



The Effectiveness of 5% White Tea (*Camellia sinensis*) Cream for Periorbital Wrinkle Reduction

Khin Thapayay Phyu* and Tanomkit Pawcsuntorn

School of Anti-aging and Regenerative Medicine, Mae Fah Luang University, Bangkok 10110, THAILAND

Received June 30th, 2022
Accepted July 13th, 2022
Published July 21st, 2022

***Conference presenter and
corresponding author:**

Khin Thapayay Phyu, School of
Anti-aging and Regenerative
Medicine, Mae Fah Luang
University, Bangkok 10110,
Thailand

E-mail:

khinthapayayphyu@gmail.com
(Khin Thapayay Phyu)

anti-aging@mfu.ac.th
(Tanomkit Pawcsuntorn)

© 2022, Phyu, K.T., et al.

This is an Open Access article
published under a Creative
Commons (CC BY-NC-ND 0.4)
license.



ABSTRACT

Introduction: Although we cannot stop wrinkles formation, we can prevent and delay the process of formation. Wrinkle is the skin topographic changes due to aging which is the distinctive sign. Therefore, the researcher studied the effectiveness of white tea extract cream for periorbital wrinkle reduction. White tea extract contains a higher level of polyphenol which means higher anti-oxidant and anti-aging properties. The white tea extract is rich in polyphenols such as polycatechin, gallic catechin, epicatechin, epigallocatechin gallate (EGCG), epigallocatechin (EGC), gallic catechingallate (GCG), epicatechin gallate (ECG), and flavanols, caffeine and gallic acid. It functions as an anti-oxidant by quenching the free radical and protects oxidative stress damage to the cells. It also inhibits elastase and collagenase activity and maintains elastin, collagen and delays skin aging process. So, it can treat fine lines, wrinkles and maintain elasticity of the skin. Besides, it prevents the occurrence of skin cancer, wrinkling and mottled pigmentation induced by photo damage.

Objective: To study the effectiveness of 5% white tea (*Camellia sinensis*) extract cream in periorbital wrinkle reduction

Methods: This research was a clinical controlled quasi-experimental study with 20 volunteers. The duration of the study was 12 weeks. Parameters such as wrinkle score by VISIA, Rao Goldman 5-point visual scale, cutometer score were used for assessment at baseline visit, 4th, 8th and 12th week.

Results: Mean cutometer scores at crow's feet and under eye area were significantly increased (p value < 0.001). Wrinkle evaluation score by VISIA was also statistically increased (p value < 0.001). No adverse effect was observed throughout the study.

Conclusion: The outcome of this study suggested that 5% white tea (*Camellia sinensis*) extract cream is effective for periorbital wrinkles reduction and safe for topical application. Hence, it could be an alternative anti-aging treatment for wrinkles reduction.

Keywords: white tea extract; *Camellia sinensis*; periorbital wrinkles; elasticity; cutometer score

Introduction

Skin is part of the human body which functions as a covering of the body. It covers 1.5-2 m² surface area of the body and weighs 15% of the total body weight, known as the largest organ of human body. Thus, it is the important indicator of aging.

Skin aging is the complex and multifactorial biological process. As the physiological process of the body changes with aging, skin also deteriorates with time. Skin aging can be mainly divided into two groups

– intrinsic aging and extrinsic aging.

Intrinsic aging is the inevitable general aging process which is also known as chronological aging. It can be influenced by genetic, hormonal changes and diversity of skin. It can cause pale skin with xerosis, fine wrinkles, laxity, production of collagen is reduced and more susceptible to infection and neoplasms. Functional changes are more distinct than morphological changes.[1]

Extrinsic skin aging is also known as external skin

aging and photoaging mainly due to environmental factors. This type of aging is preventable. The main cause of photoaging is ultraviolet (UV) light. Smoking, air pollution, exposure to chemicals, visible light, infrared radiation (IR) ozone, life style and diet also have an impact on extrinsic aging.

