

Formulation and development of a body gel scrub using *Areca catechu* L. seed extract and microbeads

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Abstract

The purpose of this study was to develop and evaluate an antioxidant body gel scrub formulation including *Areca* seed extract and *Areca* beads. The *Areca* seed ethanol extract had an IC₅₀ of 183.30 µg/ml, a radical scavenging activity of 49.196%, and a total phenolic content of 21.21 ± 2.32 µg/ml. With a pH of 6.98 at 25 °C and a viscosity of 5,590.457 cP, the optimized formulation contained 1% w/w *Areca* seed extract, 5% w/w polyvinyl alcohol, 0.5% w/w Carbomer Ultrez 21, and 5% w/w *Areca* microbeads. The formulation had a radical scavenging efficiency of 68.66%. Stability tests were carried out under accelerated heating cooling conditions at 40 ± 2 °C, 75 % RH for 48 hours, followed by 4 °C for 48 hours each cycle for 24 days (6 cycles) and 30 days for 4 °C and 30 ± 2 °C, 75% RH, and no significant changes in physical or chemical properties were observed. This body gel scrub formulation shows potential for use in skincare applications due to its antioxidant activity and stability.

Keywords

Areca catechu L., *Areca* microbeads, body gel

Introduction

Areca catechu L. is a palm tree species. The components present in *Areca* seed may be divided into various classes, including 1) polyphenols, which are mostly flavonoids and tannins; 2) fatty substances; 3) alkaloids; 4) triterpenes and steroids; and 5) starch (Xiao et al. 2019; Chen et al. 2021; Kozlakidis et al. 2022). Ethanol-extracted *Areca* seed has been shown to have numerous beneficial effects, including antioxidant activity (Tiwari et al. 2020; Byun et al. 2021; Chaikhong et al. 2023), antimicrobial and antifungal activity (Xiao et al. 2019; Chen et al. 2021; Sandhiutami et al. 2023), skin whitening (Kanlayavattanakul et al. 2018; Liu

et al. 2023), improving skin moisture and elasticity and reducing wrinkles (Byun et al. 2021; Chaikhong et al. 2023). Anti-aging compounds with antioxidant properties such as ascorbic acid, tocopherols, and polyphenols have been proven in studies to boost resistance to oxidative stress and reduce skin aging (Michalak 2022). According to the results of studies, *Areca catechu* extracts and alkaloids exhibit substantial toxicological properties. *Areca* nut toxicity is principally linked to four major alkaloids: arecoline, arecaidine, guvacine, and guvacoline (Siregar et al. 2022), as well as secondary metabolites of arecoline (arecaidine and arecoline N-oxide) (Yan et al. 2023). Arecoline's primary toxicity includes the promotion of oral submucosal

fibrosis and cytotoxic effects on normal human cells (Peng et al. 2015; Liu et al. 2016; Sari et al. 2021; Muthukumaran et al. 2023), cardiac effects (Ku et al. 2021), psychoactive side effects (Siregar et al. 2022), and neurological disorders (Chan et al. 2019). A subchronic toxicity investigation on rats revealed that prolonged and continuous administration of a high dosage of arecoline hydrobromide caused toxicity. Arecoline hydrobromide, on the other hand, was shown to be safe when administered within clinically indicated dose ranges. Wei et al. (2015) determined 100 mg/kg/day as the threshold dosage with no deleterious effects under experimental circumstances. Long-term oral treatment of *Arecae* aqueous extract in rats resulted in dose-dependent adverse effects, including cardiotoxicity and neurotoxicity (Jia et al. 2020). An investigation into the in vivo acute dermal toxicity of *A. catechu* L. aqueous extract at a dose of 15,000 mg/kg body weight in Sprague-Dawley rats yielded no toxic effects concerning mortality, clinical signs, body weight variations, or gross findings with no toxic symptoms associated with eczema, inflammation, rashes, or gross findings (Sari et al. 2016; Ansari et al. 2021).

Natural products containing phenolic compounds have been utilized to treat bacterial infections, and it was discovered that the chemicals were not poisonous to people and were not harmful to the environment (Takó et al. 2020; Ecevit 2022; Luo et al. 2022; Rybczyska et al. 2023). *A. catechu* fruit has been found as a natural source of antioxidants, anti-elastase, and anti-tyrosinase, which are thought to be potentially effective in the treatment of skin aging (Chaikhong et al. 2023). *Areca catechu* L. seed extract is a useful subject of study in the realms of cosmetics and medicine. Researchers have investigated its uses in cosmetics, such as soap formulations, as indicated by research papers (Phaechamud and Chitrattha 2012; Rahman and Purwakanthi 2021; Sofi et al. 2022). Its ability to produce long-lasting natural lipstick stains has also been examined (Bicknell et al. 2013). In the medical field, the extract has been formulated into ointments at a concentration of 5.0% to investigate its efficacy in wound healing (Abbasy et al. 2021; Sandhiutami et al. 2023). It has been used to create silver nanoparticles to harness its antimicrobial properties (Bhat et al. 2016). Copper nanoparticles produced from this extract have also been shown to suppress the development of gram-negative and gram-positive bacteria (Pradeep et al. 2019).

