

# THE USE OF HYDROGEN PURIFICATION AND MIXTURE OF COSMETICS ACIDS, AND THE INFLUENCE ON ACNE SKIN PARAMETERS: A CASE REPORT

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## ABSTRACT

**Background:** Acne vulgaris is a common disease which causes physical and mental ailments that are associated with a significantly reduced quality of life. Contemporary cosmetology is looking for innovative and effective methods of treating acne vulgaris. The synergistic action of acids and hydrogen purification has a positive effect on the reduction of sebum secretion and thus the amount of skin eruptions.

**Aim of the study:** To check the effectiveness of hydrogen purification treatment combined with topical acids for the treatment of acne vulgaris.

**Case report:** The participant of this study is a 20-year-old female, struggling with acne vulgaris for 5 years. She has a problem with large sebum secretion and numerous eruptions on her skin. Before and 30 days after a series of treatments the sebum secretion was measured with Derma Unit SCC 3Courage + Khazaka electronic GmbH, which characterizes the hydrolipidic film of the skin. The severity of acne vulgaris was measured using the GAGS scale.

**Conclusions:** There was a significant improvement in skin condition after a series of treatments. Hydrogen purification combined with phytic, pyruvic, lactic and ferulic acids 40% (pH 1.4) was found to be safe and effective.

**KEYWORDS:** hydrogen purification, cosmetics acids, acne vulgaris, GAGS scale

## BACKGROUND

Acne vulgaris is a chronic inflammatory disease affecting the sebaceous unit. It is characterized by inflammatory cutaneous lesions, such as pustules, nodules, cysts, and inflammatory papules, as well as non-inflammatory lesions, such as open and closed comedones [1]. Acne vulgaris affects 85% of the population 12–25 years of age. The occurrence of Acne vulgaris is promoted by environmental factors, a high glycemic index diet, dairy product intake, highly processed foods, and genetic mechanisms. The disease evolution is favored by the presence of *Cutibacterium acnes* [2-4]. Hormones, especially androgenic ones, are also important, as their increased activity leads to excessive sebum production. About 20% of adolescents have skin changes in the form of scars. The quality of life can be impaired by the associated pain, irritation, and itching. Additionally, acne vulgaris may be accompanied by social and mental disorders, including decreased self-esteem, anxiety, embarrassment, feeling of shame, and a desire for social isolation, which may even lead to suicidal thoughts [1].

One of the most effective, non-pharmacological methods of treating acne vulgaris is chemical peels, which have been used for centuries. The main purpose of a chemical peel is the exfoliation of dead cells in the stratum corneum, stimulation of cell renewal in the living layers of the epidermis, and remodeling of the *dermis*. Depending on the intensity of the action of fruit acids, they cause cell necrolysis at various skin depths [5]. We used a mixture of phytic, pyruvic, lactic and ferulic acids. The phytic acid has an antioxidant, moisturizing, and weak exfoliating effect, in addition to reducing the production of sebum by the sebaceous glands. The pyruvic acid easily penetrates the epidermis by penetrating the sebaceous apparatus, and has antibacterial, sebostatic, comedolytic, and keratolytic properties. Lactic acid in low concentrations has a moisturizing effect; at higher levels, it provides some superficial exfoliation of the epidermis. The ferulic acid has antioxidant and lipophilic properties, which allow it to penetrate into acne-affected skin, thus accelerating wound healing. In contrast to pyruvic and lactic acid, ferulic acid does not exhibit keratolytic activity [5,6].

Preferred anti-acne medications often have an irritant effect, which is why cosmetologists use cosmetics containing mild plant-based substances. Mazarello et al. [7] demonstrated the effectiveness of a cream which included anti-inflammatory and antibacterial ingredients, such as propolis extract, *A. Vera* leaf juice, and tea tree oil, as a treatment for acne vulgaris [7].

However, modern cosmetology is looking for non-invasive apparatus treatments that are more effective than mild plant-based substances. One of the

innovative methods is hydrogen purification. For this procedure, equipment is used that injects hydrogen-rich water under pressure, which is then discharged into a separate tank. The procedure allows for thorough cleansing of the skin of impurities, dead skin cells, and sebum. The hydrogen used in the treatment is an element found in the human body. It is used in cosmetology due to the small size of the molecule, which facilitates penetration through the epidermis and dermis [5]. Many studies have been carried out using molecular hydrogen as a treatment, due to its neutralizing effect on free radicals and anti-inflammatory properties [3,8]. During hydrogen purification, an electrolytic process takes place in which a direct current is passed between two electrodes, which are separated from each other by a semi-permeable membrane. This reaction leads to the elements contained in the water being decomposed into hydrogen ions (H<sup>+</sup>) and hydroxyl ions (OH<sup>-</sup>). The pH value of the resulting alkaline water fluctuates between 8 and 10 [8,9].