Among UV lights, major cause of photoaging is UVA and UVB. UVA can penetrate to the deeper layer of the dermis whereas 10% of UVB can penetrate up to the dermis. [2] Hormones also play an important role in skin aging. Decrease in estrogen level may lead to skin aging. It can reduce in collagen synthesis and elasticity, dryness. Skin becomes thinner, appearance of wrinkles and more fragile. [3]

People cannot stop the wrinkles formation because it is part of the normal aging process. Although we cannot stop, we can prevent its formation and delay the process of formation by avoiding the precipitating factors. Regular application of sunscreen and protection from UV radiation, maintaining healthy life style and consuming healthy diets and anti-oxidant rich food may help. Currently, there are varieties of anti-wrinkle treatments. Topical antioxidants such as tocopherols, ascorbic acid, polyphenols, flavonoids and green tea are well known. They can eliminate the free radicals and prevent harmful effects and photoaging. [4]

White tea is extracted from the leaves and leaf buds of *Camellia sinensis*. Tea have been widely consumed as a beverage by people all over the world for decades. *Camellia sinensis* plant is under the flowering plant family of genus Theaceae and it is originated from China and Asia. This plant is a hardy evergreen shrub or small tree with glossy green leaves and white to yellow flowers. It possesses fragrant, aromatic odor and prefers tropical and subtropical region. [5]

Tea can be subdivided into white tea, yellow tea, green tea, dark tea and oolong tea. They all are the products of *Camellia sinensis* plant with variations in processing method and oxidation level and harvesting time. White tea is the non-fermented tea with minimal oxidization process. White tea can be obtained only after sun withering and drying process. So, preparation methods have an important role for its properties. Recent studies show it has anti-inflammatory, antioxidant, antibacterial, anti-cancer properties and photoprotective properties. Apart from these, they are also used as weight controlling agent. [6]

Camellia sinensis contain many bioactive compounds. They are comprised with almost 4000 metabolites. [7] The major constituents are polyphenols of flavan-3ols

and flavanol which is more than one-third of metabolites and high contents of catechin and epicatechin (EC), Gallo catechin (GC), epigallocatechin (EGC), epicatechin gallate (ECG), epigallocatechin gallate (EGCG), gallic acid (GA), theaflavins and caffeine. [8] The bioactive compounds of teas are different depending on the fermentation and processing methods. Catechin contents and polyphenols are higher in white tea. It is said that level of processing has an inverse proportional to catechin contents. [6] Moreover, its caffeine and amino acid contents are higher than other teas.

Polyphenols in white tea scavenge reactive oxygen species (ROS), reactive nitrogen species (RNS) and thus reducing oxidative stress and showing great anti-oxidant activities. It scavenges singlet oxygen, superoxide-, hydroxyl-, peroxy-, and peroxynitrile radicals, chelates the trace elements and inhibits the enzymes which are involved in generation of ROS. [9] Hence, it prevents cellular inflammation induced by oxidative stress. Free radical imparts a crucial role in skin aging by triggering chain reactions and causing lipid, protein and nucleic acid damages.

Polyphenols can prevent oxidation of vitamin C and maintain the vitamin C level as well. This can maintain the skin elasticity because vitamin C functions as a coenzyme in collagen production. White tea extract can also halt the activity of metalloproteinase enzyme (MMP) and in turn prevents the destruction of collagen and elastin which are the important factors in aging. By inhibiting the elastase and collagenase, enhance the production of collagen to provide the skin elasticity and tensile strength. [6]

White tea is one of the herbal products and can be used for anti-aging purpose due to their high polyphenol content and health benefits. Apart from these, it can also protect from UV-induced damages, skin cancer and show photostability. Therefore, the researcher planned to study on anti-wrinkles action of white tea extract. There is no report of white tea on topical application for periorbital wrinkles reduction.