Body scrubs often contain skin-nourishing ingredients. They seek to remove debris that clogs pores and to shed old skin cells for a speedier peeling process, increasing the likelihood of showing fresh, more radiant skin cells, and a particle size diameter of 400–800 µm was recommended for scrub particle size diameter (Muhamad et al. 2020; Piotrowska et al. 2020). Natural scrub beads manufactured from plant seeds such as coconut, apricot, maize, or walnut can have an effect on the skin when mixed into a body scrub gel solution. *Areca catechu* extracts have potential as a cosmetics component due to their diverse therapeutic

characteristics. It is feasible to create a topical solution that can help slow down the aging process by combining ethanol-extracted *Areca* seeds into a body scrub gel composition with *Areca* beads.

Materials and methods

Preparation of *Areca* microbeads for the body scrub

40 grams of dried *Areca* seeds were processed for the necessary grinding duration in a Planetary Mono Mill Pulverisette 6 (Fritsch, Germany) to make the *Areca* microbeads. A 250-milliliter agate (SiO₂) grinding bowl and 50 silicate grinding balls with a diameter of 10 millimeters were used. At room temperature (25 + 2 °C), the *Areca* seeds were ground at a speed of 500 rpm for 5, 10, and 15 minutes. The finely ground *Areca* powder was next sifted for 20 minutes using a sieve shaker model AS 200 (Retsch, Germany) with an amplitude of 1 millimeter to separate the particles to the required size range of 400–800 micrometers. The *Areca* powder was chosen for integration into the formulations as microbeads after being ground to fulfill particular particle size parameters.

Characteristics of *Areca* microbeads

The particle size and morphology of milled *Areca* seed were examined using a compound microscope Primo-star 3 (Zeiss, Germany). The inspection was carried out at 100× magnification.

Characteristic of *Areca* seed powder

Shaanxi Honghao Bio-Tech Co., Ltd., Shaanxi, China, contributed the powdered *Areca* seed, which was obtained by extracting *Areca* seeds in 95% ethanol. The chemical properties of the extracted powder were investigated using a modified experimental technique based on Wang and Lee (1997) investigation. The Ultimate 3000 (Thermo Fischer Scientific, Germany) automated High-Performance Liquid Chromatography was used. With a mobile phase consisting of a linear gradient from 5% v/v acetic acid in distilled water to methanol, Inertsil columns ODS-35 nm (size 4.6×250 mm) were used. A reference solution of gallic acid in distilled water at 0.2% w/v was utilized for testing, whereas the sample was *Areca* ethanolic extract powder in distilled water at 2% w/v. The flow rate was 0.8 ml/min, the injection volume was 20 microliters, and the wavelength was adjusted at 280 nanometers.

The moisture content of *Areca* seed extract powder

The moisture content of the extracted *Areca* seed powder was measured with a Moisture Analyzer model HR83

(Mettler Toledo, Switzerland) using the Loss on Drying technique. Aluminum pans were dried for 60 minutes at 105 °C in a hot air oven UFE 700 (Mettler, Germany). One gram of the powder was picked at random from several positions, including the top, center, and bottom of the box. At each sampling site, the samples were tested in triplicate and the mean % moisture content was reported.

Acid-base of *Areca* seed extract powder

The pH of the dissolved *Areca* seed extract powder in distilled water was measured at room temperature using a pH meter model 3510 (Jenway, The United Kingdom). The samples were examined in triplicate, and the mean value obtained was reported.

Solubility studies of *Areca* seed extract powder

The water solubility of *Areca* seed extract powder was evaluated by dissolving it in 10 ml of distilled water at room temperature with a vortex mixer Genie 2 (Scientific, USA). *Areca* seed extract was shaken in a water tube with a screw top. The dissolving and subsequent precipitate were visually observed, and the amount of soluble extract powder at room temperature that yielded the maximum amount was recorded.

