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The influence of ozonation on the effects of cosmetics in dandruff treatment

Wpływ ozonowania na efekty działania kosmetyków w leczeniu łupieżu

ABSTRACT

Introduction: Dandruff commonly causes flaking, itching, irritation, and scalp discomfort. Although ozone has antimicrobial activity and potential dermatological applications, evidence supporting its use in salon-based scalp care is limited.

Aim: The study aimed to evaluate whether incorporating ozonation into a standard scalp care treatment improves scalp condition in women with mild to moderate dandruff.

Materials and methods: This study included 60 women aged 20-35 years who were assigned to receive creambath therapy with or without ozonization. Dandruff severity, quantity and consistency, affected scalp area, scalp hydration, visible condition, itching, and irritation were assessed before and after treatment.

Results: The ozone therapy group noted a reduction in the severity and quantity of dandruff, as well as its consistency. Simultaneously, scalp hydration increased. The incidence of itching and irritation was noticeably reduced.

Conclusions: Addition of ozone to conventional cream therapy was associated with greater short-term improvements in scalp health. Larger, randomized studies with longer follow-up are needed to confirm the effectiveness and durability of ozone.

Keywords: dandruff, irritation, itching, cream, ozone therapy, scalp, hydration.

STRESZCZENIE

Wstęp: Łupież często powoduje łuszczenie, swędzenie, podrażnienie i dyskomfort skóry głowy. Chociaż ozon ma działanie przeciwdrobnoustrojowe i potencjalne zastosowanie dermatologiczne, dowody na jego skuteczność w pielęgnacji skóry głowy w salonach kosmetycznych są ograniczone.

Cel: Badanie miało na celu ocenę wpływu ozonoterapii, jako elementu uzupełniającego standardową pielęgnację, na poprawę kondycji skóry głowy u kobiet z łupieżem o nasileniu łagodnym do umiarkowanego.

Materiały i metody: W badaniu wzięło udział 60 kobiet w wieku 20-35 lat, które poddano terapii kremowej z ozonowaniem lub bez. Przed i po zabiegu oceniano nasilenie, ilość i konsystencję łupieżu, dotknięty obszar skóry głowy, nawilżenie skóry głowy, widoczny stan, swędzenie i podrażnienie.

Wyniki: W grupie poddanej terapii ozonem odnotowano zmniejszenie nasilenia oraz ilości łupieżu, zmieniła się również jego konsystencja. Jednocześnie wzrosło nawilżenie skóry głowy. Zauważalnie obniżyła się częstość występowania świądu oraz podrażnień.

Wnioski: Dodanie ozonu do konwencjonalnej terapii z zastosowaniem kremu wiązało się z większą, krótkotrwałą poprawą zdrowia skóry głowy. Konieczne są większe, randomizowane badania z dłuższym okresem obserwacji, aby potwierdzić skuteczność i trwałość ozonu.

Słowa kluczowe: łupież, podrażnienie, swędzenie, krem, ozonoterapia, skóra głowy, nawilżenie.

INTRODUCTION

Scalp health problems are highly relevant in dermatology and professional beauty care because they can cause persistent discomfort and visible symptoms that affect daily functioning and self-confidence. Dandruff (*pityriasis capitis*) is one of the most common scalp conditions and is typically characterized by recurrent flaking and pruritus, sometimes accompanied by mild irritation or low-grade inflammation. Epidemiological evidence indicates that dandruff and related seborrheic conditions affect a substantial proportion of adults, making dandruff management a frequent concern in both clinical practice and salon-based hair care services [1-3].

Clinically, an "unhealthy scalp" is commonly reflected in measurable signs and symptoms including increased flake burden, reduced hydration, erythematous (red) spots, and subjective discomfort such as itching or irritation. Dandruff severity can be quantified using standardized flake scoring approaches such as the Scalp Flaking Severity Scale (SFSS) or similar dandruff grading methods that classify the extent and intensity of scalp flaking [4, 5].

Objective assessment can be complemented by scalp imaging and scalp condition scoring systems, while hydration measurement helps distinguish dry, normal, and oily scalp profiles because barrier imbalance and dryness are often associated with flaking and sensitivity [6-9]. Redness observation supports evaluation of irritation or inflammatory activity, and patient-reported itching or irritation remains a critical outcome because pruritus strongly influences perceived severity and quality of life [10-12].