Objectives

General Objective

To study the effectiveness of 5% white tea (*Camellia sinensis*) extract cream in periorbital wrinkles reduction.

Specific Objectives

Primary objective

To compare the mean change of periorbital wrinkle reduction by 5% white tea (*Camellia sinensis*) extract cream from the baseline to different visit and week-12 visit, assessed by skin elasticity using Cutometer® MPA 580, VISIA® Complexion Analysis System and Rao-Goldman 5-point visual scoring scale.

Secondary objectives

1. To observe the adverse effects of 5% white tea (*Camellia sinensis*) extract cream.
2. To observe the participants' satisfactory score of 5% white tea (*Camellia sinensis*) extract cream.

Methodology

This research is a quasi-experimental controlled study with 20 participants and the duration is 12 weeks. The study population is healthy male and female between the age of 30-55 years old. They need to apply the 5% white tea extract cream on both sides of the periorbital area twice a day for 12 weeks. Follow-up appointments would be at 4th, 8th and 12th week. Volunteers were thoroughly explained about the research purpose, detailed procedure and anticipated risk and benefits of the study. Participants were requested to fill the form and sign the informed consent. Wrinkles assessment is done by Rao-Goldman 5-point visual score. Patch test for white tea (*Camellia sinensis*) extract cream was done prior to the study. Wrinkles and elasticity of the skin will be measured by VISIA® Complexion Analysis System and Cutometer® MPA 580. To measure the improvement, photographs taken with VISIA® Complexion Analysis System will be evaluated by 3 dermatologists. The participants were assessed by physicians and questionnaires to detect any adverse effects and participants' satisfaction. Ingredients are *Camellia sinensis* leaf extract, water, propylene glycol, butylene glycol, hydroxyethyl acrylate/ sodium acryloyldimethyl taurate copolymer, glycerin, hydrogenated polydecene, polysorbate 80, diazolidinyl urea, sodium Hyaluronate, iodopropyl butylcarbamate.

Sample Size Calculation

To calculate the sample size, use the reference data from a similar article, a study of the efficacy of *Ziziphus jujuba* extract for periorbital reduction by Shune,2021. Means and standard deviation were used to calculate the sample size.

Biophysical Techniques

The participants were photographed by using VISIA® Complexion Analysis System at baseline, 4th, 8th and 12th week.

The elasticity of the skin is also measured at baseline, 4th, 8th and 12th week. The elasticity is measured by using Cutometer® MPA 580.

Improvement and wrinkle score were evaluated by Rao-Goldman 5-point visual scoring scale and grading system.

Statistical Analysis

The data collected from the study was analyzed statistically by using SPSS software and Microsoft Excel 2019. This was carried out at Mae Fah Luang University Hospital, Bangkok Thailand.

Results

According to the demographic data, 15 of the participants were female and 5 of the participants were male with the mean age of 32.75±3.08 years. All of them have no history of other treatments before the study. Mean duration of exposure to sunlight between 10am to 4pm is 17±8.18 minutes. According to collected data, 10 volunteers have combination skin, 6 volunteers have oily skin and 4 volunteers have dry skin.

Results of Wrinkle Evaluation Score by VISIA

Table 1 Wrinkle evaluation score of 5% white tea extract eye cream by VISIA (n=20)

Grading Scale	5% white tea extract eye cream		
	Week 4	Week 8	Week 12
-1 = worse	0	0	0
0 = no changes	0	0	0
1 = 1-25% fair improvement	14	3	0
2 = >25-50% moderate improvement	6	17	15
3 = >50-75% good improvement	0	0	5
4 = > 75-100% excellent improvement	0	0	0

According to table 1, dermatologist scored fair improvement was seen in 14 volunteers and moderate improvement was seen in 6 volunteers. By 8th week, the majority (17 volunteers) were improved moderately and 3 volunteers were fairly improved. By 12th week,

moderate improvement was seen in 15 volunteers and good improvement was seen in 5 volunteers. Compared to the 4th week, more improvements were seen by 12th week.