The antioxidant of *Areca* seed extract

Total phenolic content in *Areca* seed extract powder

The Folin-Ciocalteu technique was used to determine the total phenolic content of *Areca* seed extract powder (Chanda and Dave 2009). Initially, a 10% v/v Folin-Ciocalteu reagent was added to the phenolic compound-containing sample solution and allowed to react for 5 minutes while covered with aluminum foil. Following that, a 700 millimolar sodium bicarbonate solution was added, and the mixture was incubated in a dark room for 2 hours while remaining covered with aluminum foil. Following the incubation period, the resultant solution was carefully pipetted into a 96-well plate in exactly 200 microliters. The absorbance of this solution was then measured at 765 nanometers using a microplate reader EON model (BioTek, USA). These absorbance values were then compared to those obtained from a standard gallic acid solution dissolved in deionized water. This standard gallic acid solution has a concentration range of 20 to 100 micrograms per milliliter and was used to create a calibration curve. Finally, the amount of *Areca* seed extract solution in deionized water was estimated using the absorbance measurements and the calibration curve, and the total phenolic content was expressed as

milligrams of Gallic Acid Equivalent per gram of extract (mg GAE/g extract).

The antioxidant of *Areca* seed extract by DPPH radical scavenging assay

The reaction between the sample and a DPPH solution was evaluated to determine free radical inhibition activity in *Areca* seed extract. Initially, 25–250 microgram per milliliter *Areca* seed extract powder and a 0.5–3.0 microgram per milliliter gallic acid standard were dissolved in water to make solutions. To begin the reaction, 100 microliters of these solutions were pipetted into a 96-well plate, followed by 100 microliters of absolute ethanol-based 225.2 molar DPPH solution. The reaction was allowed to run for 30 minutes in the dark with the plate covered with aluminum foil. After that, absorbance was measured at 517 nanometers using a microplate reader EON model (BioTek, USA). The experiment was carried out in triplicate, and the results were used to compute the percentage of radical scavenging activity.

Microbial test for *Areca* seed and *Areca* seed extract

The total number of microorganisms in the samples was determined using the AOAC Official Method (AOAC 900.12 (2015), which employs Petrifilm™ agar plates containing nutrients and 2,3,5-triphenyl tetrazolium chloride, both of which are appropriate for microbial growth. The sample solution was pipetted onto 1 ml of Petrifilm™ and cultured at 20 to 25 °C for five days before counting colony forming units per gram (cfu/g).

The AOAC Official Method 2014.05 was used to determine the yeast and mold count in samples. 3MTM Petrifilm™ Rapid Yeast and Mold Count Plate First Action (AOAC 2014) using 3M Petrifilm™ Rapid Yeast and Mold Count Plates. The sample solution was pipetted onto 1 ml of Petrifilm™ and incubated for five days at 20 to 25 °C. The colony counts were then expressed as colony forming units per gram (cfu/g).

Development of body gel with *Areca* microbeads scrub

Color determination from *Areca* microbeads

A determined amount of finely crushed *Areca* microbeads was poured into a screw-cap sample tube filled with water to ascertain the hue. After that, the mixture was violently agitated for 5 minutes with a Vortex mixer Genie 2 (Scientific, USA). The suspension was then allowed to stay at room temperature for 24 hours, during which time the observed color was recorded and compared to a reference color band with a score level of 2–6.

the formulation, a score of 1 indicates that there was less separation of the gel layer, and a score of 2 indicates that there was no separation in the formulation.

Evaluation of sedimentation of microbeads scrub

The dispersion of *Areca* microbeads was evaluated using a scoring system. A score of 0 showed that the scrubbing beads had more than 50% formulation sedimentation,

making it unsuitable for scrub beads in topical treatments. Milling the finely ground *Areca* seeds for 10 and 15 minutes produced smaller sizes of *Areca* seed powder than the required goal size. However, dry grinding the *Areca* seeds for 5 minutes produced particles with a size of 0.48 ± 0.13 mm (480 m) and a reasonably round shape, appropriate for scrub beads. Fig. 1 depicts the shapes and sizes of crushed particles at various periods. To create a body scrub gel recipe, the particle size of the ground *Areca* seeds was chosen to be between 250 and 500 micrometers.

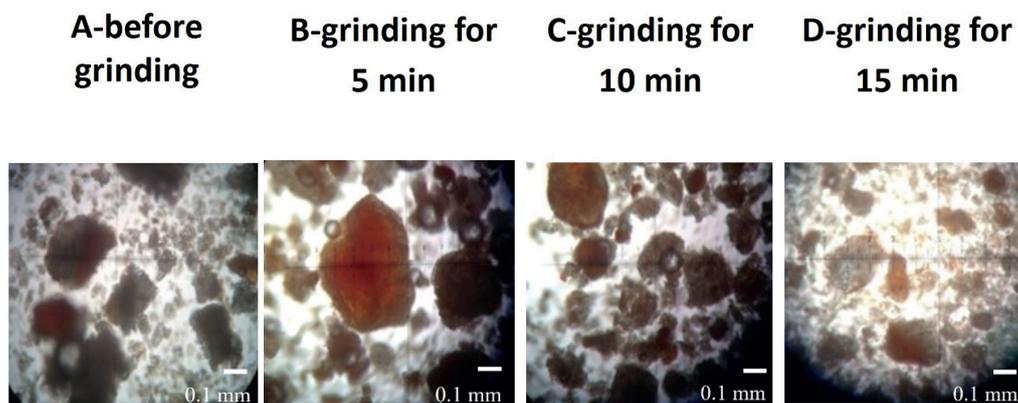


Figure 1. Characteristics of *Areca* seeds that have been ground under a microscope with a magnification at 100 \times .