Pathophysiologically, dandruff is widely considered a multifactorial disorder arising from interactions among sebaceous activity, scalp barrier integrity, and the scalp microbiome caused by genus *Malassezia* [1, 2, 13-17]. Mechanistic studies suggest that *Malassezia* can metabolize sebaceous lipids and generate irritating metabolites (including free fatty acids) that contribute to abnormal desquamation and inflammation in susceptible individuals, explaining why dandruff expression varies with host sensitivity and the local lipid environment [13-16].

In Indonesia, creambath is a well-established hair and scalp care procedure that combines topical conditioning products with systematic scalp massage to promote relaxation and perceived improvements in scalp comfort. Massage-based interventions are biologically plausible in scalp care because mechanical stimulation may influence local tissue properties and circulation. Controlled studies have reported measurable changes in hair/scalp parameters following standardized scalp massage over time [18]. These features make creambath a practical platform for adjunct modalities that target scalp microbes and support recovery of scalp comfort.

Ozone (O_3) has been used in medicine due to its strong oxidative reactivity and reported antimicrobial activity against bacteria, viruses, and fungi, alongside potential effects on oxygen metabolism and antioxidant responses when applied at controlled doses [19, 20]. Reviews describe ozone's ability to inactivate microorganisms and modulate biological responses relevant to tissue repair and inflammation, which has encouraged exploration of ozone-based approaches in dermatology and topical care [19-22]. Ozonated oils have also demonstrated antifungal potential in experimental settings, which is relevant given the fungal component of dandruff-related scalp dysbiosis [23]. Collectively, these findings support the plausibility of an ozone creambath that integrates cleansing and massage with ozone delivery to help suppress microbial overgrowth, improve hydration balance, and reduce discomfort.

Medical literature has discussed the potential benefits of ozone; however, evidence remains limited regarding the effectiveness of ozone delivered within salon-like scalp procedures, particularly for practice-relevant outcomes such as flake severity, dandruff scoring, device-based hydration, scalp redness, and subjective itching or irritation. This evidence gap is important because salon-based scalp care requires procedures that are practical, measurable, and safe for routine application [17, 19-22].

AIM

This study aimed to evaluate changes in key scalp health parameters following ozone creambath treatment and to compare these changes with a conventional creambath procedure without ozonization. The evaluated outcomes included dandruff severity, affected scalp area, dandruff quantity and consistency, scalp hydration, visible scalp condition, itching, and irritation.

MATERIALS AND METHODS

This study used a quantitative quasi-experimental pre-test and post-test control group design to evaluate the added association of ozonization within a standard creambath procedure. The treatment group received ozone creambath once weekly for four weeks, whereas the control group received the same conventional creambath procedure without ozonization during the same period. The study involved human participants and was conducted after ethical approval from the Ethics Committee at the Directorate of Research and Community Service, Universitas Negeri Yogyakarta (approval number: 726.16/UN34.9/PT.01.04/2025). All participants provided informed consent before participation. Sixty women aged 20-35 years with mild to moderate dandruff were enrolled and assigned to a treatment group and a control group. The measurements included dandruff severity assessed using a 0-5 scoring scale, scalp hydration measured with a corneometer (CM 825), visual documentation using a digital scalp analysis device (SKT Skin Technology Q22),

complaint questionnaire assessing itching and irritation, and an ozone hair steamer (Luvance LHD 5018).

The treatment group received ozone creambath therapy once a week for four weeks, whereas the control group received baseline/conventional creambath without ozonization during the same period. The groups design is presented in tab. 1. Each participant underwent a pre-test assessment of dandruff severity, hydration level, scalp redness or irritation, and complaint symptoms (itching and irritation), followed by the same assessment at post-test after four weeks. This design allowed comparison between ozone creambath and baseline/conventional creambath without ozonization, thereby enabling evaluation of the added association of ozonization within the overall creambath procedure.

