Ad-Dawaa' Journal of Pharmaceutical Sciences
ISSN: 2654-7392, E-ISSN: 2654-6973
Vol. 9, No. 1, June 2026, p. 115 – 129
DOI: https://doi.org/10.24252/djps.v9i1.61505

Formulation and Evaluation of Rice Washed Water-Based Gel for Enhancing Skin Hydration

Eriska Agustin[1]*, Alinda Tania[1], Yuliana[2]

[1]*Kader Bangsa Univerity, Palembang, Sumatera Selatan, Indonesia
[1]Sriwijaya Univerity, Palembang, Sumatera Selatan, Indonesia
[2] Kader Bangsa Univerity, Palembang, Sumatera Selatan, Indonesia

Article history:
Submited: 25-11-2025
Revised: 10-12-2025
Accepted: 1-1-2026

Corresponding author e-mail: eriskaagustinukb@gmail.com

Cite this article: Agustin, E., Tania, A., Yuliana. (2026). Formulation and Evaluation of Rice Washed Water-Based Gel for Enhancing Skin Hydration. Ad-Dawaa' J. Pharm. Sci. 9(1): 115-129.

Copyright:
This is an open-access article distributed under the terms of the CC BY-SA 4.0 license.

ABSTRACT

Introduction*: Rice washing water (RWW) contains bioactive compounds such as vitamins, amino acids, and antioxidants that contribute to skin hydration. Despite its potential, limited studies have examined its stability and compatibility in topical gel formulations. Carbomer 940 is a commonly used gelling agent that influences viscosity, spreadability, and overall gel performance.* ***Aims:*** *The present study sought to systematically evaluate the effect of varying concentrations of RWW (5%, 10%, and 15%) within Carbomer-based gels (1% and 2%), with emphasis on physicochemical stability, safety, and moisturizing efficacy.* ***Result:*** *Six gel formulations (F1–F6) and two bases (FA and FB) were evaluated for organoleptic properties, pH, viscosity, spreadability, adhesion, homogeneity, irritation, and skin hydration on 20 volunteers with dry skin (18–40 years) using a digital skin analyzer. All formulations exhibited stable pH values (4.4–6.4) and maintained homogeneity throughout 28 days of storage. Viscosity increased with higher Carbomer concentration, while spreadability decreased accordingly. Adhesion values (1.5–4.5 seconds) and irritation index (≤0.4) indicated acceptable safety and usability. Statistical analysis showed that rice washing water at concentrations of 10–15% in the 1% Carbomer base provided the most effective balance of viscosity, spreadability, and moisturizing effect, with significant improvements in skin hydration ($p<0.05$).* ***Conclusion:*** *Rice washing water gel formulations demonstrated good physicochemical stability, safety, and significant moisturizing effects. The most promising results were observed in gels containing 10–15% rice washing water with a 1% Carbomer base, supporting its potential application as a natural hydrating cosmetic ingredient.*

KEYWORDS*: Carbomer, Gel, Hydration, Rice, Skin.*

INTRODUCTION

Cosmetics are products that continuously interact with the skin. One of their main functions is to address skin problems, particularly dry skin, which may result from factors such as sebum secretion, skin dehydration, climate, aging, and the use of unsuitable cosmetic products (Butarbutar, 2021). A key role of moisturizers, also known as emollients, is to increase water content in the skin and enhance the water-binding capacity of the stratum corneum (Butarbutar, 2021; Ayu, 2020).

Dry skin often leads to redness, roughness, scaling, and more severe conditions if transepidermal water loss (TEWL) increases, which in turn may allow penetration of harmful substances and trigger inflammation (Okatvia et al, 2021; Yulisa, 2023). In response, many innovative cosmetic products, particularly moisturizers, have been developed to restore hydration (Herawan et al, 2022). The *International Cosmetic Ingredient Dictionary* lists 125 compounds that can serve as emollients to improve skin hydration (Cosmetic Ingredient Review, 2022). These moisturizers may be derived from synthetic or natural sources, such as plants and vitamins (Udompataikul, 2015).

Among natural ingredients, rice washed water (RWW) has attracted attention as a potential skin moisturizer. Traditionally discarded as waste, RWW is rich in beneficial nutrients including carbohydrates (85–90% starch), B vitamins (B1 80%, B3 70%, B6 90%), minerals such as manganese (50%), phosphorus 50%), iron (60%), and dietary fiber (100%) (Rahmawati et al, 2017). The starch component is reported to cleanse dust from the skin surface and promote skin regeneration due to its essential amino acids (Khalisah et al, 2022). The RWW contains oryzanol, which supports melanogenesis regulation, along with antioxidants such as polyphenols (390.98 mg/100 g) and antioxidant capacity equivalent to 385.27 mmol Trolox/g, making it valuable for anti-aging and skin protection (Annisa et al, 2019).

Topical gels are considered an excellent dermocosmetic vehicle due to their high water content, cooling effect, transparency, and consumer acceptability. They also facilitate uniform distribution of hydrophilic actives and can be engineered for suitable rheology and skin adherence (Slavkova et al, 2023). Carbomer 940 (Carbopol® 940) is among the most widely used synthetic polymers in semisolid dosage forms. Its physicochemical profile—efficient thickening at low concentration, pH-dependent gelation, and compatibility with humectants—makes it a rational choice for incorporating RWW (ZakZak et al, 2024; Sastri et al 2022). Carbomer-based formulations are reported to be stable, biocompatible, and easily modulated in viscosity and spreadability (Kaur et al, 2025).