while a score of 1 suggested that the scrubbing beads had less than 50% formulation sedimentation. A score of 2 showed that there was no scrubbing bead sedimentation in the preparation.

Antioxidant activity of body gel scrub by DPPH scavenging assay

The antioxidant activity of the body gel was determined using the DPPH radical scavenging test. The body gel scrub compositions were tested in water at concentrations ranging from 25 to 250 micrograms per milliliter, and the results were compared to a standard gallic acid solution of 5–150 micrograms per milliliter. To begin, 100 microliters of each of these solutions were dispensed into a 96-well plate, followed by 100 microliters of a 225.2 molar DPPH solution in absolute ethanol to start the reaction. This reaction was allowed to run for 30 minutes in a light-protected atmosphere with the plate covered with aluminum foil. Following this incubation time, the absorbance of the solutions was measured at a wavelength of 517 nanometers using a microplate reader EON model (BioTek, USA). Each formulation's free radical scavenging capability was then determined as a percentage of radical scavenging.

Results and discussion

Areca microbeads may be made by crushing dried *Areca* seeds in a planetary grinder. Grinding can create spherical particles of the appropriate size for scrub application. The dried *Areca* seed has a square shape before grinding,

The color is created by milling *Areca* seed. When *Areca* microbeads was examined for water solubility, it was discovered that the color could be dissolved from the *Areca* microbeads when added to the mixture as a scrub. The solution was reddish-brown, and the intensity of the color increased with increasing *Areca* seed concentrations, as seen in Fig. 2. The natural pigments found in *Areca catechu* seed extract have various structures that cause color variations in the solution. In acidic conditions, the color shift is mostly yellowish, while in basic media, it is reddish (Raghavendra et al. 2020).

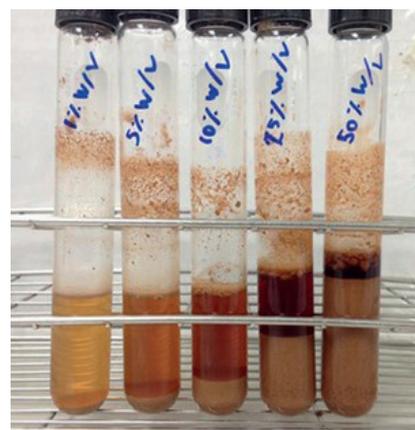


Figure 2. The color of the suspension resulting from the *Areca* microbeads at various ratios in water.

The addition of 5% w/v *Areca* microbeads produced a reddish-brown hue that is within the intended color scale range (particularly, without surpassing level 6, as the color

bands used for testing cover levels 2–6). The percentage of *Areca* microbeads to total liquid volume remained constant. As a result, 5% w/v *Areca* microbeads were used as a scrub in the body gel composition.

Identification of *Areca* seed extract by ethanol

The retention time for Gallic acid at position (1) was 4.807 min, which matched the reference Gallic acid position. Furthermore, the retention durations at locations (2) and (3), which correspond to catechin and epicatechin, were 10.853 min and 11.793 min, respectively. Figs 3, 4 show the results of the HPLC analysis.

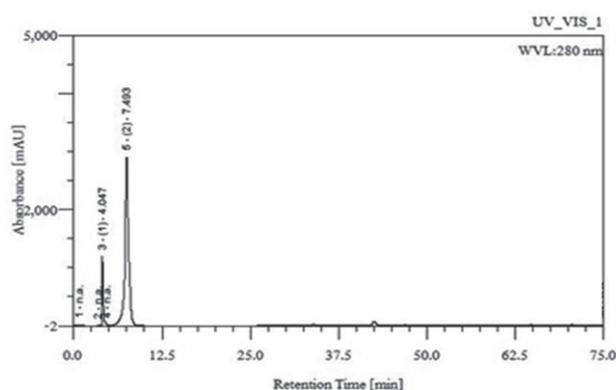


Figure 3. HPLC Chromatograms of 0.2% Gallic acid at 280 nanometer.

