

Evaluation of selected skin parameters following the application of 5% vitamin C concentrate

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Summary

Background: Ascorbic acid is a substance with confirmed anti-free-radical properties. It triggers the collagen synthesis, has a depigmenting effect and seals blood vessels. All these properties have a significant effect of the skin's appearance. The characteristic traits of capillary skin include telangiectasias as well as erythema, which might consolidate in the future, along with the feeling of burning and increased skin sensitivity.

Objectives: Study and evaluation of selected parameters of capillary skin after the application of 5% vitamin C concentrate throughout the period of 6 weeks with the use of instrumental tests and questionnaires.

Methods: The research was conducted on a group of 30 women ranging from 30 to 60 years of age with capillary skin indicating visible signs of erythematous plaques. The concentrate was applied once a day. Analyses of skin conditions were conducted four times: before the launch of the research D(0), after two 2D(14), after four 4D(28), and after 6 D(42) weeks of application. The research was conducted with the use of Mexameter MPA equipment, which was used to measure changes in the intensity of erythematous plaques. The depth of wrinkles was measured by PRIMOS system (two times D0 and 6D(42)). The research also used VISIA system which allowed to perform visual and numeral skin analyses. Each research was finalized with a questionnaire which provided a subjective evaluation of the examined product among participants.

Results: Significant reduction in erythema has been widely recorded. After 2 weeks, erythema dropped by 9%. After 4 weeks, it decreased by 16% and by 21% after 6 weeks. The concentrate's efficiency in diminishing erythematous plaques was confirmed by photographs generated by VISIA photograph system. Thanks to PRIMOS, decrease in both depth and volume of nasolabial folds was recorded in 87% of participants after 6 weeks of research.

Conclusion: 5% vitamin C concentrate is effective in treating capillary and photograph-aging skin. It decreases erythema and telangiectasias as well as triggers the shallowing of skin wrinkles.

KEYWORDS

aging skin, capillary skin, PRIMOS, VISIA, vitamin C

1 | INTRODUCTION

At the beginning of the 19th century, Albert Szent-Gyorgyi discovered ascorbic acid—also known as vitamin C. As a result, he was awarded the Nobel Prize for Medicine in 1937. This event had a significant impact and thus resulted in numerous subsequent researches on vitamin C conducted worldwide. It was observed that ascorbic acid has a great influence on skin. Vitamin C is mandatory for appropriate synthesis of collagen, where it acts as a co-factor during the hydroxylation process.^{1,2} Furthermore, it seals blood vessels and prevents telangiectasias as well as subcutaneous effusions.³ Furthermore, the vitamin also plays a great role in reducing depigmentation—it blocks melanogenesis and has a depigmenting effect.⁴ Ascorbic acid is also regarded as one of the most important free radical catchers.⁵⁻⁷

The properties of vitamin C provide an opportunity to use it for treatments on capillary skin, characterized by appearance of either persistent or interim erythema as well as telangiectasias. The vascular system of facial skin is a dense network of blood vessels and intrapapillary loops distributed on a relatively small space, which determines a large capacity of skin's vascular bed in the area. Furthermore, thin walls of vessels and location of subpapillary venular plexus directly under the epidermis (thinning of upper layers of dermis) result in the facial skin's vulnerability to develop erythema and telangiectasias.^{8,9}

The aim of the research was to evaluate selected capillary skin parameters after applying 5% vitamin C concentrate throughout the period of 6 weeks, with the use of instrumental tests and subsequent questionnaires.

2 | MATERIALS AND METHODS

The research was conducted on healthy participants with capillary skin with visible erythematous plaques and telangiectasias. The research was performed on 30 women ($n = 30$). The age limit was balanced between 30 and 65 years. Average age was 45.

Criteria qualifying to the participants' group included type of complexion, capillary, intensity of erythema >300 (measured by Mexameter®), and age above 30 years.

Criteria disqualifying from the participants' group included pregnancy and lactation, active viral changes on facial skin (herpes gestationis), active fungal and bacterial conditions, use of tanning beds, and undergoing skin lighting therapies during the research.