Table 2 Statistical analysis of wrinkle evaluation improvement score by VISIA

	Mean	SD	p-value*
4 th week	1.30	0.47	
8 th week	1.85	0.37	<0.001*
12 th week	2.25	0.44	

Note: Data were analyzed within the group by the Friedman test.
* p<0.05 is significant.

According to the statistical analysis from table 2, the mean wrinkle evaluation score with VISIA was increased and it was statistically significant (p<0.001). Evaluation score was improved and the mean scores were 1.30±0.47 in 4th week, 1.85±0.37 in 8th week and 2.25±0.44 in 12th week.

Table 3 Multiple comparison analysis of wrinkle evaluation score by VISIA at 4th, 8th and 12th week

Wrinkle evaluation by VISIA, means diff. (SD) / visit	Different Change	p-value*
8 th week-4 th week	0.6(0.1)	<0.001
12 th week-4 th week	0.9(0.1)	<0.001
12 th week-8 th week	0.4(0.1)	0.002

Note: Data were analyzed by a post hoc test. * p<0.05 is significant

According to statistical analysis of multiple comparisons of wrinkle evaluation scores, the mean change between 4th and 8th week is 0.6 and statistically significant (p<0.001) is seen. The mean change between 4th and 12th week is 0.9 and the difference is statistically significant too (p<0.001). The mean change between 8th and 12th week is 0.4 but it is not statistically significant.

Results of Dermatologists' Evaluation Score by Rao-Goldmann 5-point Visual Scale

Table 4 Dermatologists' evaluation score

Score	Week 0	Week 4	Week 8	Week 12
1=Wrinkle absent	0	0	0	3
2=Shallow but visible	2	8	16	16
3=Moderately deep	16	11	4	1
4= Deep wrinkle with well-defined edges	2	1	0	0
5=Very deep with redundant fold	0	0	0	0

At baseline visit, dermatologists evaluated 16 volunteers as score 3, 2 volunteers as score 2 and 2 volunteers as score 4. At 4th week, participants of score 2 were increased to 8 participants, score 3 was 11 participants and score 4 was 1 participant. At 8th week, dermatologists rated 16 participants as score 2 and 4 participants were score 4. In the 12th week, 3 participants achieved score 1, 16 participants were score 2 and 1 participant was score 3.

Table 5 Statistical analysis of dermatologists' evaluation score on baseline visit, 4th, 8th and 12th week

	Mean	SD	p-value*
Baseline	3.00	0.46	
4 th week	2.65	0.59	
8 th week	2.2	0.41	<0.001*
12 th week	1.9	0.45	

Note: Data were analyzed within the group by the Friedman test. * p<0.05 is significant.

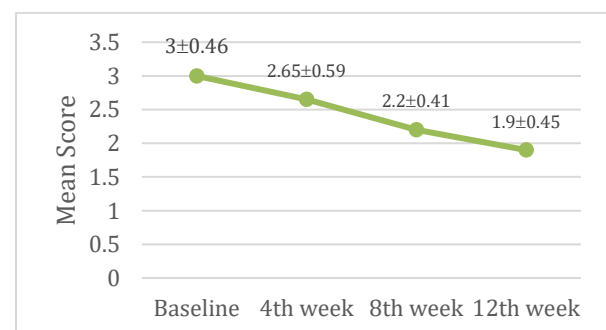


Figure 1 Linear graph revealing mean dermatologists' evaluation score at baseline, 4th, 8th and 12th week

According to table 5 and figure 1, mean dermatologists' evaluation scores were 3 ± 0.46 at baseline and 2.65 ± 0.59 at 4th week, 2.2 ± 0.41 at 8th week and 1.9 ± 0.45 at 12th week. The results decreased significantly ($p<0.001$)