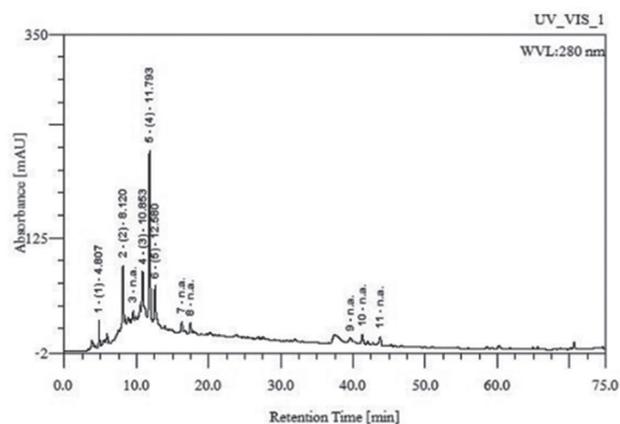


Figure 4. HPLC Chromatograms of 2% *Areca* seed in ethanolic extract at 280 nanometer

Physical properties of *Areca* seed extract powder

The ethanolic *Areca* seed extract powder is brown and has a moisture content of $4.82 \pm 0.46\%$ on average. A pH meter was used to perform acid-base analysis on extract concentrations ranging from 1–5% w/v. At 25 °C, the pH of the solution slightly decreased as the content of *Areca* seed extract increased, ranging from 4.92 to 5.07. These findings suggest that the concentration of *Areca* seed extract

in ethanol in the aforementioned concentration range has no effect on pH alteration.

Antioxidant activity by DPPH radical scavenging assay

The DPPH radical scavenging assay findings show that the antioxidant activity of the *Areca* seed extract is concentration-dependent. The IC₅₀ values for gallic acid, employed as a standard, and *Areca* seed extract were 1.35 µg/ml and 183.31 µg/ml, respectively, showing that the extract had lesser antioxidant efficacy than the standard reference. Numerous studies have been conducted to investigate the polyphenolic content of *Areca* nut, taking into account various geographical origins and extraction techniques. As established in the research (Gurumurthy et al. 2017; Gurumurthy 2018; Sari et al. 2020; Yang et al. 2023), the variance in polyphenol content is controlled by regional characteristics and environmental circumstances. Furthermore, Meutia (2021) note that the choice of *Areca* nut species and its intrinsic properties have a major influence on the quality and quantity of phytochemical contents within the nut.

The appearance of body gel from *Areca* seed extract

Combining the main component, *Areca* seed extract powder, with polyvinyl alcohol and Carbomer Ultrez 21 using various preparation factors results in a dark brown gel, as shown in Figs 5, 6. *Areca* seed extract powder and *Areca* microbeads were used in equal amounts in each gel composition. The composition and quantity of Carbomer Ultrez 21

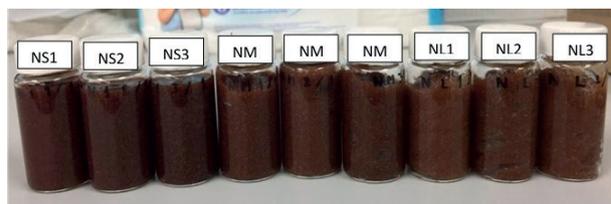


Figure 5. Appearance of gel scrub containing extract and microbeads from *Areca* seed with different component.



Figure 6. Appearance of the formulations containing *Areca* microbeads scrub, C-formula contain only *Areca* microbeads, N-formula contain with *Areca* seed extract and *Areca* microbeads.

Table 3. Physical properties of *Areca* seed extract powder.

| Topics | <i>Areca</i> in ethanolic extract |
|---|-----------------------------------|
| Moisture content % | 4.82 ± 0.46 |
| pH at 25 °C | 4.92–5.07 |
| Water Solubility (g/ml) | More than 0.5 |
| Antioxidant DPPH scavenging (IC50) µg/ml | 183.31 (Gallic acid 1.35) |
| Total Phenolic content (mg GAE/g extract) | 21.21± 2.32 |
| Total aerobic microbial count (cfu/g) | 1.1 × 10 ² |
| Total combined yeasts and moulds counts (cfu/g) | < 1.0 |

and polyvinyl alcohol, however, differed between formulations. Surprisingly, the gel with the deepest brown hue had the least amount of gelling agent. The intensity of the color reduced as the amount of gelling ingredient in the formulations rose. Every formulation's gel has a homogeneous distribution and good dispersion of *Areca* scrub microbeads.