Both fruit acids and hydrogen purification have anti-inflammatory, superficial exfoliating, and sebostatic properties. The combination of hydrogen purification and fruit acids may have a positive synergistic effect on selected skin parameters relevant to patients with acne vulgaris.

## AIM OF THE STUDY

The aim of this report was to describe the effects of hydrogen cleansing in combination with a mixture of acids for acne-prone skin in a 20-year-old female.

## MATERIAL AND METHODS

### Study design, setting and duration

This study was carried out between February 2021 and April 2021 at Opole University in Poland. The Hebe Hydrogenium + device was used, and a mixture of phytic, pyruvic, lactic and ferulic acids 40% (pH 1.4) was applied. The procedure was performed five times in 14-day intervals. Each treatment followed the same procedure. The first step was make-up removal using a micellar fluid, followed by hydrogen purification for 5 minutes using an apparatus set to a 10% vacuum. The next step was to tone the skin and protect particularly sensitive areas with petroleum jelly (i.e., the eye area, corners of the mouth, vermilion border, and melanocytic nevi). The mixture of acids was then applied to the entire face for 2 minutes. Neutralization was performed and the face was washed with water at room temperature. At the end of the treatment, an SPF50 cream was applied.

## Participant

This report described the case of a 20-year-old female who was struggling with a 5-year history of pustules, blackheads, whiteheads, and excessive sebum secretion.

## Inclusion criteria

Inclusion criteria were: no dermatological treatment within 12 months, no current hormonal contraception, participant 19–22 years of age, with mild-to-moderate acne, as measured using the global acne severity scale (GAGS).

## Exclusion criteria

The exclusion criteria that prohibited participation in this study were: taking oral medications within the last 3 months, taking isotretinoin within the last year, taking contraceptives, a tendency towards keloid formation, sun exposure after procedure, telangiectasias, skin cancers, pregnancy and breastfeeding, viral, bacterial and fungal skin diseases, hypersensitivity to acids, skin irritation, active inflammation, active rosacea, psoriasis, and atopic dermatitis.

## Ethical considerations

The patient was informed that she could withdraw from the study at any time, was informed of the study intention, and provided written informed consent for research participation. This study was approved by Human Research Ethics Committee of the Opole Medical School (KB/54/NOZ/2019) and conducted according to the principles of the Declaration of Helsinki.

## Data sources/ measurements

The GAGS scale was used to determine the severity of acne lesions. It includes the following areas: nose, cheeks, forehead, chin, as well as the back and chest. Each of them is assigned a number based on size: nose = 1; left cheek = 2; right cheek = 2; forehead = 2; chin = 1; back and chest = 3. Depending on the degree of severity, each lesion is given a grade: no cutaneous conditions = 0, comedones = 1, papules = 2, pustules = 3, and nodules = 4. The local score calculated for each area has the formula: Local score = factor × Grade (0–4). The global score is composed of the sum of the local results: 1–18 = mild acne, 19–30 = moderate acne, 31–38 = severe acne, >39 = very severe acne [9–11]. The participant was diagnosed with moderate acne (GAGS score = 22).

The amount of sebum was measured using the Derma Unit SCC 3 Sebumeter. Measurements were

taken in the morning before 11 AM. The first measurement was carried out before the treatments began, and the next one 30 days after the end of the series. In the evenings before the day of the measurements, the patient was recommended to do only gentle make-up removal. The conditions in the measurement room were constant, the temperature was 22 °C and the humidity was 40–50%. The time for acclimatization to the abovementioned factors in the room was 25 minutes. Then, sebum was measured in specific places: between the eyebrows, on the chin, on the right nose petal, on the left nose petal, as well as on the right and left cheek.

The patient's home care was divided into a morning and evening routine. In the morning, it was recommended to clean the skin with just some micellar fluid, and to then apply a SPF50 cream. In the evening, it was recommended to clean the skin again with the same preparation, and to then apply a moisturizing cream. It was forbidden to use new cosmetics and perform other cosmetic or dermatological treatments during the study and 30 days after its completion. Additionally, they were asked not to use the solarium, sauna or swimming pool. It was also recommended not to take any dietary supplements that might affect the treatment outcomes.

## RESULTS

After applying a series of five cosmetic treatments using hydrogen purification and a mixture of cosmetic acids, the skin parameters improved and the skin eruptions were reduced (Table 1). The amount of skin eruptions on the GAGS were reduced from 22 to 15. There was also a reduction in the amount of sebum on the surface of the epidermis: between the eyebrows from 198 to 123 ( $\mu\text{g}/\text{cm}^2$ ), on the chin from 210 to 134 ( $\mu\text{g}/\text{cm}^2$ ), on the right nose petal from 206 to 115 ( $\mu\text{g}/\text{cm}^2$ ), on the left nose petal from 208 to 117 ( $\mu\text{g}/\text{cm}^2$ ), on the right cheek from 212 to 125 ( $\mu\text{g}/\text{cm}^2$ ), and on the left cheek from 209 to 130 ( $\mu\text{g}/\text{cm}^2$ ).