The study included a control group consisting of 11 patients. Measurements were performed in March and April, with the use of Mexameter®.

The tested product contains 5% Vitamin C as well as trace quantities of 0.008250% *Daucus Carota Sativa* Extract and 0.008250% Beta-Carotene. The properties of the product are associated solely with the presence of ascorbic acid as the amount of other ingredients is too low to significantly change skin parameters whatsoever.

The research had been conducted throughout the period of 6 weeks and included 4 evaluations taken after every 2 weeks. The participants received the concentrate and were instructed to use it once a day—during the evening—and apply it on their facial skin. The participants were asked to fill out a questionnaire where they evaluated the properties of the applied concentrate. Furthermore, following each meeting, the same parameters were examined with the use of same testing equipment. The examined parameters can be found pinpointed below. The measurements were taken in the same room, in stable conditions (temperature 20°C and humidity of 45% \pm 5%). Prior to the measurements, the participants were subject to acclimatization to the ambient conditions for a period of 15 minutes. Appropriate instruments were used for the research, and as a result, it was possible to check the following parameters:

- The erythema level was measured with the use of Mexameter® MPA 580 probe (Courage+Khazaka Electronic GmbH). The parameters that describe erythema are measured by the characteristic waves of length corresponding to the maximum spectral absorption of pigment and presented in the form of index numbers balanced between 0 (white) and 1000 (black). Measuring accuracy is $\pm 5\%$.
- The depth and volume of wrinkles—nasolabial fold in particular—were measured with the use of Primos GF Messtechnik GmbH. The instrument allows for optical and tridimensional imaging of selected skin areas. The area that subjects to Primos during the examination comprised a fragment of $30 \times 40 \text{ mm}^2$. The method of measurement used in the device was the stripline digital projection. The analysis of photographs was available thanks to an original software installed on the computer to which the equipment was connected. Primos allows for quick and precise 3D imaging of both micro- and macrostructures of the examined skin fragment. Measuring accuracy amounted to $0.1 \text{ }\mu\text{m}$ with duration <0.1 second.
- Skin parameters such as wrinkles, texture, pores, porphyrin, UV plaques, brown spots, and red areas were measured with the use of VISIA photograph system. The instrument allows for comparison of photographs taken in different times, for example, before and after the research. Selected parameters were described with the following:

- ✓ Number of traits—the amount of measured traits, excluding its intensity.
- ✓ Result—overall size and intensity of the measured trait.

The study was approved by the Bioethics Commission.

2.1 | Statistical analysis

Continuous variables were shown as median and interquartile range, whereas numerical data were shown as percentage. To show the time change of analyzed parameters for each volunteer, we calculated the percentage change dividing time point measurement by

TABLE 1 The level of erythema (red areas) intensity after 2, 4, and 6 weeks of applications. Research was conducted with the use of Mexameter® MPA 580. Median with interquartile range was provided in the table

	Baseline	2 wk	4 wk	6 wk
Erythema	Median: 378.5 Range of measure (330-421)	Median: 343.5 Range of measure (314-370)	Median: 329.5 Range of measure (284-344)	Median: 295 Range of measure (275-331)
Erythema—percentage	100%	91% (84%-96%)	84% (75%-92%)	79% (73%-91%)
Erythema—change		–9%	–16%	–21%

baseline values. For four time points' analysis of parameters change, we used Friedman ANOVA. *P* values lower than .05 were considered as statistically significant. Analyses were carried out using Statistica 12.5 (Statsoft, Tulsa, OK, USA).

