RESEARCH PAPER

Preparation and Evaluation of *Carya illinoensis* nut oil based serum for Anti-ageing

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ABSTRACT

The current work leverages the strong antioxidant and bioactive profile of *Carya illinoinensis* (pecan) nut oil to formulate and assess a herbal anti-aging serum. In order to retain thermolabile components, pecan oil, which is rich in phenolic compounds and γ-tocopherol, was extracted by cold maceration using n-hexane. Aloe vera gel, coconut oil, vitamin E, and other excipients were used in the serum's biphasic emulsification formulation to improve skin hydration, antioxidant activity, and collagen synthesis. Physicochemical and stability criteria such as pH, viscosity, globule size, spreadability, homogeneity, and phase separation were assessed in five formulations (F1–F5). Every formulation had a smooth texture, consistent consistency, and no phase separation, all of which are desirable organoleptic qualities. The globule size (0.1–0.3 µm) showed good penetration potential, and the pH range (4.91–5.63) was consistent with skin physiology. The robustness of the formulation was validated by stability tests conducted at different temperatures and humidity levels. Optimized formulations showed stable rheological behavior, fast absorption, and adequate spreadability among the batches. According to the findings, pecan oil-based serum that is enhanced with natural antioxidants and moisturizing agents has a great deal of potential as a safe and efficient anti-aging cosmeceutical that can reduce oxidative stress and encourage skin renewal.

Keywords: Anti-ageing; *Carya illinoinensis*; Serum; Antioxidant; Cosmeceutical

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1. INTRODUCTION

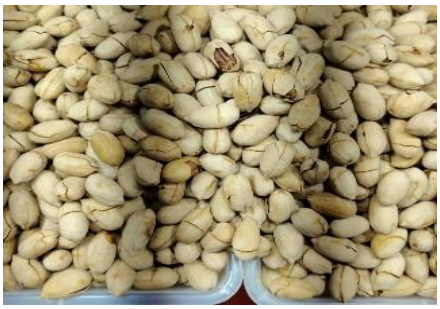
Beauty is the top priority for this age. The primary source of cosmetics is skin care preparations. Cosmetics are made of intricate chemical mixes that can be created on purpose or organically (Wikimedia Foundation, 2022). Herbal cosmetics are products that contain phytochemicals from different botanical sources that influence skin functions and offer nutrients for healthy skin. Ayurvedic science employed a range of plants to create visually beautiful and weather-resistant cosmetics (Kumar et al., 2012). Because they are safe to use, appropriate for all skin types, and have few or no adverse effects, natural cosmetics are favored over chemically produced ones. Ayurvedic cosmeceuticals are quite reliable due to their safe, all-encompassing benefits and pure herbal extracts. Urjaskara and Vyadhihara are considered significant Ayurvedic elements that help elevate and treat physical appearance and beauty. According to the vast and well-established knowledge of Ayurveda, maintaining beauty and complexion requires balancing tridoshic components, such as Vata, Pitta, and Kapha, and dhatus, such as Rasa, Rakta, and Mamsa (Gupta et al., 2018). Numerous internal and external factors can affect skin. The aging process of the skin, which causes wrinkles, is one of them. Human skin is harmed by prolonged exposure to ultraviolet (UV) radiation, and wrinkles are associated with a lack of collagen due to UV-produced reactive oxygen species (ROS), which ultimately leads to anti-aging therapy (Shamsuddin et al., 2018). Both the fundamental causes of aging and age-related disorders are the focus of this therapy. The objective is to increase the healthy lifetime of people who exhibit youthful traits (Arora, 2008).

Anti-aging treatments encourage skin regeneration and collagen synthesis (Yora,n.d.;Budiasih et al., n.d.). Serums are cosmetic products that have very high concentrations of active ingredients in their compositions. Antioxidant serums help neutralize reactive oxygen species by reducing oxidative damage to cells and tissues (Addor, 2017). Anti-aging serums can help prevent or minimize the appearance of wrinkles and fine lines, claims Lindberg (2020).

A profile of phytochemicals with well-established anti-inflammatory and antioxidant qualities may be found in pecan nuts (*Carya illinoinensis*), indicating their potential significance in skin antiaging applications (Bom et al., 2017; LondoñoLondoño et al., 2009; Shah et al., 2021). Pecans are especially high in γtocopherol, a lipid-soluble vitamin E isoform that shields dermal lipids and cell membranes from oxidation. It has been demonstrated that eating pecans increases plasma γ tocopherol and lowers oxidized LDL, indicating systemic attenuation of oxidative stress (Haddad et al., 2011; Georgia Pecan Commission, 2015; Kern et al., 2025). A variety of phenolic compounds with potent free radical scavenging and metal chelating properties, such as ellagic acid, gallic acid, protocatechuic acid, p-hydroxybenzoic acid, catechin, and condensed tannins, are also found in the kernels and shells (Li et al., 2011; Londoño Londoño et al., 2009; Shah et al.,2021; Villarreal Lozoya, 2014).With evidence of anti-inflammatory effects and modulation of matrix-remodeling enzymes, pecan shell-derived polyphenol-rich fractions also exhibit high total phenolic content and antioxidant capacity, indicating suitability for topical formulations targeting oxidative and photoinduced skin aging (Bom et al., 2017; Shah et al., 2021; Kern et al., 2025; Li et al., 2011). Therefore, pecan's inclusion as a source of bioactive principles for cutaneous antiaging techniques in the current study is justified by its known existence of γ tocopherol and other phenolic antioxidants.

