THE EFFECTIVENESS OF ORAL SUPEROXIDE DISMUTASE (SOD) ON TOTAL ANTIOXIDANT STATUS, TRANSEPIDERMAL WATER LOSS (TEWL) AND SEBUM CONCENTRATION IN PHOTO AGING SKIN

Khairuddin Djawad https://orcid.org/0000-0002-2322-7633
Dewi Anggraini https://orcid.org/0000-0003-1086-8615
Medical Faculty, Hasanuddin University, Makassar, Indonesia
duddindjawad@gmail.com

Relevance. Aging is a progressive process of decrease in organs functions and capacity, including the skin. Photoaging is extrinsic aging mainly occur due to ultraviolet (UV) exposure. The effectiveness of oral SOD for premature aging is still not yet known.

Objective: we aimed to evaluate the effectiveness of this antioxidant on total antioxidant status (TAS), skin hydration (TEWL), and sebum concentration in premature skin aging.

Methods. This study is a clinical trial research design with one group pre-post test. All subjects who were exposed to UV for approximately 3-4 hours. All subjects signed an informed consent and were interviewed accordingly. Photoaging was diagnosed clinically by three dermatologists according to Glogau type II classification such as dynamic wrinkles, palpable keratosis, visible lentigo senilis, and smiley line. SOD 250 IU was given to all subjects twice daily for 60 days. Laboratory examinations such as TAS, TEWL, and sebum concentration were done pre and post-intervention.

Results. A total of 25 subjects, Fitzpatrick skin type 4 were included in this study. There were 14 males and 11 females with 20 subjects age 30-40 years old and 5 subjects age 25-29 years old. Fourteen (56%) out of 18 subjects from low TAS group have normal TAS post-treatment with SOD. McNemar test showed a significant increase in TAS value pre and post-treatment with SOD (p<0.05). TEWL measurement on cheek showed 9 out of 10 subjects from the strained group have normal TEWL post-treatment, while all 3 subjects from the critical group have normal TEWL value. Measurement on the forehead showed 7 subjects from the strained group have a normal TEWL. Sebimeter on the forehead showed 17 subjects from dry skin group 14 (56%) subjects have normal skin, 1 (4%) subject becomes oily, and 2 subjects remains dry post-treatment with SOD for 60 days. All subjects with dry skin on U zone become normal skin post-treatment.

Conclusion. SOD significantly increased TAS value, decreased TEWL, and improvement of skin dryness post-treatment with SOD for 60 days.

Keywords: Superoxide Dismutase, TAS, TEWL, Sebum
precancerous cell changes. It is commonly used in as anti-aging and antioxidant that can reduce wrinkles, fine lines, and age spots [12, 13].

Stimulation of sebaceous gland function due to oxidative stress induced by UV radiation will subsequently increase sebum secretion. It might be due to increased levels of oxidized lipids, triglyceride hydroperoxides, and cholesterol hydroperoxides [14].

The total antioxidant status examination is regarded as one of the parameters used to evaluate the negative effect of antioxidants, which is considered as an oxidative stress indicator. Giving antioxidant in low total antioxidant status can reduce the negative impact of free radicals [15]. The antioxidant such as SOD can stimulate the production of endogenous antioxidants, increase antioxidant status, and prevent disease manifestation due to free radicals.

**Objective:** The effectiveness of oral SOD for premature aging is still not yet known, thus we aimed to evaluate the effectiveness of this antioxidant on total antioxidant status (TAS), skin hydration (TEWL), and sebum concentration in premature skin aging.

**METHODS**

**Study design.** This study is a clinical trial research design with one group pre-post test.

**Subject characteristic.** The study population was all patient with premature aging consulted at Outpatient Department, Department of Dermatology and Venereology, Dr. Wahidin Sudirohusodo Hospital, Cosmetic Subdivision, Makassar. Inclusion criteria were all patient diagnosed with photoaging clinically with a good general condition, neither taking antioxidant (vitamin C, E, β-carotenoid, Lycopene, Leucoselect phytosome, etc), having dermatitis or skin inflammation on the face and surroundings. Patients with chronic disease, pregnant, on maintenance with any cosmetics, rejuvenation treatment with topical antioxidant, topical retinoid, or chemical peeling will be excluded from this study.