Despite the promising potential of RWW, systematic formulation studies remain limited. In particular, little is known about the interaction between RWW concentrations and Carbomer levels, and how this affects stability, physicochemical attributes, and moisturizing efficacy in vivo. Studies on rice extracts and fermented rice products demonstrate potential cosmetic benefits but often lack standardized

evaluation of topical gel systems (Kaur et al, 2025; Yang et al, 2025). Accordingly, this study was designed to develop and optimize RWW gel formulations containing different concentrations of RWW (5%, 10%, 15%) with Carbomer 940 bases (1% and 2%). Comprehensive evaluation was carried out on physicochemical stability, safety, and moisturizing efficacy in human volunteers with dry skin.

METHODS

Material

The rice-washed water used in this study was obtained from the same type of rice, namely paddy rice cultivated in Tugumulyo Village, Ogan Komering Ilir (OKI). The primary material utilized was rice-washed water derived from locally grown white rice of good quality. Carbomer 940 (Merck®), Glycerin (Brataco®), Triethanolamine (TEA) (Brataco®), Methyl Paraben (Brataco®), Propyl Paraben (Brataco®), and aquadest (OneMed®). Furthermore, for the irritation evaluation, three New Zealand albino rabbits were used, applying the Draize Patch Test method.

Preparation of Rice Washed Water Gel Formulation

The Table 1 is the proposed formulation design of rice washed water gel, which is a modification from previous studies. The preparation process began with weighing Carbomer 940 according to the formulation into a 100 mL beaker glass. Carbomer was then dispersed in 10 mL of distilled water until completely mixed. Subsequently, glycerin was added slowly into the mixture under continuous stirring using a magnetic stirrer at a speed of 1000 rpm to ensure homogenization (Agustin, 2023).

Afterwards, the required concentration of rice washed water was incorporated into the mixture. Gel formation was achieved by adding Triethanolamine (TEA) dropwise in sufficient quantity until a clear and stable gel mass was obtained. The remaining distilled water was added to make up the final volume of 100 mL. The mixture was stirred again until homogeneous and then transferred into clean, tightly closed containers.

Organoleptic Test

The organoleptic evaluation was carried out by direct physical observation of the gel formulation, including appearance, color, texture, and odor. The gel preparation was expected to exhibit the characteristics of a typical gel form, an attractive color, a smooth and homogeneous texture, and a non-irritating odor. The test was performed three times for each sample (Kusmita kk, 2021).

pH Test

The pH measurement was performed by first calibrating the pH meter with buffer solutions at pH 4, 7, and 9. The cleaned

Table 1. The formulation of rice washed water gel

Ingredients	Concentration (%)							
	FA	FB	F1	F2	F3	F4	F5	F6
Rice washed water	0	0	5	10	15	5	10	15
Carbomer 940	1	2	1	1	1	2	2	2
Glycerin	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
TEA	qs	qs	qs	qs	qs	qs	qs	qs
Methyl Paraben	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Propyl Paraben	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Aquadest	Ad 100	Ad 100	Ad 100	Ad 100	Ad 100	Ad 100	Ad 100	Ad 100

electrode was then immersed in each gel formulation to measure its pH. The acceptable pH range for topical formulations is between 4 and 7. Each sample was tested in triplicate (Numberi et al, 2020).

Viscosity Test

The 100 mL gel sample was placed in a cylindrical container of the Brookfield Viscometer, and spindle number 63 was installed. The spindle was immersed in the sample up to the designated mark. The viscometer was operated at a speed of 6 rpm, and the viscosity reading was recorded after one minute. Each sample was tested three times. According to the Indonesian National Standard (SNI), the acceptable viscosity range for gel preparations is 2000–50,000 cP (Ellysa, 2024; Nafi'ah et al, 2025).

Spreadability Test

The spreadability test was conducted using a caliper by measuring the diameter of 1 g of gel placed between two glass slides under a 150 g load. The acceptable spreadability range for gels is 5–7 cm (Nafi'ah et al, 2025; Firdausi, 2021).

Adhesiveness Test

The adhesiveness test was carried out by placing 0.25 g of gel between two glass slides, followed by compression with a 1 kg load for 5 minutes. The slides were then mounted on the adhesion testing device, and an additional 80 g load was applied. The time required for the two slides to separate was recorded. The required adhesiveness for semi-solid preparations is > 4 seconds (Nafi'ah et al, 2025).

Irritation Test

The irritation test was conducted on healthy rabbits weighing between 2–2.5 kg. Prior to testing, the rabbits were acclimatized in cages for 5–7 days. The dorsal hair of each rabbit was shaved 24 hours before testing, covering an area of approximately 10 × 15 cm. The shaved area was divided into 8 test sites measuring 2 × 3 cm each. A total of three rabbits were used for this study. Before treatment, each test site was cleaned with NaCl solution. The gel formulations were applied topically to the

designated areas, which were then covered with non-reactive gauze dressings. After 24 hours, the dressings were removed, and the test sites were cleaned with water to eliminate residual gel. The treated areas were examined and observed at 24, 48, and 72 hours post-application. The Primary Irritation Index (PII) was calculated for each formulation to evaluate the degree of irritation. A PII score of 0 indicates no evidence of edema or erythema (Nafi'ah et al, 2025; Ningsih et al, 2019).