The treatment frequency of once per week for four weeks was determined based on scientific considerations and common practice in scalp care. The natural turnover of epidermal cells is approximately 28 days [24]. Therefore, a four-week treatment period was selected to capture short-term changes across a single renewal cycle, particularly in dandruff severity, scalp hydration, and discomfort symptoms. Ozone-based interventions have been proposed to act progressively through antimicrobial activity, tissue oxygenation, and modulation of biological responses [19-22, 25], four sessions were considered adequate for an initial short-term evaluation.

Tab. 1. Research design. **Source:** Own elaboration.

Group	Treatment	Duration	Respondents
Treatment	Ozone creambath once a week	4 weeks	30 women, aged 20-35 years with mild to moderate dandruff
Control	Baseline/ conventional creambath without ozonization	4 weeks	30 women, aged 20-35 years with mild to moderate dandruff

A once-weekly schedule was selected to provide time for scalp recovery between sessions while still allowing repeated exposure across a four-week observation period. The study was designed to evaluate short-term changes in dandruff severity, scalp hydration, and participant-reported discomfort. Because the control group received baseline/conventional creambath without ozonization, the findings are most appropriately interpreted as the short-term comparative effect of adding ozonization to the creambath procedure.

Research location and time

The study was conducted at the Wates Vocational Salon, Universitas Negeri Yogyakarta, Kulon Progo Regency, which provides ozone creambath services with adequate facilities and specialized equipment. The research was carried out over four months and consisted of three sequential stages: the preparation stage, research materials compliance, participants recruitment, and operators training to ensure standardized implementation of the ozone creambath procedure. In the implementation stage, treatment sessions were administered once weekly for four weeks, and outcome measurements were obtained for both the treatment and control groups; finally, in the data analysis stage, pre-test and post-test results were compared to evaluate the effectiveness of the intervention.

Population and sample

The accessible population was recruited from customers of beauty clinics and salons in the study area. A purposive sampling approach was used. Eligible participants were adult women aged 20-35 years with clinically detectable mild to moderate dandruff who reported no history of allergies to hair-care products or ozone and were willing to follow the full research protocol, including refraining from using other hair-care products during the study period. Participants were excluded if they were undergoing dermatological treatment for scalp conditions or had a history of chronic scalp diseases such as psoriasis or atopic dermatitis. The final sample comprised 60 participants, with 30 in each group, as presented in tab. 1.

Research procedure

The research procedure began with respondent screening based on the inclusion and exclusion criteria to ensure eligibility. After informed consent was obtained, a pre-test assessment was conducted using dandruff scoring on a 0-5 scale, scalp hydration measurement using a corneometer (CM 825), visual documentation using a digital scalp analysis device, and a complaint questionnaire capturing itching and irritation. The treatment group then received ozone creambath therapy once weekly for four weeks, whereas the control group received baseline/conventional creambath without ozonization on the same schedule. After the intervention period, a post-test was conducted using the same measurements. The resulting data were analyzed to determine the association between the intervention and changes in scalp health outcomes. The procedure is presented in fig. 1.

Ozone creambath procedure

Each ozone creambath session lasted approximately 60 minutes and included scalp assessment, equipment preparation, cleansing, drying, application of a hair mask or nutritional cream with massage, ozone exposure for approximately 10-15 minutes, rinsing and re-cleansing, and final drying. The control procedure followed the same conventional creambath steps but omitted the ozonization step. The session began with an initial scalp analysis using a digital scalp analysis device to identify the primary scalp condition, such as dandruff, oily or dry scalp (Fig. 2).

