L, Zhang H, QiR, TsaoR, MineY. Recent Advances in the Understanding of the Health Benefits and Molecular Mechanisms Associated with Green Tea Polyphenols. Journal of Agricultural and Food Chemistry, 2019, acs.jafc.8b06146. doi:10.1021/acs.jafc.8b06146.
3. ChakravortyS. Kombucha: A Promising Functional Beverage Prepared From Tea, Non-Alcoholic Beverages.2019, 285–327. doi:10.1016/B978-0-12-815270-6.00010-4.
4. Kouhihabibidehkordi G, Kheiri S, Karimi I, Taheri F, Bijad E, Bahadoram M. Effect of White Tea (*Camellia sinensis*) Extract on Skin Wound Healing Process in Rats. WJPS. 2021; 10 (1) :85-95. URL: <http://wjps.ir/article-1-727-en.html>.
5. Aditya RM, Setyaningtyas SW, Rachmah Q. White tea drink (*Camellia sinensis*) improves endurance and body weight maintenance of rats, Journal of Health Research, 2020, 42-58.<https://doi.org/10.1108/JHR-01-2020-0020>.
6. Brimson JM, Prasanth MI, Malar DS, Thitilertdecha P, Kabra A, Tencomnao T, Prasansuklab A. Plant Polyphenols for Aging Health: Implication from Their Autophagy Modulating Properties in Age-Associated Diseases. Pharmaceuticals (Basel).2021, 14(10), 982.doi: 10.3390/ph14100982.

7. Zhang Z, Zhang Y, Li J, Fu C, Zhang X. The Neuroprotective Effect of Tea Polyphenols on the Regulation of Intestinal Flora. *Molecules*. 2021;17, 26(12):3692. doi: 10.3390/molecules26123692. PMID: 34204244; PMCID: PMC8233780.
8. FİDAN M, AYAR A. Modulatory effects of White Tea (*Camellia sinensis* L.) on genotoxicity in Streptozotocin and Cyclophosphamide-treated *Drosophila melanogaster*: Modulatory effects of White Tea on genotoxicity. *Progr Nutr [Internet]*. 2021 Oct. 7 [cited 2021 Dec. 6];23(3):e2021112. Available from: <https://mattioli1885journals.com/index.php/progressinnutrition/article/view/10571>
9. Dini I. An Overview of Functional Beverages. *Functional and Medicinal Beverages*. 2019, 1–40. doi:10.1016/B978-0-12-816397-9.00001-7.
10. Paiva, L, Rego C, Lima E, Marcone M, Baptista J. Comparative Analysis of the Polyphenols, Caffeine, and Antioxidant Activities of Green Tea, White Tea, and Flowers from Azorean *Camellia sinensis* Varieties Affected by Different Harvested and Processing Conditions. *Antioxidants*. 2021, 10, 183. <https://doi.org/10.3390/antiox10020183>.
11. Aryal S, Baniya MK, Danekhu K, Kunwar P, Gurung R, Koirala N. Total Phenolic Content, Flavonoid Content and Antioxidant Potential of Wild Vegetables from Western Nepal. *Plants (Basel)*. 2019, 8(4):96.
12. Rashmi SP, Yogendra P, Nikita S, Pranay W, Ankita W. Current Review on Herbs for Derma Care. *The Open Dermatology Journal*. DOI: 10.2174/1874372201913010041, 2019, 13, 41-46.
13. Hinojosa-Nogueira D, Pérez-Burillo S, Pastoriza CS, Rufián-Henares JA. Green and white teas as health-promoting foods. *Food & Function*, 2021, 12(9), 3799–3819. Doi:10.1039/d1fo00261a.
14. Rohadi, Lelita D I, Putri AS. Antioxidant Capacity of White Tea (*Camellia Sinensis*) Extract: Compared to Green, Oolong and Black Tea. *International Conference on Food Science & Technology IOP Conf. Series: Earth and Environmental Science*. 2019, 292. doi:10.1088/1755-1315/292/1/012018.
15. Joniova J, Wagnieres G. Catechin reduces phototoxic effects induced by protoporphyrin IX-based photodynamic therapy in the chick embryo chorioallantoic membrane. *J Biomed Opt*. 2020, 25(6), 1-9. doi:10.1117/1.JBO.25.6.063807.
16. Bae J, Kim N, Shin Y, Kim S, Kim Y. Activity of catechins and their applications. *Biomedical Dermatology*. 2020, 4(1), 8-17. doi:10.1186/s41702-020-0057-8.

17. Frasheri L, Schielein MC, TizekL, Mikschl P, Biedermann T, ZinkA. Great green tea ingredient: A narrative literature review on epigallocatechingallate and its biophysical properties for topical use in dermatology. *Phytotherapy Research*. 2020. doi:10.1002/ptr.6670.
18. Waranuch N, Phimnuan P, Yakaew S, Nakyai W, Grandmottet F, Onlom C, Srivilai J, Viyoch J. Antiacne and antiblotch activities of a formulated combination of Aloe barbadensis leaf powder, Garciniamangostana peel extract, and Camellia sinensis leaf extract. *ClinCosmetInvestigDermatol*. 2019, 30 (12), 383-391. doi: 10.2147/CCID.S200564.
19. Yang D, Wang T, Long M, Li P. Quercetin : Its Main Pharmacological Activity and Potential Application in Clinical Medicine. *Oxid Med Cell Longev*. 2020, 30, 53-87. doi: 10.1155/2020/8825387.
20. Andrade JM, Dominguez-Martin EM, Nicolai M, Faustino C, Rodrigues LM, Rijo P. Screening the dermatological potential of camellia species components: antioxidant and inhibitory capacities over elastase, collagenase and tyrosinase. *J Enzyme Inhib Med Chem*. 2021, 36(1), 257-269. doi: 10.1080/14756366.2020.1862099.
21. Yang-Hee H, Eun YJ, Dong ON, Hyung JS. Physiological effects of formulation containing tannase-converted green tea extract on skin care: physical stability, collagenase, elastase and tyrosinase activities, *Integrative Medicine Research*, 2019, 3(1), 25-33. <https://doi.org/10.1016/j.imr.2013.12.003>.
22. Koch W, Zagorska J, Marzec Z, Kukula-Koch W. Applications of Tea (*Camellia sinensis*) and its Active Constituents in Cosmetics. *Molecules*. 2019, 24(23), 42-77. doi:10.3390/molecules24234277.
23. Koch W. Dietary polyphenols - important non-nutrients in the prevention of chronic noncommunicable diseases. A systematic review. *Nutrients*. 2019, 11, 1039. doi: 10.3390/nu11051039.
24. Hes M, Dziedzic K, Gorecka D, Jedrusek-Golinska A, Gujska E. Aloe vera (L.) Webb.: Natural Sources of Antioxidants—A Review. *Plant Foods Hum.Nutr*. 2019, 74, 255–265. doi: 10.1007/s11130-019-00747-5. 30:1-1. <https://doi.org/10.1007/s10924-021-02058-w>.