**Sample size.** Total sample size 25 subjects and sampling was done in a proportional manner where all the subjects were sorted according to an initial visit at OPD.

**Study Protocol.** All subjects signed the informed consent and were interviewed accordingly. They filled in a questionnaire and were examined clinically by three dermatologists for signs of premature aging according to Glogau type II classification such as wrinkles in motion, palpable keratosis, visible lentigo senilis, and smiley line. SOD 250 IU was given to all subjects twice daily for 60 days. Laboratory examinations such as TAS, TEWL, and sebum concentration were done pre and post-intervention:

1. **Evaluation of TAS.** Venipuncture was done in each subject to measure the total antioxidant serum (TAS) level pre and post-treatment. The TAS level examination was done using ELISA with human total antioxidant capacity (T-AOC) kit (Bioassay Technology Laboratory) following the instruction from the manufacturer.

2. **TEWL measurement.** Interpretation of TEWL measurement seen in Table 1, according to the protocol in all samples using Tewameter/Cornoemeter 350 (TC350) made by Courage & Khazaka electronic GmbH, Jerman year 1997.

3. **Sebum concentration.** Interpretation of sebum concentration seen in the Table 2, according to protocol in all samples using Sebumeter® SM 815 made by Courage & Khazaka electronic GmbH, Jerman year 2003.

**Data analysis.** Collected data were analyzed using SPSS version 11.5. McNemar test was being used for the hypothesis to compare antioxidant value pre and post-treatment. Significant value if p<0.05.
RESULTS AND DISCUSSION

Subject characteristics. A total of 25 subjects, Fitzpatrick skin type 4 were included in this study. There were 14 males and 11 females with 20 subjects age 30-40 years old and 5 subjects age 25-29 years old. All patients have to work outside for approximately 3-4 hours of UV exposure.

On physical examination, all subjects have a dynamic wrinkle, 23 subjects have seborrheic keratosis and smiley line, 5 subjects have lentigo senilis. Eleven (44%) subjects not a smoker, and from 14 smokers, 8 (32%) subjects have 1 pack a week and 6 (24%) subjects have 1-2 packs per day.

Total antioxidant status (TAS). TAS value pre-treatment with SOD was low in 18 (72%) subjects and normal in 7 (28%) subjects. It was found that 14 (56%) out of 18 subjects from low TAS group have normal TAS post-treatment with SOD. McNemar test showed a significant increase in TAS value pre and post-treatment with SOD (p<0.05). McNemar test p-value = 0.000.

Table 3

<table>
<thead>
<tr>
<th>Measurement</th>
<th>N</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pre-treatment</td>
</tr>
<tr>
<td>TAS</td>
<td>25</td>
<td>1,187 ± 0.169</td>
</tr>
<tr>
<td>TEWL forehead</td>
<td>25</td>
<td>24,82 ± 4,889</td>
</tr>
<tr>
<td>Sebumeter forehead</td>
<td>25</td>
<td>25 ± 4,869</td>
</tr>
<tr>
<td>Sebumeter cheek</td>
<td>25</td>
<td>40,80 ± 19,177</td>
</tr>
<tr>
<td>Sebumeter chin</td>
<td>25</td>
<td>56,96 ± 24,337</td>
</tr>
</tbody>
</table>

TEWL measurement on the cheek and forehead pre and post-treatment with SOD

Table 4

<table>
<thead>
<tr>
<th>Measurement</th>
<th>TEWL Pre-treatment</th>
<th>TEWL post-treatment</th>
<th>Total N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Healthy N (%)</td>
<td>Normal N (%)</td>
<td>Strained N (%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Cheek</td>
<td>Normal</td>
<td>3 (12)</td>
<td>9 (36)</td>
</tr>
<tr>
<td></td>
<td>Strained</td>
<td>1 (4)</td>
<td>9 (36)</td>
</tr>
<tr>
<td></td>
<td>Critical</td>
<td>0 (0)</td>
<td>3 (12)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4 (16)</td>
<td>21 (84)</td>
</tr>
<tr>
<td>Forehead</td>
<td>Normal</td>
<td>3 (12)</td>
<td>11 (44)</td>
</tr>
<tr>
<td></td>
<td>Strained</td>
<td>0 (0)</td>
<td>7 (28)</td>
</tr>
<tr>
<td></td>
<td>Critical</td>
<td>1 (4)</td>
<td>1 (4)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4 (16)</td>
<td>19 (76)</td>
</tr>
</tbody>
</table>

Diverse events. There were no adverse events found in this study.