3 | RESULTS

3.1 | Results of questionnaires

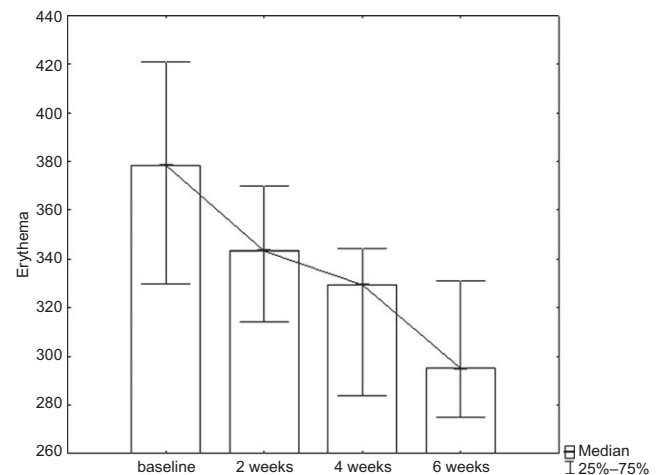
The product was well-tolerated among participants, 83% of them did not observe any adverse reactions related to the use of the concentrate. About 10% of participants noted the feeling of discomfort in the form of dryness of skin which lasted from 20 minutes to 3 days (differently among different participants). Eye irritation and pustular and grain changes as well as redness were recorded by one of the participants, which accounts for 3% of all women taking part in the study. The results disappeared after the first week of application. Burning sensation and the feeling of warm skin were also recorded by one of the participants (3% of participants—it lasted through several minutes). Despite minor adverse effects noted by some of the participants, none of the women decided to cease the application and withdraw from the research.

Along with the research's progress, the number of participants, who indicated high efficiency of the product, increased. They underlined reduced erythema and decreased visibility of telangiectasias as well as decreased oversensitivity of skin. In the questionnaires, the participants favorably evaluated the product's efficiency in decreasing the frequency and intensity of erythematous plaques resulting from different conditions, such as weather conditions (frost, sun exposure, wind) and emotional factors (stress) as well as alcohol consumption and consumption of hot spices.

3.2 | Results of instrumental tests

Measurements of erythema intensity made with the use of Mexameter® confirmed high efficiency of the applied product. During the research, the following results were obtained (Table 1 and Figure 1)—erythema decreased by 9% after 2 weeks, by 16% after 4 weeks, and by 21% after 6 weeks ($P < .0001$).

The results of the control group confirmed increase in the level of erythema by 7% (19.83 units) compared to the study group undergoing vitamin C treatment, at the level of significance $P > .05$, was $P = .22$.

**FIGURE 1** The level of erythema intensity after 2, 4, and 6 weeks of applications. Research was conducted with the use of Mexameter® MPA 580 probe (Courage + Khazaka Electronic GmbH) $P < .0001$

The concentrate's efficiency in preventing erythematous plaques was confirmed by photographs taken with the use of VISIA system (Figure 2). After 6 weeks of the study, it was found that the amount of red areas (without its intensity) was reduced by 16.06% (Table 2), while the overall surface and intensity of red areas dropped by 19.51% (Table 3).

Instrumental tests indicated favorable effects of vitamin C concentrate on photograph-aging skin. With the use of PRIMOS, it was possible to reduce the volume and depth of nasolabial folds as presented in graph 2.3. Improvement was recorded among 87% of participants (Figures 3 and 4).

4 | DISCUSSION

Ascorbic acid is commonly used in cosmetics, most often in skin care products dedicated to photograph-aging skin as well as pigmented skin and skin with erythematous plaques.¹⁰

The use of ascorbic acid in cosmetics and its application in skin are hindered due to its physicochemical properties. Therefore, its derivatives are used in products aimed at external use—most often esters of ascorbic acid, characterized by average lipophilicity. The ester, which meets all requirements necessary to effectively penetrate the skin, used in the research is ascorbyl palmitate. It is