Viscosity measurement

According to the findings, increasing the volume of Carbomer Ultrez 21 and polyvinyl alcohol resulted in a greater formulation viscosity. Table 4 compares the viscosity values in *Areca* gel containing 1% w/w *Areca* seed extract powder, a Carbomer Ultrez 21 content of 0.5% w/w and a polyvinyl alcohol content of 0, 2.5, and 5.0% w/w (NS1, NS2, and NS3), *Areca* gel containing 1% w/w *Areca* seed extract powder, a Carbomer Ultrez 21 content of 1.0% w/w, and a polyvinyl alcohol content of 0, 2.5, and 5.0% w/w (NM1, NM2, and NM3), and *Areca* gel containing 1% w/w *Areca* seed extract powder, a Carbomer Ultrez 21 content of 2.0% w/w, and a polyvinyl alcohol content of 0, 2.5, 5.0 % w/w (NL1, NL2, and NL3). When the carbomer or polyvinyl alcohol percentage was increased, the viscosity increased from 719.86 cP to 224,974.69 cP.

Table 4. Viscosity and acid-base properties of *Areca* gel scrub.

| Formula | Viscosity (cP) | pH, 26 °C | Formula | Viscosity (cP) | pH, 26 °C |
|---------|----------------|-------------|---------|----------------|-----------|
| NS1 | 719.86 | 7.20 ± 0.17 | CS1 | 545.88 | 7.32 |
| NS2 | 2,546.79 | 7.00 ± 0.18 | CS2 | 2,087.55 | 7.22 |
| NS3 | 5,094.55 | 6.96 ± 0.12 | CS3 | 17,716.22 | 7.32 |
| NM1 | 23,751.60 | 6.00 ± 0.11 | CM1 | 16,856.40 | 6.59 |
| NM2 | 30,679.62 | 6.02 ± 0.21 | CM2 | 28,023.67 | 6.32 |
| NM3 | 36,228.98 | 6.01 ± 0.05 | CM3 | 41,803.01 | 6.35 |
| NL1 | 102,623.56 | 5.15 ± 0.31 | CL1 | 115,584.35 | 5.41 |
| NL2 | 168,379.68 | 5.24 ± 0.21 | CL2 | 124,751.39 | 5.59 |
| NL3 | 224,974.69 | 5.18 ± 0.21 | CL3 | 156,610.16 | 5.45 |

The viscosity of gels containing Carbomer Ultrez 21 was affected by the formulation's pH. When the viscosity of *Areca* gel (NS1, NS2, NS3, NM1, NM2, NM3, NL1, NL2, and NL3) was compared to the viscosity of non-extracted seeds gel (CS1, CS2, CS3, CM1, CM2, CM3, CL1, CL2, and CL3), higher viscosity was linked with lower pH. Given the changes in polyvinyl alcohol content within the

formulations despite employing the same concentration of triethanolamine for neutralization, additional research into the rheological behavior is required to help in the creation of these formulations.

Due to the gelling qualities of Carbomer Ultrez 21, which are impacted by the pH of the formulation, the formulation without *Areca* seed extract had a lower viscosity than the formulation with *Areca* seed extract powder. The data in Table 4 also show that the pH and viscosity values in the NS2 and NS3 formulations were similar to human skin (Saryanti and Zulfa 2017) and recommended for semi-solid cosmetic product viscosity (Badan Standardisasi Nasional 1996 (SNI 16-3499-1996; Ervina et al. 2020). It indicates that these formulations are ideal for further development as an *Areca* seed extract body scrub gel for skin care products.

Stability study

The physicochemical stability of the *Areca* gel scrub containing 1% w/w of *Areca* seed extract powder, 0.5% w/w of Carbomer Ultrez 21, and 2.5% w/w of polyvinyl alcohol (NS2) and the *Areca* gel scrub containing 5.0% w/w of polyvinyl alcohol (NS3), packed in 100 g plastic jars, was evaluated under various conditions. The formulations were kept for 30 days under accelerated conditions at 4 °C and 30 °C. The NS2 and NS3 formulations were found to be similar after testing. As seen in Fig. 7, the gel exhibited a brown color with high homogeneity and even dispersion of microbead particles.

**Figure 7.** Physical characteristics of the gel scrub containing 1% w/w *Areca* seed extract powder, 0.5% w/w of Carbomer Ultrez 21, and 2.5 % w/w of polyvinyl alcohol (NS2) at the test condition A = 4 °C, B= 30 °C, C = heating-cooling.

The stability of the body gel formulation comprising seed extract components was examined, and the pH values for both formulations were found to be between 5–7. Under all storage settings, the pH values for the seed extract formula (NS2, NS3) were consistently lower than the control (CS2, CS3). Notably, the pH was lower when held at 30 °C with a heating-cooling cycle compared to 4 °C, which might be ascribed to the harsher storage circumstances. Fig. 8 depicts this information.