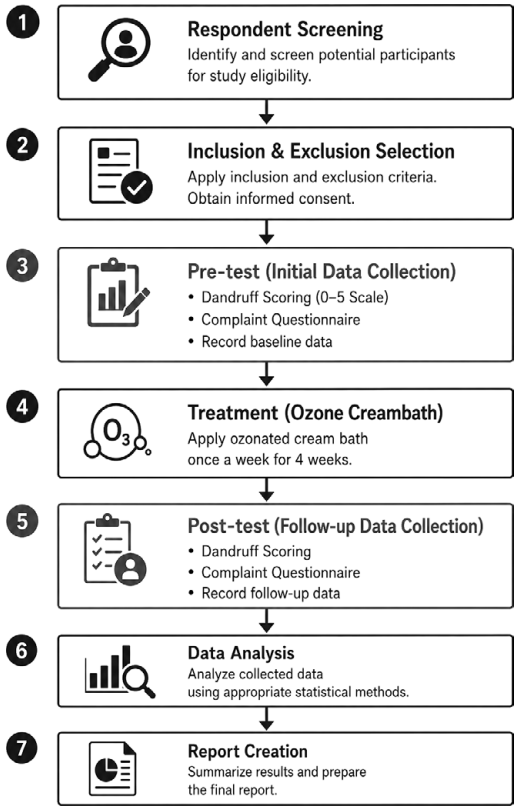

Fig. 1. Diagram of research procedure. **Source:** Own elaboration.

Fig. 2. Scalp analysis applied to a participant. **Source:** Own elaboration.

Next, the creambath equipment, including the ozone hair steamer was prepared for about 3 minutes, and a hair mask or specialized cream containing nourishing ingredients was selected according to the scalp's needs (e.g., hydration or oil control). The hair and scalp were then cleansed for approximately 6 minutes using a mild shampoo to remove dirt, excess oil, and product residue, followed by a gentle massage to stimulate blood circulation. After scalp cleansing, the hair was towel-dried for around 5 minutes until half-dry to prepare for product application and ozone treatment. A hair mask or nutritional cream was subsequently applied evenly to the scalp and hair shafts for approximately 10 minutes.

The products contained active ingredients such as vitamins, proteins, or natural extracts, and circular scalp massage was performed to support absorption, promote relaxation, and enhance circulation. Ozone therapy was then administered for approximately 15 minutes by activating the ozone hair steamer and delivering ozone directly to the scalp using a cap-shaped applicator or nozzle system (Fig. 3). After ozone exposure, the hair mask was rinsed thoroughly with warm water, and the scalp and hair were rewashed with a mild shampoo for about 7 minutes to remove any remaining product or ozone residue. Finally, the hair was dried for approximately 9 minutes using a towel and/or a low-temperature hair dryer until fully dry.

Fig. 3. Ozone therapy applied to a participant. **Source:** Own elaboration.

Assessment instruments

Dandruff assessment was performed using a visual scale (0-5), scalp moisture was measured in percentage (%) using a corneometer, visual documentation was obtained using a digital scalp analysis device, and subjective complaints were assessed with a closed questionnaire addressing itching and irritation, as presented in detail in tab. 2 [7, 8, 26].

The dandruff severity scale, hydration measurement, imaging observation, and complaint questionnaire were applied consistently at pre-test and post-test. Observations were performed under standardized lighting and positioning conditions by trained operators to reduce measurement variability [4, 5]. Redness and other observable scalp features were interpreted with reference to scalp condition scoring frameworks and imaging-based assessments [6, 26, 27], whereas itching and irritation were recorded as participant-reported complaints relevant to scalp discomfort [10-12].

The validity of the ozone generator was determined by verifying that its application protocol conformed to established standards in ozone-based dermatological therapy. Proper calibration, controlled ozone concentration, and adherence to international safety guidelines [20, 28] were intended to reduce technical variability during treatment delivery.

Tab. 2. Aspects and indicators of the research instrument. **Source:** Adapted from relevant literature [4-6,10-12, 27].

Instrument	Aspect	Indicator	Rating Scale
Scalp flaking severity scale (dandruff scoring) [4-6]	Area/spot affected	Percentage of the scalp area affected by dandruff flakes.	0: No flakes. 1: Less than 10% of the scalp area affected. 2: 10-30% affected. 3: 30-50% affected.
	Dandruff quantity	Amount and size of dandruff flakes visible on the scalp, hair, or clothing.	0: No visible flakes. 1: Very small flakes (almost invisible). 2: Small flakes visible only when hair is moved. 3: Flakes visible on scalp and hair. 4: Large, noticeable flakes on hair and clothing.
	Consistency and appearance	Thickness, peeling, and characteristics of the dandruff flakes.	0: No flakes or peeling. 1: Fine flakes, almost invisible. 2: Thin flakes with light peeling. 3: Thick flakes with moderate peeling. 4: Thick and massive flakes with heavy peeling.
Scalp hydration measurement (using corneometer)	Scalp moisture level	Amount of water measured in the stratum corneum layer of the scalp.	0-10: Very dry (very low moisture, high irritation risk). 11-20: Dry (low moisture, rough skin). 21-30: Moderate (adequate moisture, normal sensation). 31-40: Moist (adequate hydration, no dryness). >40: Very moist (optimal moisture, soft skin).
Redness spot observation on scalp [6, 10, 27]	Redness on scalp	Presence of redness on the scalp.	Yes / No
	Thick scales or large white flakes	Presence of thick, large white flakes or scales.	Yes / No
	Spot enlargement or spread	Whether the spot is increasing in size or spreading.	Yes / No
	Severity of the spot	Severity level of the spot based on visual assessment.	1 (Mild), 2 (Moderate), 3 (Severe)
Respondent complaints [10-12]	Itching	Itching sensation reported by respondent.	Yes / No
	Irritation	Irritation or discomfort reported by respondent.	Yes / No