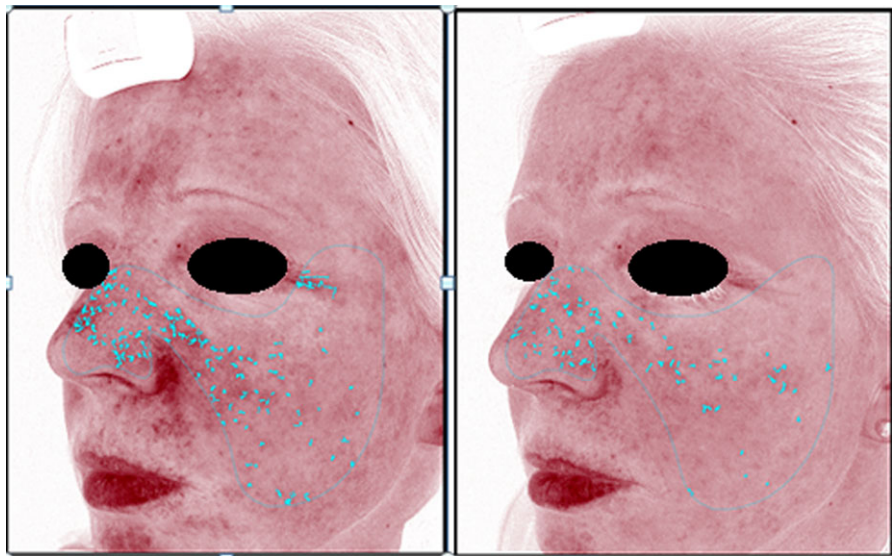


FIGURE 2 Evaluation of reduction of capillary changes after 6 weeks of product application in VISIA system

TABLE 2 The level of objective assessment in the number of attribute (the amount of measured attribute, excluding it intensity) of red areas after 6 wk in VISIA system

Number—red areas (participant)	Before application D(0)	After 6 wk D(42)	Difference after 6 wk D(42)
Average out of all three profiles	259	219	−40 (16.06%)

TABLE 3 The level of objective assessment (overall size and intensity of measured attribute) of red areas after 6 wk in VISIA system

Result—red areas (participant)	Before application D(0)	After 6 wk D(42)	Difference after 6 wk D(42)
Average out of all three profiles	41	33	−8 (19.51%)

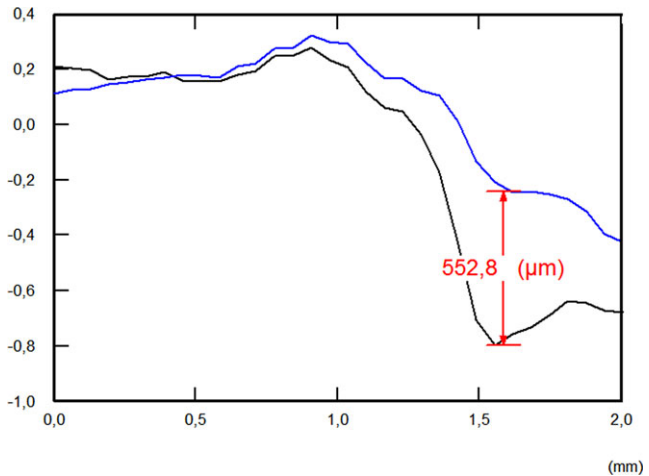


FIGURE 3 The level of objective assessment of nasolabial fold after 2 weeks of applications—evaluation in Primos system

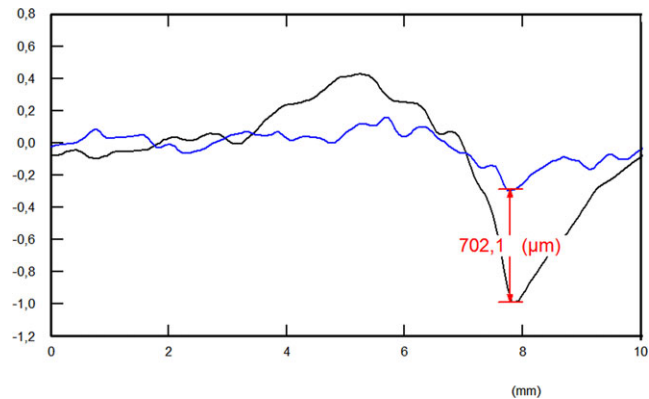


FIGURE 4 The level of objective assessment of nasolabial fold after 6 weeks of applications—evaluation in Primos system

characterized by great fat solubility and high stability, which allows to use it in different physicochemical forms. Furthermore, it shows convenient bio-accessibility of pure ascorbic acid released in the hydrolysis process within viable epithelial layers as well as anti-free-radical properties.¹¹