Table 1. Sebum level before and after treatment

Area of measurement	Sebum level before the treatment ( $\mu\text{g}/\text{cm}^2$ )	Sebum level 30 days after the end of the treatment ( $\mu\text{g}/\text{cm}^2$ )
Between the eyebrows	198	123
On the chin	210	134
Right nose petal	206	115
Left nose petal	208	117
Right cheek	212	125
Left cheek	209	130

## DISCUSSION

### Key results

In brief, our case study showed that alkaline water in combination with a mixture of phytic, pyruvic, lactic and ferulic acids 40% (pH 1.4) had a positive effect in reducing the level of sebum on the surface of the epidermis, as well reducing skin eruptions such as pustules, whiteheads, and blackheads.

### Interpretation

The hydrogen purification treatment was an effective method of reducing acne lesions. Chilicka et al. [3] were the first to show that, under the influence of hydrogen purification, the secretion of sebum decreases, and the level of skin hydration increases. A gradual reduction of inflammatory eruptions is also noticeable [3].

The external use of alkaline water has not been widely researched so far, therefore access to scientific articles on the subject is limited. Studies to date have only investigated the intrinsic effects of alkaline water. Osada et al. [12] conducted a study in which a reduction of cholesterol and triglyceride levels was observed in people with hyperlipidemia, and a similar reduction in blood glucose levels in most subjects with type II diabetes mellitus (DM II). The participants were asked to consume 2 liters of alkaline water daily for a period of 2 months [12]. A similar study was conducted by Gadek et al. [13]. The authors showed that blood sugar levels decreased significantly in patients with DM II (n = 401) after drinking 2 liters of alkaline water daily [13].

The combined use of hydrogen purification with a mixture of phytic, pyruvic, lactic and ferulic acids in this study was considered innovative, and led to a more pronounced reduction in acne lesions in the index case.

The most used acid in anti-acne treatments is pyruvic acid, which is an  $\alpha$ -keto acid with a keratolytic effect that stimulates the skin to produce collagen and elastin fibers. Pyruvic acid has antimicrobial and sebo-regulating properties; after coming into contact with water, which has a neutralizing effect, it transforms into lactic acid [5]. Jaffary et al. [14] compared the effectiveness of salicylic acid 30% and pyruvic acid 50% in the treatment of mild and moderate acne. The study involved 86 patients who were randomly assigned to one of two groups. In order to eliminate external factors that could distort the result, some unified care routine was applied in each of the respondents. Topical erythromycin 4% solution, trichloro carbon soap, and sunscreen was recommended. Participants in the first group were treated with salicylic acid, while the second group was treat-

ed with pyruvic acid. Therapy consisting of a series of five treatments resulted in a significant reduction in the number of comedones and papules [14]. Marczyk et al. [15] also compared the effects of 30% salicylic acid and 50% pyruvic acid on facial sebum secretion. Secreted sebum levels were measured in the T and U zones with the use of Sebumeter SM 815. Both peels reduced the amount of sebum on the epidermis surface. Additionally, it was noticed that the salicylic acid has a slight drying effect on the skin, which was not observed in the case of the pyruvic acid application [15]. Zdrada et al. [16] showed a significant effect for pyruvic acid on epidermal hydration and tyrosinase inhibition, which resulted in melanin reduction and lightening of post-inflammatory discoloration [16].

Nofal et al. [17] found that the action of a mixture of some acids on acne lesions is more effective than the use of only a single exfoliating substance. Another study found that a single acid used at high concentration had more side effects than using a mixture of acids. The treatment effects are, however, comparable [16].

An innovative study using a mixture of acids and hydrogen purification was carried out on a patient with a light skin phototype. In the case of dark skin struggling with acne, the use of acids is sometimes riskier due to the increased risk for discoloration and scars. The use of acids in high concentrations is not recommended in pregnant women due to the lack of sufficient research in this population [18]. The risk for side-effects after acid peels depend on the concentration and pH of the solution used for treatment [5].

Despite the abovementioned contraindications, treatments with acids are safe, effective and cheap procedures performed on a large scale in cosmetology [18]. Hydrogen purification is also a safe and effective treatment for Acne vulgaris. It does not cause redness, irritation, dryness, burning and itching of the skin [3].

### Study limitations and recommendations

In the future, we plan to expand the research with more participants, a control group and include male sex. It is also planned to combine hydrogen purification with other treatments: microneedle RF and TCA acid.

## CONCLUSIONS

The combination of hydrogen purification with acids is a safe and effective treatment, it does not require long convalescence, but it cannot replace dermatological treatment. It can be treated as an adjunct to the treatment of acne vulgaris.

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