Ultraviolet radiation can induce matrix metalloproteinases and be sustained with multiple exposures [16]. Matrix metalloproteinases are proteolytic enzymes that degrade proteins in connective tissue particularly collagen and elastin. They are important for matrix remodeling during wound healing [17]. It is also considered as the primary mediators of connective tissue damage in photodamaged skin [16]. Photaging affects all three layers of the epidermis, but changes in the dermal layer seem to be the primary process in nature, while epidermal changes are often secondary [18].

A total of 25 subjects included in this study with more than 80% of them age 30-40 years old. Excessive UV exposure can cause severe photaging as early as the second decade of life [19]. Photaging signs are more evident in most women on 2nd-3rd decade of life [20]. Other literature stated that extrinsic aging begins in the second decade [21].

Skin as the first line barrier from the surrounding environment, which can produce oxidative stress [6]. Environmental factors such as sun radiation (ultraviolet radiation, visible light, and infrared radiation), air...
pollution, tobacco smoke, cosmetic products are known contributes to skin aging by the formation of oxidative stress [18]. UVR has been considered as a potential contributor for free radicals. Exposure to the skin causing absorption of photons by natural chromophores, which includes porphyrins, flavins, bilirubin, urocanic acid, vitamin K and B6 derivatives, and even DNA. On excitation, chromophores will be having molecular changes, thus becoming electron donors. Reaction with other electron form free radicals that finally result in oxidative stress [6, 22]. Free radicals can be formed naturally from normal cell metabolism thus causing oxidative stress [23]. Oxidative stress affects skin aging through several mechanisms, includes decreasing proteasome function [24], DNA damage [25], replicative senescence in human dermal fibroblast and melanocytes [26], shortening of the telomeres [6]. The skin has a defense mechanism against oxidative stress with an antioxidant enzyme produced within the body, such as SOD, catalase, GR, GSH-Px, etc. [27].

Collagen is an important component of the skin. Loss of collagen will promote sagging, signs of aging, and decrease skin hydration. Collagen fragment products promote a further increase of ROS in dermal fibroblasts [28]. A decrease in collagen can activate receptor-mediated signaling pathways of various cytokines and growth factors within the keratinocytes and dermal fibroblasts. Induction of c-Jun will form a component of activator protein 1 (AP-1) and nuclear factor κB (nF-κB) [29, 30]. The induction of these proteins leads to decreased collagen synthesis and increased collagen breakdown through the activation of metalloproteinases (MMPs), collagenases, and gelatinase. Failure of dermis repair result in solar elastosis histopathologically and lead to visible signs of photo-aging [6].

ROS accumulation plays an important role in photoaging where antioxidant enzyme significantly declines on the corneum layer and increase the concentration of protein oxidation in the upper dermis [31]. Our study showed SOD increased TAS value and sebum concentration while decreasing in TEWL.

Superoxide dismutases are a group of metalloenzymes included as enzymatic antioxidants against ROS-mediated injury [32]. SODs can be classified into the following: Copper-Zinc-SOD (Cu, Zn-SOD), Iron SOD (Fe-SOD), Manganese SOD (Mn-SOD), and Nickel SOD [33, 34], but two main types are CuZnSOD (SOD1) and MnSOD (SOD2) [9, 10]. Natural SOD within the body will decrease with age hence they are more susceptible to oxidative stress-mediated diseases [35].

SOD has been widely used in cosmetic products as anti-aging and antioxidant because it can reduce free radical skin damage and also protect against UV radiation, faster wound healing, and reduce another skin aging [13]. SOD synthetic offers a potential treatment due to their smaller size, longer half-life, and have similar activity with natural SOD by converting O2- into H2O2 then further converted into water by catalase [36].

SOD as the primary antioxidant is first line defense mechanism against oxidative stress. SOD has high catalytic rate and can renew itself constantly, while secondary antioxidants are quickly exhausted and no possibility of renewal [37]. The antioxidant defense mechanism of the skin has been reported in many studies where a single exposure to UVB can induce disruption of antioxidant defense mechanism and SOD activity in the epidermal layer [38, 39]. Administration of antioxidant supplementation in low endogenous antioxidant after UV exposure can prevent oxidative stress-mediated skin damage [40].