Collagen is responsible for proper functioning and appearance of the skin. Type I collagen is most prominent in skin (80%) and acts as a fibrous support along with type III collagen (15%), responsible for proper alignment of collagen I fibers and skin resilience. Furthermore, type III collagen is the main ingredient of blood vessel walls.^{12–14}

Vitamin C is directly responsible for proper collagen synthesis. It takes part in the process of hydroxylation of proline to 4-hydroxyproline, acting as a co-factor.^{15,16} Ascorbic acid also has a stimulating effect on the processes of transcription and stabilization of mRNA for pro-collagen I and III in fibroblasts. This has been confirmed by *in vitro* studies.^{14,17} Furthermore, *in vivo* studies also confirm that applying vitamin C can increase the levels of mRNA of collagen I

and III.^{14,18} In addition, vitamin C also has a stimulating effect on the synthesis of tissue inhibitor of metalloproteinases TIMP and therefore reduces the intensity of collagen degradation.¹⁹

Scientific research confirm that vitamin C improves skin with visible traits of photograph-aging,²⁰ reduces the frequency of erythematous plaques resulting from UV radiation, improves the appearance of capillary skin, and protects keratinocytes by preventing the occurrence of sunburn cells.^{21,22} Ascorbic acid also has a positive influence on healing of wound and sores.²³

Philippe G. Humbert et al conducted a research on the effects of vitamin C on photograph-damaged skin by applying a crème with 5% vitamin C. The research confirmed the high efficiency of the product with good tolerance recorded among participants. The research included two groups of patients, out of which one was a blind test. The evaluation of skin conditions conducted by the researcher at the beginning of the study, and afterward after 3 and 6 months of everyday application, was compared with self-assessment among treated women. Furthermore, the skin was also examined by taking a sample for histopathological research from patients who completed the application of vitamin C. The research underlines the stimulation of cytoplasmic structures of fibrocytes, which might result in increased production of collagen and elastin. Clinical assessment conducted by dermatologists, based on a worldwide scale and focused on hydration, roughness, elasticity, pigmentation spots, and wrinkle depth, confirmed the product's effectiveness in all mentioned parameters. In addition, a significant improvement of microstructure density of skin and decrease in depth of nasolabial folds were also observed. Ultrastructural evidence confirming improvement of tissue elasticity, confirmed further by clinical research on the skin surface, was also obtained.²⁴

Another research conducted by Xu TH et al confirmed the positive influence of vitamin C on photograph-aging skin. The research included 20 patients. A 23.8% vitamin C serum was applied by iontophoresis on one part of patients' face once a day throughout the period of 2 weeks. The other side of patients' face did not undergo any treatment. The results were presented in a 5-point scale (0-4) created by Dover, describing the level of photograph-aging of skin (Global Score for Photoaging).²⁵ The researchers recorded an average drop of results from 3.37 before the treatment to 1.68 after the treatment. About 75% of patients evaluated the results as Very Good. On the treated side of the face, patients confirmed reduced pigmentation and roughness as well as slighter wrinkles, without any adverse effects.²⁶

5 | CONCLUSIONS

The research confirmed that vitamin C is very effective in treating erythema as well as decreasing the visibility of telangiectasias. This was also confirmed by questionnaires, focusing on patients' self-evaluation and instrumental results. After 6 weeks of everyday application of vitamin C concentrate, erythema was reduced by 21% and skin's vulnerability due to environmental factors dropped. This confirms ascorbic acid's positive influence on increasing mechanical

resistance of blood vessels to cracking as well as its protective effect on endothelial cells. What is more, comparison with the control group indicates that the absence of skin care caused increase in erythema. Visible improvement in the form of reduced depth of nasolabial fold, conducted with the use of Primos, was also observed.

Summing up, the abovementioned research confirmed that 5% vitamin C concentrate is effective in the treatment of capillary and photograph-aging skin. It reduces erythema and the visibility of telangiectasias as well as shallows skin wrinkles.

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