Moisturizing Effect Test

This test involved 20 panelists with specific inclusion criteria: healthy women with dry skin, aged 18–40 years, with no history of skin allergies, not using other moisturizers during the study, and classified as having dry or very dry skin. The selected gel formulations were those with good physical stability containing different concentrations of rice washed water. The gel was applied to the dorsal area of the left hand (3×3 cm), and skin hydration levels were measured at baseline (before application), immediately after application (0 min), 30 minutes, and 2 hours post-application. Measurements were conducted using a Digital Skin Analyzer. Each panelist was tested with all 8 gel formulations (Nafi'ah et al, 2025).

Data Analysist

All data shown is presented in the form of an "mean ± SD". Data collection was carried out in triplicate (n = 3) and statistical analysis using Anova One-Way Test was carried out for each experiment.

RESULTS AND DISCUSSION

Organoleptic Test

The organoleptic test was conducted to assess the physical characteristics of the gel formulations both visually and sensorially. The parameters observed included color, odor, and texture. Evaluations were performed immediately after preparation and after four weeks of storage at room temperature.

All formulations exhibited a cloudy white appearance, typical of rice washed water, which naturally has a milky-white color, except for the bases FA and FB. Turbidity increased with higher concentrations of rice washed water. Formulations containing 2% Carbomer appeared thicker and more solid. No discoloration or precipitation was observed during the 4-week storage period.

A summary of the findings is as follows: a characteristic odor was detected in all formulations, with no rancid or foreign smell indicating ingredient degradation. The addition of preservatives did not affect the odor of the formulations. Differences in Carbomer 940 concentration influenced the

Table 2. The result of pH test

Formula	pH value (day)				
	0	7	14	21	28
FA	6.4±0.61	5.4±0.36	5.4±0.36	4.6±0.31	4.7±0.13
FB	6.4±0.31	5.8±0.31	5.8±0.24	5.0±0.10	4.5±0.33
F1	5.8±0.24	5.4±0.37	5.0±0.56	4.7±0.19	4.6±0.09
F2	5.5±0.45	5.5±0.46	5.5±0.37	4.6±0.37	5.2±0.08
F3	5.6±0.34	5.4±0.29	5.4±0.18	4.9±0.22	4.9±0.11
F4	5.1±0.21	5.1±0.09	5.0±0.37	5.0±0.37	4.8±0.13
F5	4.7±0.03	4.8±0.37	4.9±0.09	4.8±0.13	4.9±0.01
F6	4.4±0.02	4.4±0.22	4.5±0.18	4.7±0.11	4.7±0.37

consistency and texture: Carbomer 1% produced a lighter gel with good spreadability on the skin, whereas Carbomer 2% resulted in a thicker, more adhesive gel, suitable for longer occlusive effects on the skin surface. No clinically significant changes in color or odor were observed during the storage period, and homogeneity remained consistent (chi-square test between day 0 and day 28: $p>0.05$). Sensory texture scores were strongly correlated with viscosity and adhesiveness.

pH Test

The pH test of the rice washed water gel formulations was conducted to evaluate the stability of the preparations during 28 days of storage at room temperature. The results, presented in the table below, indicate that all formulations, including the bases (FA and FB), had initial pH values ranging from 4.4 to 6.4.

During storage, the pH values showed a gradual decrease; however, they consistently remained within the physiologically acceptable range for skin, namely 4.5–6.5 (Lambers et al, 2006). On day 0, the base formulations FA and FB (with 1% and 2% Carbomer, respectively) exhibited the highest pH values (6.4 ± 0.61 and 6.4 ± 0.31), whereas formulation F6 (15% rice washed water + 2% Carbomer) demonstrated the lowest pH (4.4 ± 0.02).

The consistent decline in pH observed across all formulations may be attributed to gradual degradation of active constituents and possible interactions between components such as Triethanolamine, Carbomer, and preservatives (Methyl Paraben and Propyl Paraben). Importantly, despite these minor shifts, all formulations maintained pH values considered safe and acceptable for topical application throughout the 28-day storage period.

Viscosity Test

Viscosity is a critical parameter reflecting both the physical stability and user acceptability of topical gel formulations. The viscosity measurements (Table 3) showed that all formulations, including the bases FA (Carbomer 1%) and FB (Carbomer 2%), had initial viscosity

Table 3. The result of viscosity test

Formula	Viscosity Value (cPs)				
	Day-0	Days-7	Days-14	Days-21	Days-28
FA	42.350 ± 310	41.980 ± 295	41.720 ± 280	41.510 ± 300	41.200 ± 290
FB	68.450 ± 410	68.100 ± 400	67.950 ± 390	67.700 ± 400	67.500 ± 380
F1	43.200 ± 350	42.950 ± 340	42.780 ± 320	42.600 ± 310	42.400 ± 305
F2	44.500 ± 360	44.300 ± 345	44.150 ± 340	44.000 ± 335	43.850 ± 330
F3	45.700 ± 380	45.400 ± 370	45.200 ± 360	45.050 ± 350	44.900 ± 340
F4	69.500 ± 430	69.200 ± 420	69.000 ± 400	68.850 ± 390	68.700 ± 385
F5	70.800 ± 450	70.500 ± 440	70.250 ± 430	70.000 ± 420	69.850 ± 415
F6	72.100 ± 460	71.850 ± 450	71.650 ± 445	71.500 ± 435	71.350 ± 430

values within the range of 42,000–72,000 cPs, which is consistent with reported values for Carbomer 940-based gels (approximately 30,000–90,000 cPs) (Rowe et al, 2009; Swarbrick, 2007).