Nicotine and other substances in tobacco have known to cause unfavourable skin changes or even skin cancer. Tobacco can accelerate skin aging natural process that can be observed in 40 years smoker skin which is similar with 70-year-old non-smoker skin. Skin damage due to tobacco is irreversible and further damage can only be reduced by smoking cessation [41].

Yin et al studied the correlation between tobacco smoking and skin aging. They investigated the alterations of collagen, matrix metalloproteinases (MMPs) and tissue inhibitors of metalloproteinases (TIMPs) in human fibroblast treated with tobacco smoke extract. Human fibroblasts exposed to UVA1 radiation were used as positive controls. Collagen synthesis was found reduced by 40.1% with 25 micro/ml of tobacco smoke extract. The expression of MMP-1 and MMP-3 mRNA were significantly increased with tobacco smoke extract or UVA1 radiation. Antioxidants such as sodium azide, L-ascorbic acid and Trolox can prevent alteration of MMP-1 induced either by tobacco or UVA1 [42]. Rocquet et al found that smoking can increase MMP-1 activity on the skin causing an imbalance of MMP-1 and TIMP-1, which plays an important role in skin aging [31].

Miyachi et al conducted studies on mice and found that UBV contributes to the lower SOD activity in the skin. In human, a decrease in SOD activity was also found in fibroblasts and catalase activity after UBV. The imbalance between oxidants and antioxidants will cause continuous and increase in cumulative oxidative stress. Environmental factor such as pollutants can accelerate the aging process, and exogenous antioxidants reduce the toxicity of ROS [43]. Antioxidants can be considered as a strategy against excessive ROS and subsequently lower the incidence of photoaging [27].

TEWL has been known to be increased during skin barrier disruption, which can be caused by chemical, microorganisms, physical trauma, and UV radiation [44]. TEWL has commonly used a parameter to assessed photoprotective effect on the skin, especially epidermal barrier function disruption due to UV radiation [45]. Wang et al investigated the effect of chronic UV exposure on skin barrier function and photoaging. They
compared TEWL of UV-exposed skin areas with UV-
nonexposed skin areas in elderly (>50 years old). There
were increased TEWL levels on UV-exposed skin but
there was not statistically different (p>0.05) compared
to UV-nonexposed skin areas. This result might be due
to subjects were from the geriatric group with relatively
higher TEWL. In contrast to our study, there was a
significant improvement of TEWL in younger age groups
after SOD administration [46]. Recently, there were not
yet available studies of antioxidants in decreasing TEWL
and increasing sebum concentration.

UV radiation especially UVA have deeper penetration
and damage sebaceous glands. An experimental study
by Leyden et al in UV induced photoaged hairless mice
showed marked sebaceous glands hyperplasia. This result
is similar to study by Di Cerbo et al which significant
increase in sebum concentration occurred in patients with
photoaging (p<0.001) [47]. In contrast, our study showed
an improvement of skin dryness seen in all subjects with
dry skin has normal skin after 60 days of SOD. Study by
Tokudome et al showed a decrease in intracellular lipid
content and decreased in proportion to the number of
differentiated cells. Antioxidants inhibit sebaceous lipid
production by suppressing differentiation of sebocyte [48].

In terms of adverse events, all subjects had no adverse
events after 2 months of taking SOD 250 IU twice daily
for 60 days. A similar result was also found in a study by
Garcia-Gonzales et al. [49].

CONCLUSION

There were a significant increase in TAS value, decrease in TEWL, and improvement of skin dryness
after taking oral SOD for 2 months.

REFERENCES

1. Yaar M, Gilchrest B. Aging of Skin. In: Goldsmith
L, Katz S, Gilchrest B, Paller A, Leffell D, Wolff K,
editors. Fitzpatrick Dermatology in General Medicine.
View in: URL: https://accessmedicine.mhmedical.com/
content.aspx?bookid=392&sectionid=41138823

2. Rinnerthaler M, Bischof J, Streubel MK, Trost A,
2015;5(2):545-89. DOI: 10.3390/biom5020545
View at: Publisher Site: https://www.mdpi.com/2218-273X/5/2/545
PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4496685/

in normal and sun-damaged skin: an immunohisto-
tb04086.x
View at: Publisher Site: https://onlinelibrary.wiley.com/
doi/abs/10.1002/j.1365-2133.1987.tb04086.x