Aloe Vera gel slows down the aging process of the skin by encouraging the production of collagen and elastin. The gel revitalizes the skin, moisturizes it, and removes dead skin cells. This plant's antioxidant qualities can stop some signs of aging, such as scratches and scars. (M. Umadevi1, R. Rajeswari, et al., 2012). Collagen production is improved by vitamin C's stimulation of lipid peroxidation. It has strong antioxidant properties. (Saokar Telang Pumori et al., 2013). By offering emollience, antioxidant protection, and support for collagen construction, coconut oil functions as a multipurpose anti-aging excipient in serums, enhancing skin elasticity and minimizing fine wrinkles (Pham et al., 2022; Ninh et al., 2025)

1.(a)



(b)

Figure No-1:
(a) Showing Pecan nut without Shell
(b) Showing Pecan nut with Shell

2. METHODOLOGY

The 'Maharaja' kind of mature pecan nuts (*Carya illinoinensis* Wangenh. K. Koch) were purchased from local marketplaces in Jammu & Kashmir, India. Analytical-grade n-hexane, cetosteryl alcohol, PEG 600, Tween 80, potassium sorbate, and L-ascorbic acid were taken. Equipment includes an analytical balance (Shimadzu, ±0.1 mg), a rotary evaporator (Ace Scientific & Glassware), a grinder (Moulinex, France), and a vacuum filtering apparatus (Buchner funnel, Whatman No.1 filter paper).

2.1 Pre-treatment of Pecan Kernels

After manually separating 500 g of pecan nuts, the kernels were oven-dried at 40°C for hours to a moisture level of 4–5% (as determined by AACC 44 -15.01). In order to enhance solvent penetration and extraction efficiency by increasing surface area, dried kernels were crushed into a 40- mesh particle size (average 0.425 mm) using a laboratory grinder (do Prado et al., 2014).

Table No. 1: Formulation Table of different Samples

Sr. No.	Ingredients	Description	F1	F2	F3	F4	F5
1	Pecan nut Extract	API	3 ml	3ml	3ml	2ml	2 ml
2	Cestosteryl Alcohol	Stabilizer	1gr	1gr	1gr	1gr	1gr
3	Aleo vera Gel	Moisturizer	0.5 ml	0.5 ml	0.5 ml	1ml	1 ml
4	PEG 600	Binder	1ml	0.5 ml	0.5ml	1ml	1ml
5	Vitamin E	Anti-oxidant	1ml	1ml	1ml	1ml	1ml
6	Tween 80	Solubilizer	2ml	1ml	1.5ml	2 ml	2.5ml
7	Potassium Sorbate	Preservative	0.25 gm	0.2 gm	0.25 gm	0.25 gm	0.25 gm
8	Coconut oil	Anti-microbial	1 ml	1 ml	1 ml	1ml	1 ml
9	Distilled water	Solute	50 ml	50ml	50 ml	50 ml	50 ml
10	Glycerin	Viscosity enhancer	1ml	1ml	1 ml	1ml	1 ml
11	L- Ascorbic Acid	pH Adjuster	Q.S	Q.S	Q.S	Q.S	Q.S

2.(a)

2.(b)

Figure-2:
(a) Rotary Evaporator used for separating n-Hexane and Pecan nut oil (b) Showing Extracted Pecan oil

2.2 Cold Maceration Extraction

To encourage the diffusion of lipids and bioactives, 50.0 ± 0.1 g of powdered pecan kernels were weighed into a 500 mL Erlenmeyer flask and soaked in 250 mL of n-hexane (solvent-to-solid ratio 5:1 v/w) at room temperature (28 ± 2°C) for 72 hours while being stirred twice a day. By minimizing thermal degradation, this cold maceration technique preserves thermolabile substances such tocopherols (Azevedo et al., 2014). Whatman No. 1 filter paper and a Buchner funnel were used to filter the mixture under vacuum. After reprocessing the marc (residue) twice (150 mL n-hexane each, 24 hours), all filtrates were mixed (a total of about 500mL). In order to fully remove the solvent, the combined filtrate was concentrated using a rotary evaporator (Heidolph Hei-VAP) at 61°C (below the n-hexane boiling point of 68.7°C) at reduced pressure (150 mbar). By proceeding to evaporate at 40°C for 30 minutes, residual solvent traces were reduced. Crude oil was filtered, dried over anhydrous sodium sulfate (5 g, 30 min), and kept in amber glass bottles at 4°C under a N_2 environment.