Viscosity evaluation

The NS2 and NS3 body gel formulations were found to have high viscosity and varied viscosity variations during

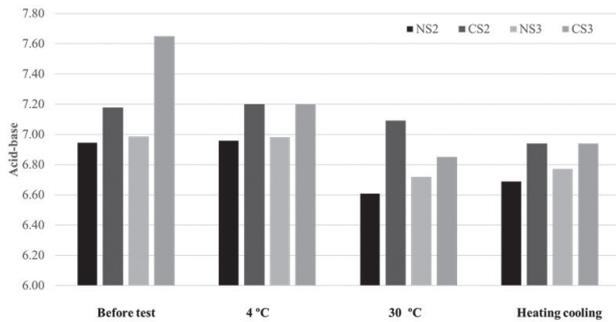


Figure 8. pH chart of body gel scrub tested for stability. NS2, containing 1% *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez 21, and 2.5% w/w Polyvinyl alcohol. NS3, consisting of 1% *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez, and 5% w/w Polyvinyl alcohol. CS2 with no *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez 21, and 2.5% w/w Polyvinyl alcohol. CS3 with no *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez 21, and 5% w/w Polyvinyl alcohol.

storage conditions of 30 °C and a heating-cooling cycle, as illustrated in Fig. 9. Those held at 4 °C, on the other hand, remained identical to those made in the original preparation. It was also discovered that the viscosities of the NS2 and NS3 formulations held at 30 °C and under fast heating-cooling circumstances exceeded the initial. In terms of the formulation's homogenous acid-base and scrubber distribution, the accelerated condition was shown to be the most significant modification among the three sample conditions. Nonetheless, samples held in all three settings satisfied the established acceptability requirements of gel viscosity 2,500–6,000 mPa.s, semi-solid cosmetic product viscosity (Badan Standarisasi Nasional 1996 (SNI 16-3499-1996; Ervina et al. 2020).

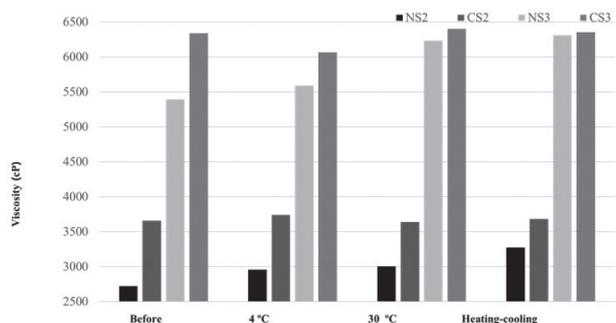


Figure 9. Viscosity chart of body gel tested for stability. NS2, containing 1%w/w *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez 21, and 2.5% w/w Polyvinyl alcohol. NS3, consisting of 1% w/w *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez, and 5% w/w Polyvinyl alcohol. CS2 with no *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez 21, and 2.5% w/w Polyvinyl alcohol. CS3 with no *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez 21, and 5% w/w Polyvinyl alcohol.

The antioxidant activity of gel with DPPH scavenging assay

The antioxidant activity of the gel formed from seed extract was assessed using the DPPH radical scavenging assay, and the body gel formulations NS2 and NS3 showed

radical scavenging values of 61.609% and 62.187%, respectively. The stability test revealed that the antioxidant activity of the body gel formulation was stable. Furthermore, under the test condition, the product developed from NS2 seed extract and NS3 formula showed an enhanced% radical scavenging activity. The antioxidant activity of the formula increased in the stability test at different storage temperatures, which might be ascribed to the increased quantity of extract in the formulation due to the dissolution of granules generated from finely crushed powder.

The appearance of antioxidant activity may be related to a noticeable dramatic color change and an increase in heating temperature. The study also found that raising the heating temperature boosted the DPPH radical scavenging capacity and antioxidant property, which conforms to the temperature rise described in Kim (2018) study. According to Molaveisi et al. (2019), relationships between antioxidant activity and brown pigment were identified, with the highest phenol concentration associated with the darkest sample. The effect of heat processing on flavonoids' antioxidant activity was demonstrated by the observation of an increase in the breakdown of phenolic acid components with increasing temperature (Chaaban et al. 2017; Che Sulaiman et al. 2017; Fei Zhou et al. 2017; ElGamal et al. 2023). The impact of thermal treatments on phenolics, including phenolic and flavonoid contents and antioxidant properties, is dependent on the characteristics of phenolic compounds and the processing conditions (Li et al. 2020; Zapata et al. 2021). Studies have investigated the thermal degradation of visual color of gallic and protocatechuic acids, detectable increases in polymeric color and browning indexes were observed (Sinela et al. 2017; Oliveira and Antelo 2020). Furthermore, the effect of heat processing on the color and molecular structure was investigated, at higher pH values, changes in both color and molecular structure was reported (Ngamwonglumlert et al. 2020).