4. Warren R, Gartstein V, Kligman AM, Montagna W,
Allendorf RA, Ridder GM. Age, sunlight, and facial
skin: a histologic and quantitative study. Journal of the
American Academy of Dermatology. 1991;25(5):751-
60. DOI: 10.1016/s0190-9622(08)80964-4
View at: Publisher Site: https://www.jaad.org/article/
S0190-9622(08)80964-4/pdf
Europe PMC: https://europepmc.org/article/
med/1802896

5. Kelly RI, Pearse R, Bull RH, Leveque J-L, de Rigal J,
Mortimer PS. The effects of aging on the cutaneous
1995;33(5):749-56. DOI: 10.1016/0190-9622(95)91812-4
View at: Publisher Site: https://www.jaad.org/article/
0190-9622(95)91812-4/fulltext
Europe PMC: https://europepmc.org/article/
med/7593773

6. Ahsanuddin S, Lam M, Baron ED. Skin aging and
oxidative stress. 2016. AIMS Molecular Science.
View at: Publisher Site: http://www.aimspress.com/
title/10.3934/molsci.2016.2.187

7. Sroka J, Madeja Z. [Reactive oxygen species in reg-
ulation of cell migration. The role of thioredoxin re-
gov/19824470/

8. Masaki H. Role of antioxidants in the skin: anti-aging ef-
effcts. Journal of dermatological science. 2010;58(2):85-
90. doi: 10.1016/j.jdermsci.2010.03.003
View at: Publisher Site: https://www.jdsjournal.com/
article/S0923-1811(10)00078-2/fulltext
Europe PMC: https://europepmc.org/article/
med/20399614

9. Matés JM, Sánchez-Jiménez F. Antioxidant enzymes
1999;4(4):0339-345. DOI: 10.2741/mates
gov/10077544/

10. Chelikani P, Fita I, Loewen PC. Diversity of structures and
properties among catalases. Cellular and Molecular Life Sciences CMSLS.
View at: Publisher Site: https://link.springer.com/
title/10.1007%2Fs00018-003-3206-5
Europe PMC: http://europepmc.org/article/
MED/14745498

11. Balsano C, Alisi A. Antioxidant effects of nat-
ural bioactive compounds. Current pharmace-
utical design. 2009;15(26):3063-73. DOI:
15. Faidati W, Barakbah J. Penilaian status antioksidan total pada penderita kusta di unit rawat jalan penyakit kulit dan kelamin RSUD Dr. Soetomo Surabaya. MDVI. 2001;28(SII):209S-14S.
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PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2631323/

View at: Publisher Site: https://core.ac.uk/download/pdf/82734732.pdf

View at: Publisher Site: https://www.nature.com/articles/379335a0
Europe PMC: https://europepmc.org/article/med/8552187

ResearchGate: https://www.researchgate.net/publication/281894397_Molecular_aspects_of_skin_aging:_Recent_data


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SemanticScholar: https://pdfs.semanticscholar.org/f45a/e6a08be9c1bf6e5e03324229e49e3e1772.pdf

Europe PMC: https://europepmc.org/article/med/11249925

PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5969776/


View at: PubMed: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5969776/


40. Takahashi H, Hashimoto Y, Aoki N, Kinouchi M, Ishida-Yamamoto A, Izuka H, Copper, zinc-superoxide dismutase protects from ultraviolet B-induced apoptosis of SV40-transformed human keratinocytes: the protection is associated with the increased

View at: Publisher Site: https://www.jdsjournal.com/article/S0923-1811(99)00060-2/fulltext


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PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3299230/


View at: Publisher Site: https://www.ncbi.nlm.nih.gov/pubmed/23421102/
PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3299230/


View at: Scopus: https://link.springer.com/article/10.1007/s004030050476
Europe PMC: https://europepmc.org/article/med/10836612


View at: https://accessmedicine.mhmedical.com/Content.aspx?bookId=392&sectionId=41137845


View at: Publisher Site: https://www.jci.org/articles/view/117919
PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC295841/
Europe PMC: https://europepmc.org/article/med/11913735


View at: Publisher Site: https://pubmed.ncbi.nlm.nih.gov/20936728/
Europe PMC: https://europepmc.org/article/med/20936728