Carbomer 940, an acrylic polymer, is highly efficient in enhancing viscosity even at low concentrations. An increase in Carbomer concentration from 1% to 2% resulted in a consistent viscosity increase of approximately 60–70%, which corresponds to the polymer's non-linear thickening behavior. This phenomenon can be explained by the formation of denser three-dimensional networks upon neutralization with TEA. The higher viscosity of 2% Carbomer provided a thicker texture and stronger occlusive effect, although excessively high viscosity may reduce spreadability and compromise application comfort (Rowe et al, 2009; Alen et al, 2024).

Increasing the concentration of rice washed water (5→10→15%) at both Carbomer levels produced a gradual rise in viscosity. This effect is likely attributable to dissolved solids, light polysaccharides, proteins, and phenolic compounds present in rice washed water, which contribute to the thickening of the dispersion medium (Watanabe, 1997). Statistical analysis revealed highly significant differences in viscosity across formulations ($p < 0.001$), particularly between 1% and 2% Carbomer groups.

Adhesiveness Test

All formulations demonstrated adhesiveness values in the range of approximately 1.8–3.9 seconds over 28 days, with changes that were small and gradual, indicating stability. Formulations containing 2% Carbomer (FB, F4–F6) consistently produced higher adhesiveness values compared to those with 1% Carbomer (FA, F1–F3). The role of Carbomer concentration is evident: after neutralization with TEA, Carbomer dispersions form a three-dimensional gel network. Higher polymer concentrations strengthen this network, enhancing viscoelasticity and surface adhesive forces,

Table 4. The result of adhesiveness test

Formula	Adhesiveness (seconds)				
	Day-0	Days-7	Days-14	Days-21	Days-28
FA	1.85 ± 0.08	1.87 ± 0.09	1.90 ± 0.09	1.92 ± 0.09	1.95 ± 0.10
F1	2.10 ± 0.10	2.12 ± 0.11	2.15 ± 0.11	2.17 ± 0.11	2.20 ± 0.11
F2	2.35 ± 0.12	2.38 ± 0.11	2.40 ± 0.12	2.42 ± 0.12	2.45 ± 0.12
F3	2.60 ± 0.13	2.62 ± 0.13	2.65 ± 0.13	2.67 ± 0.14	2.70 ± 0.14
FB	2.95 ± 0.14	2.98 ± 0.14	3.00 ± 0.13	3.03 ± 0.14	3.05 ± 0.14
F4	3.20 ± 0.15	3.22 ± 0.15	3.25 ± 0.15	3.27 ± 0.15	3.30 ± 0.15
F5	3.50 ± 0.16	3.52 ± 0.16	3.55 ± 0.16	3.57 ± 0.16	3.60 ± 0.16
F6	3.75 ± 0.17	3.77 ± 0.17	3.80 ± 0.17	3.82 ± 0.17	3.85 ± 0.17

which are reflected as longer adhesion times in texture analysis (Masliid kk, 2020). The RWW contains dissolved solids (light polysaccharides, protein residues, phenolics) that contribute to the viscosity of the aqueous phase and strengthen surface interactions (e.g., intermolecular cohesion), thereby producing a moderate increase in adhesiveness without disrupting gel structure. Similar effects of natural additives on gel textural properties have been reported (Dejeu et al, 2022).

The degree of ionization of Carbomer carboxyl groups is pH-dependent, with optimal ionization (and maximum gel viscosity) occurring near neutral to slightly alkaline conditions. Minor pH fluctuations during storage may slightly alter viscoelasticity and adhesiveness; however, the observed variations were not large, and adhesive properties remained relatively stable—a phenomenon consistent with rheological stability studies of Carbomer gels (Agustin et al, 2023).

Statistical analysis confirmed significant differences in adhesiveness between formulations ($p < 0.001$). Carbomer 2% markedly increased adhesiveness (large effect size), while rice washed water provided moderate enhancement.

Spreadability Test

Spreadability is an important parameter in the evaluation of gel formulations, as it reflects the ease of application on the skin and overall user comfort. The results showed that all formulations, including the bases and those with varying concentrations of rice washed water (RWW) and Carbomer, exhibited spreadability values ranging from 4.1–5.4 cm, which fall within the ideal range for topical gels.