The NS3 formulation was found to be stable and acceptable for generating a body gel scrub for skin products after analyzing the stability of the NS2 and NS3 body gel formulations, as shown in Tables 5, 6. With *Areca* seed extract and *Areca* microbeads scrub, this mixture had 1%

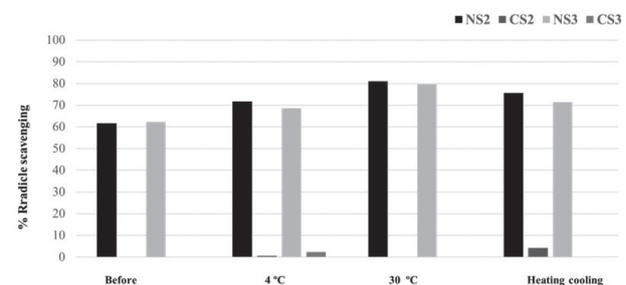


Figure 10. % Radical scavenging chart of body scrub at various storage conditions of NS2, containing 1% w/w *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez 21, and 2.5% w/w Polyvinyl alcohol. NS3, consisting of 1% w/w *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez 21, and 5% w/w Polyvinyl alcohol. CS2 with no *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez 21, and 2.5% w/w Polyvinyl alcohol. CS3 with no *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez 21, and 5% w/w Polyvinyl alcohol.

Table 5. The comparison results before and after the stability test of the NS2; containing 1% w/w *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez 21, and 2.5% w/w Polyvinyl alcohol formulation when stored at various conditions.

| Evaluation topic | Initial | 4 °C | 30 °C | Heating-cooling |
|---|-----------|---|--|---|
| pH | 6.95 | 6.96 (Increase 0.187 %) | 6.61 (Decrease 4.85%) | 6.69 (Decrease 3.70%) |
| viscosity (cP) | 2,721.997 | 2,957.75 (Increase 8.66 %) | 3,003.75 (Increase 10.35 %) | 3,275.45 (Increase 20.33 %) |
| homogeneity of body gel level | 2 | 2 No change | 2 No change | 2 No change |
| sedimentation of microbeads scrub level | 2 | 2 No change | 2 No change | 2 No change |
| color (level number) | 6 | 6 No change | >6 Darker | >6 Darker |
| antioxidant activity by DPPH radical scavenging assay | 61.609 | 71.723 statistical difference (P-value = 0.033) | 81.061 statistical difference (P-value = 0.0064) | 75.514 statistical difference (P-value=0.045) |

Table 6. The comparison results before and after the stability test of the NS3; consisting of 1% w/w *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez 21, and 5% w/w Polyvinyl alcohol formulation when stored at various conditions.

| Evaluation topic | Initial | 4 °C | 30 °C | Heating-cooling |
|---|-----------|--|---|--|
| pH | 6.98 | 6.98 No change | 6.72 Decrease 3.82% | 6.77 Increase 3.06% |
| viscosity (cP) | 5,394.213 | 5,590.457 Increase 3.64% | 6,235.373 Increase 15.59% | 6,308.91 Increase 16.96% |
| homogeneity of body gel level | 2 | 2 No change | 2 No change | 2 No change |
| sedimentation of microbeads scrub level | 2 | 2 No change | 2 No change | 2 No change |
| color (level number) | 6 | 6 No change | >6 Darker | >6 Darker |
| antioxidant activity by DPPH radical scavenging assay | 62.187 | 68.664 no statistical difference (P-value = 0.139) | 79.545 statistical difference (P-value = 0.030) | 71.402 no statistical difference (P-value=0.339) |

w/w *Areca* seed extract powder, 0.5% w/w Carbomer Ultrez, and 5% w/w polyvinyl alcohol.

Conclusions

In conclusion, the ethanol extract of *Areca* seeds revealed modest antioxidant activity and a total phenolic content appropriate for cosmetic purposes. The formulation allows for a phenolic content of at least 0.005% w/w produced from *Areca*, making it a suitable option for inclusion in antioxidant skincare products. To successfully reduce the aging process, the amount of extract and overall phenolic content should be evaluated. The *Areca* seeds influenced the volume of Carbomer Ultrez 21 and polyvinyl alcohol in the formulation, resulting in a modest alteration in the

brown tint of the formulation. After stability tests, the % radical scavenging value stays constant after one month of storage at 4 °C. A gel formulation that is both physically and chemically stable may be created by using Carbopol Ultrez 21 at 0.5% w/w and 5% w/w polyvinyl alcohol. *Areca* seed extract's potential in skincare products can be investigated further. In the future, more studies on the acute and long-term toxicity of this substance should be undertaken.

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