The effect of ozone creambath on scalp health and observations were conducted across several anatomical regions of the head to capture a comprehensive assessment of scalp conditions [1]. These included the nape and back of the head, which represent the lower posterior scalp area often prone to tension and sweat accumulation; the front hairline, which is commonly exposed and sensitive to environmental factors; the crown and vertex, located at the upper central region of the scalp and frequently associated with issues such as thinning or dryness; and the sides of the head, which provide balance in evaluating lateral scalp health [1, 2, 17, 29]. By systematically examining these multiple sites, the study ensured an evaluation of the effects of ozone creambath, considering variations in scalp sensitivity, hair density, and exposure across different head regions such as represented in fig. 4.

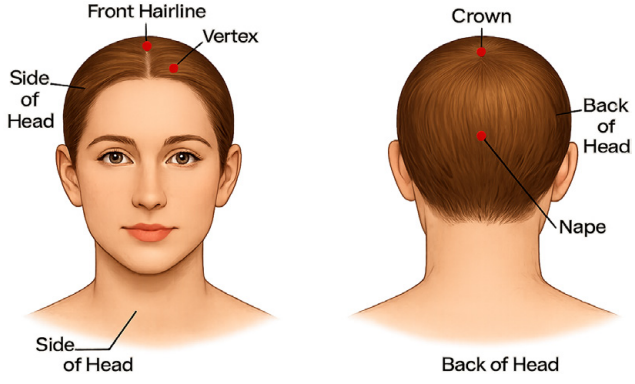

Fig. 4. Diagram of head area observed. **Source:** Own elaboration.

Data analysis

Statistical analyses were performed using SPSS version 20. Prior to hypothesis testing, the distribution of each continuous variable (normality) was assessed using the Shapiro-Wilk test, and homogeneity of variances was evaluated using Levene's test. The null hypothesis (H0) was when there was no significant difference between pre-test and post-test measurements, whereas the alternative hypothesis (H1) was when a significant difference existed between the two measurements. When the normality assumption was satisfied, pre-test and post-test values were compared using a paired t-test. All tests were two-tailed with a significance level of 0.05. The normality and homogeneity tests yielded p-values greater than 0.05, meeting the assumptions for parametric testing.

Tab. 3. The average pre-test and post-test values for each evaluated parameter in the experimental group. **Source**: Own elaboration.