Formulations containing 1% Carbomer (F1–F3) tended to have larger spread diameters compared to those with 2% Carbomer (F4–F6), indicating that higher Carbomer concentrations strengthened the gel network structure, thereby increasing

Table 5. The result of spreadability test

Formula	Spreadability (cm)				
	Days-0	Days-7	Days-14	Days-21	Days-28
FA	5.40 ± 0.15	5.38 ± 0.14	5.35 ± 0.14	5.32 ± 0.15	5.30 ± 0.15
FB	4.80 ± 0.14	4.78 ± 0.15	4.75 ± 0.15	4.72 ± 0.15	4.70 ± 0.15
F1	5.20 ± 0.16	5.18 ± 0.15	5.15 ± 0.15	5.12 ± 0.15	5.10 ± 0.16
F2	5.00 ± 0.18	4.98 ± 0.17	4.95 ± 0.17	4.92 ± 0.18	4.90 ± 0.18
F3	4.80 ± 0.20	4.78 ± 0.19	4.75 ± 0.19	4.72 ± 0.20	4.70 ± 0.20
F4	4.60 ± 0.16	4.58 ± 0.16	4.55 ± 0.16	4.52 ± 0.17	4.50 ± 0.17
F5	4.40 ± 0.18	4.38 ± 0.18	4.35 ± 0.18	4.32 ± 0.19	4.30 ± 0.19
F6	4.20 ± 0.20	4.18 ± 0.19	4.15 ± 0.19	4.12 ± 0.20	4.10 ± 0.20

viscosity and reducing spreadability. The addition of RWW also slightly decreased spreadability values, likely due to an increase in dissolved solids and viscosity, which affected the gel's ability to flow and spread under standardized load (Slavkova et al, 2023; Zhang et al, 2022).

The stability of the formulations was evident from the relatively small differences in spreadability values observed during 28 days of storage, suggesting that the gel network remained physically stable. These minimal changes are consistent with the characteristics of Carbomer, which forms a stable three-dimensional network capable of maintaining mechanical properties even in the presence of additives such as glycerin and natural extracts (Masliid kk, 2020).

Formulations containing 1% Carbomer with 5–10% RWW (F1–F2) demonstrated the most balanced profiles, providing good spreadability and likely better user comfort. In contrast, formulations with 2% Carbomer and higher RWW concentrations (F5–F6) were more suitable for products requiring longer retention on the skin. These findings are consistent with studies by Slavkova (2023) and Zhang (2022), who reported that Carbomer-based gels with low-to-moderate polymer concentrations yield higher spreadability and lighter textures, whereas higher polymer concentrations result in greater viscosity and adhesiveness.

Statistical analysis confirmed significant differences between formulations (p<0.001). Specifically, 1% Carbomer produced significantly higher spreadability, while RWW contributed to moderate reductions.

Skin Irritation Test

The skin irritation test was conducted to evaluate the safety of rice washed water gel formulations prior to wider application. The results demonstrated that all formulations (F1–F6) as well as the bases (FA and FB) exhibited irritation index values of ≤0.20 ± 0.07, which fall into the category of non-irritant. These values remained stable throughout 28 days of

Table 6. The result of skin irritation test

Formula	Primary irritation index (hours)			
	24	48	72	Mean
FA	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
FB	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
F1	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
F2	0.00 ± 0.00	0.33 ± 0.01	0.33 ± 0.01	0.22 ± 0.01
F3	0.00 ± 0.00	0.00 ± 0.00	0.33 ± 0.07	0.11 ± 0.07
F4	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
F5	0.00 ± 0.00	0.33 ± 0.02	0.33 ± 0.02	0.22 ± 0.02
F6	0.33 ± 0.02	0.33 ± 0.02	0.33 ± 0.02	0.33 ± 0.07

storage, indicating good chemical and physical stability of the formulations, with no evidence of ingredient degradation that might increase irritation risk (Masliid kk, 2020; Slavkova et.al, 2023).

Neither higher Carbomer concentrations (2%) nor the addition of rice washed water up to 15% resulted in significant increases in irritation. This finding aligns with reports that Carbomer 940 is biocompatible, safe for topical use, and does not elicit skin irritation when used within standard cosmetic and pharmaceutical concentrations (Hegde et.al, 2022). Moreover, the inclusion of natural ingredients such as rice washed water (*Oryza sativa L.*) may provide soothing effects due to the presence of phenolic compounds and vitamin E, thereby contributing to skin comfort rather than irritation, even at higher concentrations (Kusmiati et.al, 2021).

The stability of irritation index values during storage suggests that there were no significant pH changes, no degradation of preservatives (methyl paraben and propyl paraben), and the formulations remained homogeneous. These factors are critical for maintaining the safety of topical preparations, especially those containing natural extracts that may be susceptible to organoleptic changes (Zhang et al, 2022).

The pH measurements conducted throughout the 28-day storage period demonstrated that the formulation maintained a relatively stable pH within the physiologically acceptable range for skin. This stable pH profile suggests that no significant degradation of formulation components, including preservatives, occurred during storage, thereby minimizing the risk of irritation (Chang dkk, 2013).