Results of Cutometer Score for Elasticity of Skin

Table 6 Statistical analysis of cutometer score at crow's feet

	mean±SD	p-value*
Baseline	0.56±0.055	<0.001*
4 th week	0.63±0.054	
8 th week	0.71±0.050	
12 th week	0.80±0.059	

Note: Data were analyzed within the group by repeated measures ANOVA test. * $p<0.05$ is significant

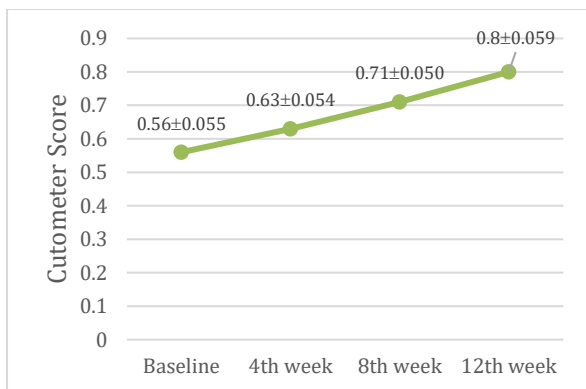


Figure 2 Linear graph revealing mean cutometer score at crow's feet on baseline, 4th week, 8th week and 12th week.

According to statistical analysis of cutometer score at crow's feet from table 6 and figure 2, mean cutometer score on baseline visit was 0.56 ± 0.055 . On the 4th week, the results were 0.63 ± 0.054 and on the 8th week it was increased to 0.71 ± 0.05 and on the 12th week the result was 0.80 ± 0.059 . The mean cutometer score was significantly increased at the level of 0.05. ($p<0.001$). Therefore, the mean cutometer score at crow's feet on 4th, 8th and 12th week were remarkably higher than the mean cutometer score at crow's feet on baseline visit.

Table 7 Multiple comparison analysis of cutometer score at crow's feet on 4th, 8th and 12th week

Cutometer score at crow's feet, mean diff. (SD) / visit	different change	p-value*
4 th week-Baseline	0.07(0.01)	<0.001
8 th week-Baseline	0.15(0.01)	<0.001
12 th week-Baseline	0.24(0.01)	<0.001
8 th week-4 th week	0.08(0.01)	<0.001
12 th week-4 th week	0.17(0.01)	<0.001
12 th week-8 th week	0.09(0.01)	<0.001

Note: Data were analyzed by post hoc test. * $p<0.05$ is significant

According to multiple comparison analysis of cutometer score by post hoc test from table 7, it was indicating statistical difference in each follow-up. Therefore, the difference in mean skin elasticity was significant when compared with different visits.

Table 8 Statistical analysis of cutometer score at under eye area

	mean±SD	p-value*
Baseline	0.54±0.080	<0.001*
4 th week	0.64±0.079	
8 th week	0.72±0.070	
12 th week	0.80±0.067	

Note: Data were analyzed within the group by repeated measures ANOVA test. * $p<0.05$ is significant.

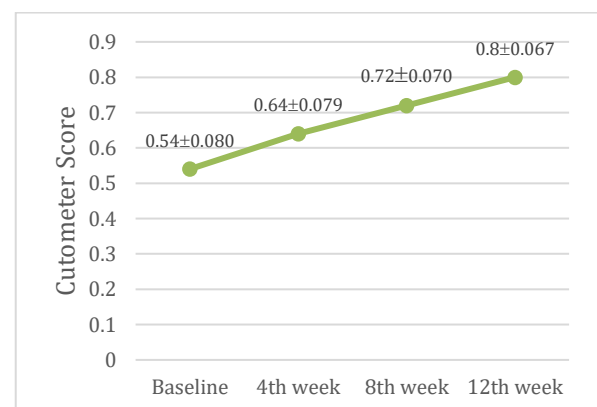


Figure 3 Linear graph showing mean cutometer score at under eye area on baseline, 4th week, 8th week and 12th week

Regarding to statistical analysis of cutometer score at under eye area from table 8 and figure 3, mean cutometer score were 0.54 ± 0.08 on baseline visit, 0.64 ± 0.079 on 4th week, 0.72 ± 0.07 on 8th week and 0.80 ± 0.067 on 12th week. The data indicated that the mean cutometer score was significantly increased at the level of 0.05. ($p < 0.001$). Therefore, the mean cutometer score at under eye on 4th, 8th and 12th week were remarkably higher than the mean cutometer score at under eye on baseline visit.