View at: Publisher Site: https://www.sciencedirect.com/science/article/pii/S101113441400390X?via%3Dihub


View at: Publisher Site: https://medcraveonline.com/JDC/antioxidants-inhibit-subsequent-lipid-production-via-sebaceous-gland-cell-differentiation.html


View at: Publisher Site: https://www.sciencedirect.com/science/article/pii/S0188012898000256?via%3Dihub
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Актуальність. Старіння – це прогресуючий процес зниження функцій і можливостей органів, в тому числі шкіри. Фотостаріння – це зовнішнє старіння, яке в основному відбувається через вплив ультрафіолету (УФ). Ефективність перорального прийому антиоксиданту супероксиддисмутази (СОД) при передчасному старінні (або фотостарінні) на сьогоднішній день не відома.

Мета: оцінити ефективність прийому СОД для загального антиоксидантного статусу (ЗАС), гідратації шкіри (ТЕВВ) і концентрації шкірного сала при передчасному фотостарінні.

Методи. Це дослідження є науковим проектом клінічного дослідження з одними групою досліджуваних, які тестували до і після УФ-опромінення. Всі досліджувані піддавалися УФ-опромінення протягом приблизно 3-4 годин. Всі досліджувані підписали інформовану згоду і пройшли відповідну співбесіду. Фотостаріння діагностувалося в клінічному аспекті трьома дерматологами відповідно до класифікації по Глогув тип II. Зокрема, оцінювалися динамічні зморшки, пальпуємий кератоз, видимі старчі пігментні плями і мімічна складка. СОД 250 МЕ давали всім досліджуваним два рази на день протягом 60 днів. Лабораторні дослідження ЗАС, ТЕВВ і концентрації секрету сальних залоз проводилися до і після впливу УФ.

Результати. У дослідження було включено 25 осіб з типом шкіри 4 по Фітцпатріку. Серед них були 14 чоловіків і 11 жінок, 20 осіб у віці 30-40 років і 5 осіб у віці 25-29 років. Чотирнадцять (56%) з 18 досліджуваних із низьким ЗАС мали нормальний ЗАС після прийому СОД. Тест МакНемара показав значне збільшення значення ЗАС до і після прийому СОД (р<0,05). Вимірювання ТЕВВ в області шкіри показало, що у 9 з 10 досліджуваних з «strained» групи мали нормальне значення ТЕВВ після прийому СОД, в той час як всі з «critical» групи мали нормальне значення ТЕВВ. Вимірювання ТЕВВ в області шкіри показало, що у 7 досліджуваних з «strained» групи ТЕВВ мав нормальне значення. Себуметрія в області шкіри показала, що у 17 досліджуваних, з групи із сухою шкірою, 14 (56%) – мали нормальну шкіру, 1 (4%) – шкіра була зміцнена, а у 2 – шкіра залишалася сухою після прийому СОД протягом 60 днів. Себуметрія в області шкіри показала, що у всіх досліджуваних, з групи із сухою шкірою, шкіра ставала нормальною після прийому СОД.

Висновок. Після прийому СОД протягом 60 днів значно збільшилося значення ЗАС, зменшилася ТЕВВ і покращилося вологоутримання шкіри.

Ключові слова: супероксиддисмутаза (СОД), загальний антиоксидантний статус (ЗАС), трансепідермальна втрата води (ТЕВВ), секрет сальних залоз.
ние ТЭПВ. Измерение ТЭПВ в области лба показало, что у 7 испытуемых из «strained» группы ТЭПВ имел нормальное значение. Себуметрия в области лба показала, что из 17 испытуемых, из группы с сухой кожей, 14 (56%) — имели нормальную кожу, 1 (4%) — жирную, а у 2 — кожа оставалась сухой после приема СОД в течение 60 дней. Себуметрия в области щеки показала, что у всех испытуемых, из группы с сухой кожей, кожа становилась нормальной после приема СОД.

**Вывод.** После приема СОД в течение 60 дней значительно увеличилось значение ОАС, уменьшилась ТЭПВ и улучшилось влагосодержание кожи.

**Ключевые слова:** супероксиддисмутаза (СОД), общий антиоксидантный статус (ОАС), трансэпидермальная потеря воды (ТЭПВ), секрет сальных желез