Participant ID	Dandruff scoring (0-5)		Area affected by dandruff (%)		Dandruff quantity (0-4)		Dandruff consistency (0-4)		Scalp moisture (AU) (0-40)		Redness on scalp		Thick scales/ white flakes		Affected area		Spot enlargement		Severity of spot (1-3)		Itching		Irritation	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
1	4	3	24	20	4	3	3	2	24	35	Yes	Yes	Yes	No	Vertex	Clear	Yes	No	3	2	Yes	No	Yes	No
2	3	2	20	15	3	2	3	2	22	30	No	No	Yes	Yes	Crown	Crown	Yes	Yes	3	2	Yes	No	Yes	No
3	4	2	15	10	3	2	3	2	16	25	Yes	Yes	Yes	Yes	Temple	Temple	Yes	Yes	3	2	Yes	No	Yes	No
4	3	1	14	10	2	1	2	1	19	30	No	No	No	No	Nape	Clear	No	No	2	1	No	No	No	No
5	4	3	25	20	4	3	3	2	24	31	Yes	Yes	Yes	No	Front Hairline	Clear	Yes	No	3	2	Yes	No	Yes	No
6	4	2	20	15	3	2	3	2	20	30	No	No	No	No	Crown	Clear	No	No	2	1	No	No	No	No
7	2	0	10	0	1	0	1	0	22	31	No	No	No	No	Back of Head	Clear	No	No	2	1	No	No	No	No
8	3	2	28	15	4	3	3	2	13	22	Yes	Yes	Yes	Yes	Crown	Crown	Yes	Yes	3	2	Yes	No	Yes	No
9	4	3	30	20	4	3	3	2	20	28	Yes	Yes	Yes	Yes	Crown	Crown	Yes	Yes	3	2	Yes	No	Yes	No
10	4	2	22	12	3	2	3	2	23	31	No	No	No	No	Side of Head	Clear	No	No	2	1	No	No	Yes	No
11	4	3	24	18	4	3	3	2	16	26	Yes	Yes	Yes	No	Nape	Clear	Yes	No	3	2	Yes	No	Yes	No
12	4	3	32	25	3	2	3	2	12	23	Yes	Yes	Yes	Yes	Vertex	Vertex	Yes	Yes	3	2	Yes	Yes	Yes	Yes
13	3	1	16	8	2	1	2	1	22	31	No	No	No	No	Crown	Clear	No	No	3	1	No	No	No	No
14	4	2	20	16	3	2	3	2	18	30	Yes	Yes	Yes	Yes	Crown	Crown	Yes	Yes	3	2	Yes	No	Yes	No
15	4	3	26	20	4	3	3	2	21	31	Yes	Yes	Yes	No	Nape	Clear	Yes	No	3	2	Yes	No	Yes	No
16	3	2	23	12	3	2	3	2	23	31	No	No	Yes	Yes	Nape	Clear	Yes	No	3	2	Yes	No	Yes	No
17	4	3	30	20	4	3	3	2	18	29	Yes	Yes	Yes	No	Back of Head	Clear	Yes	No	3	2	Yes	No	Yes	No
18	3	1	13	6	2	1	2	1	22	32	No	No	No	No	Crown	Clear	No	No	3	1	No	No	No	No
19	4	3	24	20	5	4	3	2	16	27	Yes	Yes	Yes	Yes	Vertex	Clear	Yes	No	3	2	Yes	No	Yes	No
20	4	2	29	14	3	2	3	2	23	32	Yes	Yes	Yes	No	Front Hairline	Clear	Yes	No	3	2	Yes	No	Yes	No
21	4	3	30	20	4	3	3	2	20	30	No	No	Yes	Yes	Crown	Clear	Yes	No	3	2	Yes	No	No	No
22	3	1	15	9	2	1	2	1	23	31	No	No	No	No	Back of Head	Clear	No	No	2	1	No	No	No	No
23	4	3	28	20	4	3	3	2	21	30	Yes	Yes	Yes	No	Side of Head	Clear	Yes	No	3	2	Yes	No	Yes	No
24	3	2	26	18	3	2	3	2	20	31	Yes	Yes	Yes	No	Nape	Clear	Yes	No	3	2	Yes	No	Yes	No
25	3	1	14	7	2	1	2	1	36	31	No	No	No	No	Nape	Clear	No	No	2	1	No	No	No	No
26	4	2	28	13	3	2	3	2	31	29	Yes	Yes	Yes	No	Vertex	Clear	Yes	No	3	2	Yes	No	Yes	No
27	4	3	27	20	4	3	3	2	28	26	Yes	Yes	Yes	No	Back of Head	Clear	Yes	No	3	2	Yes	No	Yes	No
28	4	3	28	20	4	3	3	2	29	25	Yes	Yes	Yes	No	Crown	Clear	Yes	No	3	2	Yes	No	Yes	No
29	4	2	25	17	3	2	3	2	36	32	Yes	Yes	Yes	No	Crown	Clear	Yes	No	3	2	Yes	No	Yes	No
30	3	1	13	8	2	1	2	1	35	31	No	No	No	No	Back of Head	Clear	No	No	3	1	No	No	No	No
Mean	3.6	2.13	22.63	14.93	3.17	2.17	2.73	1.73	22.43	29.37	63% (Yes)	20% (Yes)	70% (Yes)	27% (Yes)	All distributed	80% (Clear)	70% (Yes)	20% (Yes)	2.80	1.70	70% (Yes)	3.3% (Yes)	67% (Yes)	3.3% (Yes)