Table 9 Multiple comparison analysis of cutometer score under the eye on 4th, 8th and 12th week

Cutometer score under eye area mean diff. (SD) / visit	Different Change	p-value*
4 th week-Baseline	0.09(0.01)	<0.001
8 th week-Baseline	0.18(0.01)	<0.001
12 th week-Baseline	0.26(0.02)	<0.001
8 th week-4 th week	0.09(0.011)	<0.001
12 th week-4 th week	0.161(0.01)	<0.001
12 th week-8 th week	0.08(0.01)	<0.001

Note: Data were analyzed by post hoc test. * $p < 0.05$ is significant

According to multiple comparison analysis of cutometer score at under eye area from table 9, the mean difference was seen in different time points. The mean change in cutometer score at under eye area is statistically different in each week.

Participants' Satisfactory Score

Table 10 Participants' satisfactory score of 5% white tea (*Camellia sinensis*) extract eye cream on 12th week

Satisfactory Score	n (%)
Score 0 = No satisfaction	0
Score 1 = Little satisfaction	0
Score 2 = Moderate satisfaction	2 (10%)
Score 3 = More satisfaction	14 (70%)
Score 4 = Most satisfaction	4 (20%)

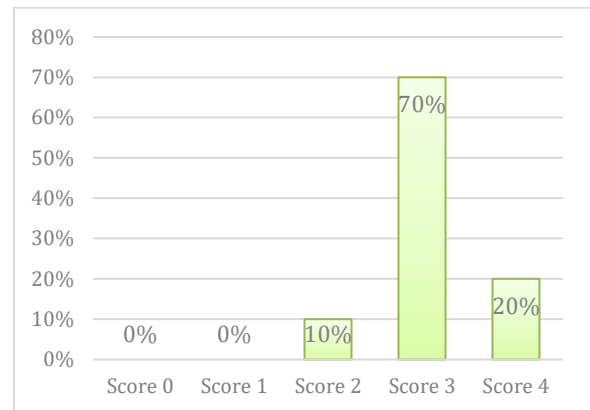


Figure 4 Bar chart exhibiting frequencies of participants' satisfactory score of 5% white tea (*Camellia sinensis*) extract eye cream on 12th week

Participants rated the satisfactory score on the 12th week. Regarding the collected data of table 10 and figure 4, the majority of the volunteers ($n=14$, 70%) rated more satisfaction, 2 volunteers (10%) rated moderate satisfaction and 4 volunteers (20%) rated most satisfaction.

Adverse Effects

In all participants, no adverse effect was detected throughout the treatment with 5% white tea (*Camellia sinensis*) extract eye cream.

Discussion

This was the study of 5% white tea (*Camellia sinensis*) extract eye cream for periorbital wrinkles reduction. In this study, 20 volunteers were recruited and all the volunteers came regular follow-up and completed the study. This was carried out in healthy male and female volunteers who were between 30-55 years old.

Improvement was measured with wrinkle evaluation score by VISIA. According to the statistical analysis, the results of mean wrinkle evaluation score with VISIA is increased statistically significant ($p < 0.001$). When comparing the mean change from each visit, statistical different was seen between 4th and 8th week, 4th and 12th week ($p < 0.001$). However, the mean change between 8th week and 12th week was not statistically significant. The results were indicating that the improvement was increased in each follow-up. Rao-Goldman 5-point visual scale was also used to evaluate the wrinkles. Mean scores were reduced in each follow-up and it was statistically significant ($p < 0.001$). For the elasticity of the skin, cutometer was measured at two areas: crow's feet and under eye area. The mean cutometer score was significantly increased at the level of 0.05. ($p < 0.001$). Mean change of cutometer score at

crow's feet was compared for different visit and skin elasticity was improved significantly in each visit.