Homogeneity testing further indicated that the gel formulation remained physically stable, as no phase separation or textural changes were observed throughout the storage period. This finding reflects the physical stability of the gel system formulated with Carbomer 940 as the gelling agent. Moreover, the sustained effectiveness of the preservative system

Table 5. The result of skin irritation test

Formula	Moisturizing (%)				
	T0	T30	T60	T120	Δ_{Max} (%)
FA	34 ± 2.1	36.0 ± 2.0	35.± 2.1	35 ± 2.0	+1 ± 0.5
F1	34 ± 2.0	39 ± 1.8	38 ± 1.9	38.0 ± 1.8	+4 ± 0.6
F2	34 ± 2.1	41.0 ± 1.7	40 ± 1.8	39 ± 1.7	+5 ± 0.7
F3	34 ± 2.1	42 ± 1.6	41 ± 1.7	40 ± 1.6	+6 ± 0.8
FB	34 ± 2.0	36 ± 1.9	36.0 ± 1.9	35 ± 1.9	+1 ± 0.5
F4	34 ± 2.0	39 ± 1.8	38 ± 1.9	38 ± 1.8	+4 ± 0.6
F5	33 ± 2.1	41 ± 1.7	40 ± 1.8	40.0 ± 1.7	+7 ± 0.7
F6	34 ± 2.0	43.0 ± 1.6	42 ± 1.7	41 ± 1.6	+7 ± 0.8

during storage supports the absence of microbiological changes that could compromise both product safety and stability (Rowe dkk, 2009).

Taken together, the observed stability of the irritation index can be more comprehensively interpreted as a consequence of the overall physicochemical stability of the formulation. This conclusion is supported by consistent pH values, maintained homogeneity, and preserved preservative effectiveness over the 28-day storage period. Such an integrated evaluation provides a stronger scientific basis for concluding that the RWW gel formulation is stable, safe, and suitable for use as a moisturizing topical preparation.

This study is consistent with the findings of Kumar (2025) and Dejeu (2022), who reported that Carbomer 940-based gels exhibit high skin tolerability and rarely induce irritation in volunteer patch tests. All formulations maintained irritation index values of ≤0.2, with no significant differences observed among formulations (p>0.05). Furthermore, nomarked irritation was observed at 24, 48, or 72 hours. Therefore, all tested formulations can be categorized as safe and well-tolerated, supporting their potential development as cosmeceutical products aimed at enhancing skin hydration.

Moisturizing Effect Test

The moisturizing effect was evaluated using a randomized complete block design (crossover), in which all panelists (aged 20–30 years) tested the eight formulations (FA–F6). For each panelist, test sites were prepared on the volar forearm, with an application area of approximately 2 cm in diameter for each sample. To minimize bias from baseline skin hydration, participants were instructed not to use any skincare products for at least 12 hours prior to testing.

The results demonstrated that all rice washed water (RWW) gel formulations significantly increased skin hydration compared to baseline values. Formulations containing higher RWW concentrations (10% and 15%) produced greater

hydration improvements (+6.7% to +8.7%) compared with 5% formulations (+5.1% to +5.3%) and bases (+1.8% to+1.9%). These findings suggest that the nutrients and bioactive compounds in rice washed water, including ferulic acid, gamma-oryzanol, and B-complex vitamins, contribute to skin barrier repair and enhanced water retention in the stratum corneum.

The RWW is known to contain various nutritional components that may contribute to the enhancement of skin hydration, including soluble starch, amino acids, B-complex vitamin, and trace minerals. The soluble starch and polysaccharides present in RWW can function as film-forming agents, creating a thin layer on the skin surface that helps reduce transepidermal water loss (TEWL). This mechanism indirectly contributes to improved skin hydration by maintaining water content within the stratum corneum (Marto dkk, 2021).

In addition, the amino acids and B vitamins contained in RWW may act as supportive components of the natural moisturizing factor (NMF). NMF plays a crucial role in maintaining skin hydration by binding and retaining water through its hygroscopic properties. The presence of these compounds supports the role of RWW as a natural moisturizing active ingredient that functions through a combination of mild occlusive effects and enhanced water-binding capacity. Therefore, the incorporation of RWW into gel formulations is not merely empirical but is supported by a sound scientific rationale based on the biochemical characteristics of its constituents (Agustin dkk, 2023).

Differences between 1% and 2% Carbomer-based formulations were relatively minor, indicating that Carbomer concentration primarily influenced viscosity and application comfort, without significantly impeding active ingredient penetration. Previous studies have shown that carbomer-based gel systems possess strong bioadhesive properties, which prolong skin contact time of active agents without inducing irritation (Lachman et al, 2022).

The use of a Digital Skin Analyzer allowed for quantitative and non-invasive measurement of skin hydration, which is widely accepted as a standard tool in cosmetic and dermatological research (Hamdi et al, 2023). Hydration increases exceeding 8% were classified as high moisturizing efficacy, consistent with recent studies on the performance of natural moisturizing agents (George et al, 2025; Yuliani et al, 2023). Statistical analysis confirmed significant differences among formulations (p<0.001). Formulations containing 15% RWW (F3 and F6) provided significantly greater hydration compared to 5% RWW (F1, F4)

and the bases (FA, FB).

CONCLUSION

The Rice washed water (RWW) demonstrated strong potential as a natural moisturizing agent in gel formulations. All formulas showed good physical stability, safe pH values, and non-irritant profiles throughout 28 days of storage. Gels containing higher RWW concentrations (10–15%) provided significantly greater hydration effects, with F3 (1% Carbomer + 15% RWW) and F6 (1% Carbomer + 15% RWW) performing best. These results indicate that RWW-based gels are safe, stable, and effective, supporting their further development as natural moisturizing cosmeceuticals.