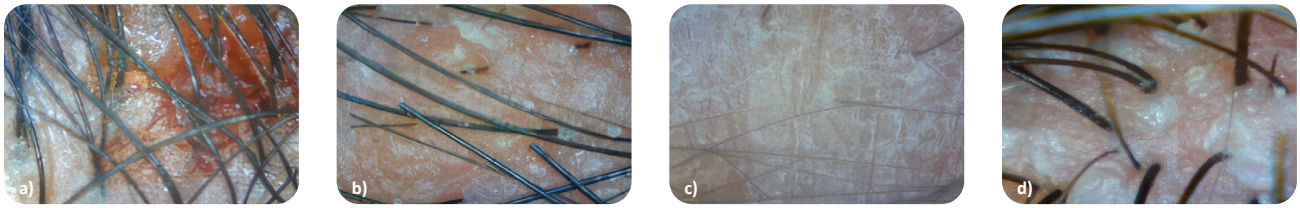

Fig. 5. Visual documentation of scalp condition before treatment: a) severity and irritation of spot, b) thick scales on scalp, c) scalp with low moisture, and d) white flakes. **Source**: Own elaboration.

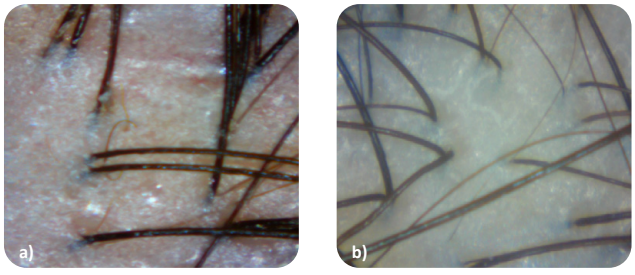

Fig. 6. Visual documentation of scalp condition after treatment: a) normal scalp without irritation and b) normal moisture. **Source**: Own elaboration.

RESULTS

The treatment group showed significant pre-post improvements in multiple scalp health parameters following the ozone creambath intervention. The mean dandruff score decreased from 3.60 at baseline to 2.13 at post-treatment, indicating a statistically significant reduction in dandruff severity ($p < 0.05$). The mean percentage of scalp area affected by dandruff declined from 22.63% to 14.93%. Dandruff quantity decreased from 3.17 to 2.17, and dandruff consistency reduced from 2.73 to 1.73. Scalp hydration improved, with mean moisture levels increasing from 22.43% before treatment to 29.37% after treatment. Participant-reported itching decreased from 70.0% at baseline to 3.3% after treatment, while reported irritation declined from 67.0% to 3.3% (Tab. 3). Overall, clinical indicators including dandruff quantity and consistency, scalp redness, thick scales or white flakes, spot enlargement and severity improved in the treatment group. Compared with the control group that received conventional creambath without ozonization, the treatment group showed greater overall improvement across the assessed endpoints.

Visual documentation before and after the ozone creambath intervention was obtained using a digital scalp analysis device (Fig. 5-6) to support comparison of scalp condition over time. Magnified visualization and digital image recording were performed using the digital scalp imaging analysis device [26, 30, 31]. The corneometer was used separately to estimate scalp hydration through measurement of the stratum corneum [7]. The visual documentation before treatment obtained with the scalp analysis device is presented in fig. 5, whereas the post-treatment images are presented in fig. 6.

DISCUSSION

This study found that the ozone creambath intervention was associated with a reduction in dandruff severity among participants with mild to moderate scalp disorders. The mean dandruff score decreased, and the scalp area affected by dandruff was also declined. This direction of change is biologically plausible because dandruff is closely linked to *Malassezia*-associated dysbiosis and ozone has documented antimicrobial activity in dermatological applications [13-17, 19-21, 32]. Contemporary dandruff and scalp-care studies also suggest that reductions in flaking and discomfort can be captured using combined clinical, participant-reported, and device-based assessments [7, 8, 11, 29, 33]. Because the control group received the same conventional creambath without ozonization, the observed between-group difference may be interpreted as the added short-term benefit associated with ozonization within the creambath package.