Regarding to statistical analysis of cutometer score at undereye area, the data were indicated that mean cutometer score was significantly increased at the level of 0.05. ($p < 0.001$). Therefore, mean cutometer score at undereye on 4th, 8th and 12th week were remarkably higher than the mean cutometer score at undereye on baseline visit. When comparing the mean change of undereye area's cutometer score from each visit, statistical different was seen.

In this study, increased in elasticity was seen significantly. This may be due to the action of white tea extract which halt the activity of metalloproteinase enzyme (MMP) and in turn prevents the destruction of collagen and elastin which are the important factors in aging [6]. Polyphenols involve in white tea can also prevent vitamin C oxidation and maintain skin elasticity. This is due to the fact that vitamin C functions as a coenzyme in collagen production. In this way, white tea extract can be used to treat fine lines and wrinkles and increase the elasticity of the skin. Therefore, this study is correlated with the previous study on maintaining skin elasticity and tensile strength [6].

Patients' satisfactory score was recorded on 12th week. Amazingly, 70% (14 volunteers) rated score 3 (more satisfaction) and only 10% (2 volunteers) rated score 2 (moderate satisfaction). 20% (4 volunteers) scored high satisfaction. Therefore, 5% white tea (*Camellia sinensis*) extract eye cream has high patients' satisfactory score. Throughout the study, no adverse effect was detected and the patch test did not show any allergic reaction. Hence, 5% white tea (*Camellia sinensis*) extract eye cream is safe for topical application.

Although intrinsic aging is inevitable, extrinsic aging can be prevented. Along with other wrinkles reduction lifestyles and treatments, topical use of eye cream can delay the process of wrinkles formation. This study revealed that 5% white tea (*Camellia sinensis*) extract eye cream is effective for periorbital wrinkles reduction. This may be due to its richness in bioactive compounds and antioxidants. High contents of polyphenol, epicatechin (EC), epigallocatechin gallate (EGCG) and other catechins might help in wrinkles reduction [6].

Polyphenols in white tea scavenge reactive oxygen species (ROS), reactive nitrogen species (RNS) and thus reducing oxidative stress and showing great anti-oxidant activities. It scavenges singlet oxygen, superoxide-

hydroxyl-, peroxy-, and peroxy nitrile radicals, chelates the trace elements and inhibits the enzymes which are involved in generation of ROS [9]. These anti-oxidant activities might enhance in delaying of aging process. This research indicated that it was correlated with the previous study about anti-oxidant action of white tea extract by scavenging free radicals and reactive oxygen species (ROS) and reactive nitrogen species (RNS).

Previous study had proved that white tea can prevent damage to the Langerhans cells caused by UV radiation. UV radiation can provoke cutaneous immunosuppression which in turn leading to radiation of free radicals and enhance the aging process. [10,11] Polyphenols can lower UVB-induced inflammation and oxidative stress [12]. Hence, this may be the fact that white tea extract can increase elasticity and reduce wrinkles although no sunscreen was given in this study. Further study is required for photoprotective action to use as a photoprotective agent.

According to this study and results, 5% white tea (*Camellia sinensis*) extract eye cream is safe and effective for periorbital wrinkles reduction and also well tolerated. Any adverse effects such as erythema, skin irritation and hyper or hypopigmentation were not detected. For better results and efficacy, it should be used longer in further studies.