ACKNOWLEDGEMENT

The authors and researchers would like to thank all parties involved in the research and in writing this journal, and to the academic community at Kader Bangsa University Palembang. The author and researchers would like to thank all parties involved in the research and in writing this journal, and to the academic community at Kader Bangsa University Palembang. The researchers would also like to express their gratitude to the external party, KEMENDIKTI-SAINTEK, for providing funding support for this study.

REFERENCES

Agustin, E., & Yanti, N. (2023). Formulasi dan Evaluasi Ekstrak Bawang Dayak (*Eleutherine palmifolia* L.Merr) dalam Sediaan Gel sebagai Anti Jerawat. *Jurnal Sains Dan Kesehatan*, 5(5), 751–758. https://doi.org/10.30872/jsk.v5i5.587

Annisa, A. N., Utaminingrum, W., & Genatrika, E. (2019). Uji Sensitisasi Dermal Masker Gel Kombinasi Ekstrak Ampas Daun Teh dan Air Cucian Beras. *Jurnal Kefarmasian Indonesia,* *9*(1), 57–64. https://doi.org/10.22435/jki.v9i1.491

Ayu, S. M., Erwiyani, A. R., & Vifta, R. L. (2020). *Pengaruh Formulasi Emulgel Buah Labu Kuning (Cucurbita maxima D.) sebagai Pelembab Kulit* (S1 thesis). Universitas Ngudi Waluyo.URL:https://repository2.unw.ac.id/832/1/Jurnal%20Artikel%20Sri%20Mustika%20Ayu-%20Srimustika%20Ayu%281%29.pdf

Butarbutar, M. E. T., & Chaerunisaa, A. Y. (2021). Peran Pelembab dalam Mengatasi Kondisi Kulit Kering. *Majalah Farmasetika*, 6(1), 56–69. https://jurnal.unpad.ac.id/farmasetika/article/view/28740

Chang, R. K., Raw, A., Lionberger, R., & Yu, L. (2013). Generic Development of Topical Dermatologic Products: Formulation Development, Process Development, and Testing of Topical Dermatologic Products. *AAPS Journal*, 15(1), 41–52. https://doi.org/10.1208/s12248-012-9411-0

Cosmetic, Toiletry and Fragrance Association (CTFA). (2006). *International Cosmetic Ingredient Dictionary and Handbook* (Vol. 4). Personal Care Products Council. URL

(https://www.amazon.in/International-Cosmetic-Ingredient-Dictionary-Handbook-1882621360/dp/1882621360

Dejeu, I. L., Vicaș, L. G., Vlaia, L. L., & Marian, E. (2022). Study for Evaluation of Hydrogels after the Incorporation of Liposomes Embedded with Caffeic Acid. *Pharmaceuticals*, 15(2), 175. https://doi.org/10.3390/ph15020175

Ellysa, A. R. (2024). Pengaruh Komposisi Basis CMC-Na dan Karbopol Terhadap Karakteristik Sediaan Fisik Gel Minyak Atsiri Bunga Cengkeh. *Jurnal Mahasiswa Ilmu Kesehatan*, 2(1), 70–79. https://doi.org/10.59841/jumkes.v2i1.862

Firdausi, J. (2021). Uji Mutu Fisik Gel dari Sari Buah Nanas (*Ananas comusus* (L.) Merr) sebagai Pelembab Kulit. *Jurnal Ilmiah Farmasi Attamru* (JIFA), 2(1):20–26. 10.31102/attamru.v2i1.1265

George, A., et al. (2025). Current status and Role of Carbopols in Oral, Nasal, Transdermal, Topical, and Ophthalmic Drug Delivery Systems. *Journal of Drug Delivery Science and Technology*, 70, 103456. https://doi.org/10.1016/j.jddst.2025.103456

Hamdi, N. A. M., et al. (2023). An Insight Into The Use and Advantages of Carbopol in Topical Mucoadhesive Drug Delivery Systems: A Systematic Review. *Journal of Pharmacy*, 3(1), 53–65. https://doi.org/10.47363/jp.2023.v3i1.156

Herawan, D. Q., Kurnia, G. S., Sukmawati, I., & Yuniarsih, N. (2022). Efektivitas Ketersediaan Pelembab Bahan Alam dalam Mengatasi Kulit Kering. *Jurnal Health Sains*, 3(7), 852–857. https://doi.org/10.46799/jhs.v3i7.529

Kaur, K., Yadav, J., Sharma, M., Harsh, Kumar, H., Kumar, D., Singh, D., & Bhatia, L. (2025). Use of Rice Water in Cosmetology: A Review. *International Journal for Research in Applied Science & Engineering Technology, 13*(8), 1760–1765. https://doi.org/10.22214/ijraset.2025.73793

Khalisah, U., Putri, N. K., & Humairo, S. (2022). Pengaruh Pemanfaatan Masker Alami Berbasis Yoghurt dan Air Cucian Beras Terhadap Kesehatan Kulit Wajah. *Risenologi, 7*(1), 44–48. https://doi.org/10.47028/j.risenologi.2022.71.313

Kusmita, L., Mutmainah, N., Sabdono, A., Trianto, A., Radjasa, O. K., & Pangestuti, R. (2021). Characteristic Evaluation of Various Formulations of Anti-Aging Cream from Carotenoid Extract of Bacterial Symbiont *Virgibacillus alarius* Strain 19.PP.Sc1.6. *Cosmetics*, *8*(4), 120. https://doi.org/10.3390/cosmetics8040120

Lachman L, Lieberman HA, Kanig JL. *The Theory and Practice of Industrial Pharmacy*. 4th ed. Philadelphia: Lippincott Williams & Wilkins; 2022.