Scalp hydration also improved, as indicated by an increase in moisture levels. Adequate hydration is important for maintaining barrier function and reducing irritation [7, 9, 16]. Ozone-based therapy has been discussed as a modality that may support tissue oxygenation and modulate biological responses relevant to skin recovery [19-23, 25, 34]. Nevertheless, improved hydration may also have been influenced by the moisturizing hair mask and massage components of the creambath procedure. Therefore, the hydration findings should be interpreted as the effect of the combined treatment package rather than a definitive ozone-specific effect.

Participant-reported outcomes corroborated the objective measures: itching and irritation decreased following the therapy. These improvements are clinically relevant because scalp discomfort strongly influences perceived severity and quality of life [2, 3, 10-12]. The once-weekly, four-week protocol was selected to align with the approximate 28-day epidermal turnover cycle [24] and with the short-term use of ozone-based interventions in dermatology [22, 25, 34].

An important methodological clarification should be emphasized. In this study, the control group received conventional creambath without ozonization, whereas the treatment group received the same procedure with an

added ozonization step. Thus, the comparison reflects ozone creambath versus conventional creambath without ozone, allowing the observed difference to be interpreted as the added short-term benefit associated with ozonization. Safety and technical consistency were supported by controlled application time, standardized operator procedures, and adherence to published ozone-therapy safety principles, including controlled exposure and avoidance of unnecessary inhalation risk [22, 25, 34]. Nevertheless, the quasi-experimental design, modest sample size, and absence of blinding remain important limitations that should be addressed in future studies

This study provides one of the first empirical evaluations of ozone creambath in an Indonesian setting, addressing a literature gap in salon-based scalp care. The observed improvements across dandruff severity, hydration, and participant-reported comfort suggest that adding ozonization to conventional creambath may be useful as a cosmetic-therapeutic intervention. However, the findings should be interpreted cautiously because of the modest sample size, the absence of follow-up beyond four weeks, and the quasi-experimental design without blinding. Given the chronic-recurrent nature of dandruff and seborrheic dermatitis [1-3, 12, 13, 16, 17], future research should include larger cohorts, randomized controlled comparisons between ozone creambath and baseline/conventional creambath without ozonization, mechanistic readouts such as *Malassezia* quantification, and longer follow-up to assess durability and relapse dynamics [19, 22, 26, 29, 33, 34].

CONCLUSIONS

This study showed that a four-week ozone creambath intervention was associated with short-term improvements in scalp health among women with mild to moderate dandruff, including reduced dandruff severity, improved scalp hydration, and less itching and irritation. Compared with conventional creambath without ozonization, results of ozone creambath suggest that the addition of ozonization may enhance the effect of a standard creambath procedure. Nonetheless, the findings should be interpreted in light of the quasi-experimental design, modest sample size, and short follow-up period. Future studies should include larger and more diverse populations, longer follow-up, and randomized controlled comparisons to determine the specific efficacy and durability of ozonization in scalp care practice.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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AUTHORS' CONTRIBUTIONS

Conceptualization, C.U.T.; methodology, C.U.T.: validation, W.P.L.T.; formal analysis, C.U.T; investigation, C.U.T. and W.P.L.T; writing original draft preparation, C.U.T; writing, review and editing, W.P.L.T.: supervision, C.U.T.: project administration, C.U.T. All authors have read and agreed to the published version of the manuscript.

ETHICS STATEMENT

The study was approved by the Ethics Committee at the Directorate of Research and Community Service, Universitas Negeri Yogyakarta (No. T/26.16/UN34.9/PT.01.04/2025). Informed consent was obtained from all subjects involved in the study. Written informed consent for publication of identifiable data/images was obtained from the participant(s) where applicable. Informed consent was obtained from all subjects involved in the study.

USE OF AI TOOLS

Artificial intelligence tools were used only for grammar checking and language editing. All AI-assisted text was reviewed and edited by the authors, and the authors take full responsibility for the final content of the manuscript.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors on request.

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