Conclusion

In regard to this study, the outcome of the mean change of cutometer scores at crow's feet and under eye area were significantly increased in different visits. Thus, 5% white tea (*Camellia sinensis*) extract could improve elasticity of the skin. Improvement was also statistically increased in follow-up visits. This study of 5% white tea (*Camellia sinensis*) extract also achieved high participants' satisfactory score and any adverse effect was not detected. To summarize, 5% white tea (*Camellia sinensis*) extract eye cream is effective for periorbital wrinkles reduction and safe for topical application. Hence, it can be an alternative anti-aging treatment for wrinkles reduction.

Funding

The researcher used personal funding.

Acknowledgements

First and foremost, I would like to express my sincere gratitude to my Advisor Dr. Tanomkit Pawcsuntorn for his patience, motivation and guidance through my journey of writing and accomplishing the thesis. Besides my advisor, I would also express my

sincere gratitude to Professor and Dean Dr.Paisal Rummaneethorn, Professor Dr. Thamthiwat Nararatwanchai and Associate Professor Dr.Wongdyan Pandii who are the external examiners for my thesis. Without their guidance and advice, I would not be able to finish my thesis within this limited time period. I would also like to extend my gratitude to Dr. Thep Chalermchai who steered me through a great deal of work in statistics.

References

- [1] Vierkötter A, Krutmann J. Environmental influences on skin aging and ethnic-specific manifestations. *Dermato-Endocrinology*. 2012;4(3):1-231.
- [2] Pedic L, Pondeljak N, Situm M. Recent information on photoaging mechanisms and the preventive role of topical sunscreen products. *Acta Dermatovenerologica Alpina, Pannonica et Adriatica*. 2020;29(4):201.
- [3] Archer DF. Postmenopausal skin and estrogen. *Gynecological Endocrinology*. 2012;28:2-6.
- [4] Eassa HA, Eltokhy MA, Fayyaz HA, Khalifa MKA, Shawky S, Helal NA, et al. Current Topical Strategies for Skin-Aging and Inflammaging Treatment: Science versus Fiction. *Journal of Cosmetic Science*. 2020;71(5):321-50.
- [5] White tea extract: a tea less processed. 2003;20.
- [6] Koch W, Zagórska J, Marzec Z, Kukula-Koch W. Applications of Tea (*Camellia sinensis*) and its Active Constituents in Cosmetics. *Molecules* (Basel, Switzerland). 2019;24(23).
- [7] Sumpio BE, Cordova AC, Berke-Schlessel DW, Qin F, Chen QH. Green Tea, the “Asian Paradox,” and Cardiovascular Disease. *Journal of the American College of Surgeons*. 2006;202(5):813-25.
- [8] Zhang L, Ho C-T, Zhou J, Santos JS, Armstrong L, Granato D. Chemistry and Biological Activities of Processed *Camellia sinensis* Teas: A Comprehensive Review. *Comprehensive reviews in food science and food safety*. 2019;18(5):1474-95.
- [9] Xu Y, Gao X, Wang L, Yang M, Xie R. Bakuchiol ameliorates cerebral ischemia-reperfusion injury by modulating NLRP3 inflammasome and Nrf2 signaling. *Respiratory Physiology & Neurobiology*. 2021;292.
- [10] Camouse MM, Domingo DS, Swain FR, Conrad EP, Matsui MS, Maes D, et al. Topical application of green and white tea extracts provides protection from solar-simulated ultraviolet light in human skin. *Experimental Dermatology*. 2009;18(6):522-6.
- [11] Camouse MM, Domingo DS, Swain FR, Conrad EP, Matsui MS, Maes D, et al. Topical application of green and white tea extracts provides protection from solar-simulated ultraviolet light in human skin. 2009;522.
- [12] Sharma P, Montes de Oca MK, Alkeswani AR, McClees SF, Das T, Elmetts CA, et al. Tea polyphenols for the prevention of UVB-induced skin cancer. *Photodermatology, Photoimmunology & Photomedicine*. 2018;34(1):50-9.