2.3 Aloe Vera gel extraction

The aloe vera plant was used to extract the transparent gel. The two phases of the formulation were the aqueous phase and the oil phase. After mixing the oil phase for 15 minutes at 1000 rpm in a beaker, the emulsifying agent (Tween 80) was applied. The oil phase was then continuously stirred while the aqueous phase was gradually introduced. After that, both phases were thoroughly homogenized at the same rpm for more than 20 minutes.

To formulate a serum formulation, Aloe Vera leaf extract and coconut oil were then added to the mixture and homogenized for 15 minutes at the same speed (Nawarathne et al., 2019).

Figure-3: Showing sample of formulations containing Pecan Nut oil based Serum

3. EVALUATION PARAMETER

3.1 Rheological Parameters: As emulsions are non-Newtonian systems, the viscosity of the formulation was measured at 100 revolutions per minute using a multipoint viscometer (Brookfield Viscometer). Before the readings were taken, the spindle was immersed in a beaker containing a small amount of the serum for roughly five minutes.

3.2 Texture and appearance: Visual inspection of the compositions' color and look showed that they were pale green in colour. A visual examination of the homogeneity of both formulations revealed a uniform distribution and no particle residue.

3.3 Formulation pH: Distilled water was used to dilute the formulations, and the pH was measured using a Ph meter. It was determined to be 6.84 for F1 and 6.54 for F2, which is within the appropriate pH range for skin, which is approximately 4.1 to 6.7

3.4 Determining globule size: A drop of formulation was diluted with distilled water and examined under a microscope; the size was discovered to be between 0.1 and 0.3 μm. The permeating power of the formulation is improved by this spectrum of formulations.

3.5 Ash Value: To determine the ash value, both formulations were weighed in a crucible and heated to 600°C in a muffle furnace.

3.6 Phase Separation: After two to four hours, the formulation was tested for phase separation while kept in a sealed container at room temperature and out of the light. Phase separation was absent, indicating that the test was successfully completed.

3.7 Spreadability: The filter paper's total area was measured (A1). A syringe was used to dispense out precisely twenty droplets of the formulation. The saturated portion was carefully cut off after the formulation spread in a circular pattern. The constructed circle's diameter was measured (A2) % spread = (A2/A1) 100.

3.8 Stability: The samples were held at 3–5 °C, 25°C RH=60%, and 45°C RH=75% before being examined.

4. RESULT AND DISCUSSION

The evaluation of the five serum formulations revealed that all samples exhibited consistent physical attributes suitable for dermal application. Each formulation demonstrated a "white milky" appearance and a "smooth & glossy" texture, confirming the success of the blending process. The formulations of F3 and F4 maintained a favorable pH range, which is essential for compatibility with human skin. Homogeneity tests confirmed that all batches had a uniform texture without lumps, and stability testing showed no signs of phase separation or odor changes after 72 hours, indicating robust shelf-life potential. Furthermore, microscopic analysis revealed globule sizes between 0.1 and 0.3 μm, a range known to enhance the permeating power of topical formulations. Collectively, these results suggest that the *Carya illinoinensis* nut oil-based serums are physically stable and possess the necessary rheological properties for effective skin absorption.

Table -2: Showing Evaluation data of Samples

Sr.No.	Parameter	F1	F2	F3	F4	F5
1	Appearance	White Milky	White Milky	White Milky	White Milky	White Milky
2	Texture	Smooth & Glossy	Smooth & Glossy	Smooth & Glossy	Smooth & Glossy	Smooth & Glossy
3	Viscosity (Spindle No. 62)	600cP	650cP	290cP	300 cP	700cP
4	pH	5.52	5.63	5.15	5.38	4.91
5	Ash Value (% w/w)	1.03	1.23	0.85	1.46	1.54
6	Spreadability	5.2	5.4	5.7	5.7	6.1
7	Homogeneity	Uniform Texture (No Lumps Found)	Uniform Texture (No Lumps Found)	Uniform Texture (No Lumps Found)	Uniform Texture (No Lumps Found)	Uniform Texture (No Lumps Found)
8	Phase Separation	No	No	No	No	No
9	Odour stability (Change in Odour after 72 hrs)	No	No	No	No	No
10	Drying time (secs)	18	17	19	20	21
11	Deep absorption (mins/secs)	1min 07sec	1min 45 sec	1 min 16 sec	1 min 14 sec	1 min 25 sec

5. CONCLUSION

The development of *Carya illinoinensis* nut oil-based serum successfully demonstrates the feasibility of utilizing plant-derived ingredients for high-performance topical anti-aging therapeutics. By achieving an optimal balance of physicochemical properties—including a skin-compatible pH range, stable homogeneity, and efficient absorption kinetics—the study confirms that these formulations are well-suited for commercial or clinical development especially in the F3 and F4 formulations. The absence of phase separation and the retention of physical integrity across all formulations (F1–F5) suggest that the chosen emulsification strategy is both robust and stable. Ultimately, this research provides a strong foundation for incorporating pecan-derived bioactives into sustainable, natural skincare, offering a compelling alternative to synthetic anti-aging agents.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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