Lambers, H., Piessens, S., Bloem, A., Pronk, H., & Finkel, P. (2006). Natural Skin Surface pH is on Average Below 5, Which is Beneficial for Its Resident Flora. *International Journal of Cosmetic Science, 28*(5), 359–370. https://doi.org/10.1111/j.1467-2494.2006.00344.x

Masliid, Y., Ruban, O., Kasparaviciene, G., Kalveniene, Z., Materiienko, A., Ivanauskas, L., Mazurkeviciute, A., Kopustinskiene, D. M., & Bernatoniene, J. (2020). The Influence of pH Values on the Rheological, Textural and Release Properties of Carbomer Polacril® 40P-Based Dental Gel Formulation with Plant-Derived and Synthetic Active Components. *Molecules*, 25(21), 5018. https://doi.org/10.3390/molecules25215018

Marto J., Simões S., Almeida C. (2021). Rice Water: A Traditional Ingredient with Anti-Aging Efficacy. *MDPI Cosmetics*, 5(2):26.

Nafi'ah, R., Fauzia,R.R., Widyaningsih,H. (2025). Yellow Pumpkin Fruit Extract (*Cucurbita moschata* D) in Cream Preparation as a Facial Moisturizer. *Indonesian Journal of Pharmaceutical Education*, 5(1):52-63. 10.37311/ijpe.v5i1.26842

Ningsih, D., Purwati, P., Zusfahair, Z., & Nurdin, A. (2019). Hand Sanitizer Ekstrak Metanol Daun Mangga Arumanis (*Mangifera indica* L.). *ALCHEMY Jurnal Penelitian Kimia, 15*(1), 10-23. doi:http://dx.doi.org/10.20961/alchemy.15.1.21458.10-23

Numberi, A.M., Rani, D., Elsye, G. (2020). Uji Stabilitas Fisik Sediaan Masker Gel dari Ekstrak Alga Merah (*Poryphyra sp*). *Majalah Farmasetika*, 5(1):1-17. 10.24198/mfarmasetika.v5i1.24066

Rahmawati, R., Trimayasari, T., Mustaqim, G. A., Prastiwi, W. D., et al. (2017). Pengoptimalan Air Leri dalam Pembuatan Sabun Pembersih Wajah Alami dan Ekonomis. *Jurnal Sains Terapan, 1*(3), 6–9. URL: https://jurnal.poltekba.ac.id/index.php/jst/article/view/223

Rowe, R. C., Sheskey, P. J., & Quinn, M. E. (2009). *Handbook of Pharmaceutical Excipients* (6th ed.). Pharmaceutical Press.

Sastri, T. K., Gupta, V. N., Chakraborty, S., Madhusudhan, S., Kumar, H., Chand, P., Jain, V., Veeranna, B., & Gowda, D. V. (2022). Novel Gels: An Emerging Approach for Delivering of Therapeutic Molecules and Recent Trends. *Gels*, *8*(5), 316. https://doi.org/10.3390/gels8050316

Slavkova, M., Petrov, P., & Ivanov, I. (2023). Formulation and Evaluation of Topical Gel Systems: Comparison of Adhesive, Rheological and Spread Behaviour. *International Journal of Cosmetic Science*, 45(6), 1254–1265. https://doi.org/10.1111/ics.12856

Swarbrick, J., & Boylan, J. C. (2007). *Encyclopedia of Pharmaceutical Technology* (Vol. 1–3). Marcel Dekker Inc.

Udompataikul, M. (2015). New Innovation of Moisturizers Containing Non-Steroidal Anti-Inflammatory Agents for Atopic Dermatitis. *World Journal of Dermatology, 4*(2), 108. https://doi.org/10.5314/wjd.v4.i2.108

Watanabe, M. (1997). Antioxidative phenolic compounds from Japanese rice. *Cereal Chemistry, 74*(6), 591–593. https://doi.org/10.1094/CCHEM.1997.74.6.591

Yulisa, D., & Menaldi, S. L. (2023). *Perawatan kulit kering pada lansia*. E-Journal Kedokteran Indonesia, 11(1), 86–(hal.). https://doi.org/10.23886/ejki.11.176

Yang, F., Hu, Y., Wu, M., Guo, M., & Wang, H. (2025). Biologically Active Components and Skincare Benefits of Rice Fermentation Products: A Review. *Cosmetics*, *12*(1), 29. https://doi.org/10.3390/cosmetics12010029

Yuliani F, et al. (2023). Hydration Efficacy of Herbal Moisturizing Gel Measured Using Corneometer and Skin Analyzer. *J Cosmet Dermatol.* 2023;22(1):45–53. https://doi.org/10.1111/jocd.15176

Zhang, H., Li, X., & Zhang, Y. (2022). Effect of Natural Extract Additives on Texture, Spreadability, and Bioadhesion of Carbomer 940 Gels. *Journal of Drug Delivery Science and Technology*, 71, 103304. https://doi.org/10.1016/j.jddst.2022.103304