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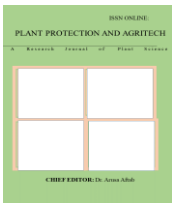

Research Article

Investigation of Natural Antioxidants and Bioactive Compounds in Medicinal Plant Extracts Using In Vitro Approaches for Health Applications

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Abstract

Skin is the protective outer covering that acts as insulator between internal and external environment. Skin diseases are the major problem nowadays. Mostly skin problems are raised due to the oxidative stress. Synthetic compounds and drugs are available in the market but they contain toxic compounds that are carcinogenic and leads to the cancer. Herbal and natural products are preferred as they contain natural antioxidants. In the present study extracts of different solvents at various concentrations of five plants *Aloe barbadensis*, *Camellia sinensis*, *Cocos nucifera*, *Ficus carica* and *Rosa indica* are selected for experiment to evaluate their antioxidant potential by DPPH, TPC and Total Antioxidant Assay. Among all the plant extracts 100% v/v Petroleum ether extract of *Aloe barbadensis* showed the highest radical scavenging value i.e. 98.6 ± 0.55^{d}. After the screening of all the extracts by the DPPH, TPC and Total Antioxidant Assay the combination of five plants is concluded. These plant extracts can be used in cosmetics and other industry as the source of natural antioxidants.

Keywords: Oxidative stress; Antioxidant; 2, 2-diphenyl-1-picrylhydrazl (DPPH); Total Phenolic Content (TPC)

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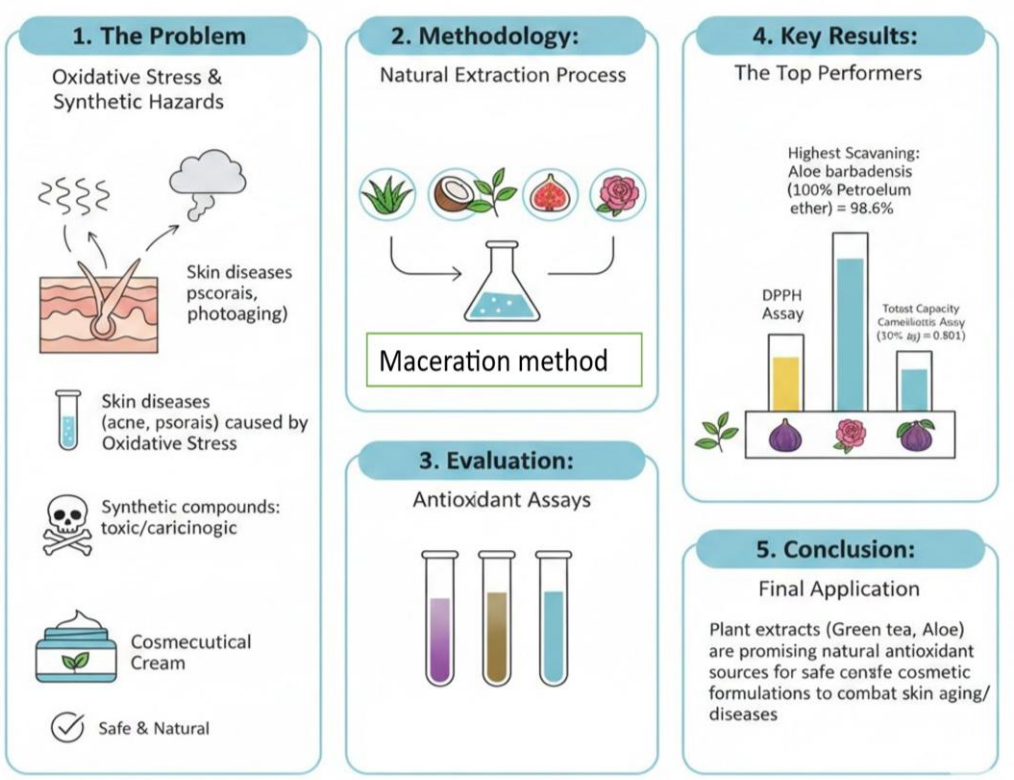
Graphical Abstract



1. Introduction

Skin is a multifunctional organ comprising about one-sixth of the body weight. It is the outermost layer and integument of the body and acts as barrier between the internal and external environment (Kimothi, 2025). Skin is protective in nature and provides defense against serious injuries caused by microbial and chemical agents (Chanda and Baravalia, 2010). Skin diseases are more common now a days and cause major impact on the quality life of people. More than 60% of the general population, almost all age groups, is now suffering from different skin diseases (Faraz *et al*., 2024;Joel *et al.*, 2013). The most common and general skin problem faced by dermatologists and physicians nowadays are acne, atopic dermatitis and psorisasis (Barankin and Dekoven, 2002). Some other skin problems like photosensitivity, itching, allergies, eczema, Tinea infections, skin eruptions, pigmentation, folliculitis pigmentary disorders like vitiligo and other disorders include keloid and xerosis are also in literature (Pai *et al*., 2024) .

A large number of skin problems are raised due to the oxidative stress. The disorders of oxidative stress are psoriasis, polymyositis, atopic dermatitis, eczema, mycosis fungoides, acne, lupus, scleroderma, sebborrheic, vasculitis, pemhigod and most important photoageing (aging) (Chanda and Baravalia, 2010). Uncontrolled release of the reactive oxygen species (ROS) due to the skin exposure to the ultraviolet radiations also causes human skin disorders including cutaneous neoplasia (Bickers and Athar, 2006). Most common inflammatory and chronic disease caused due to oxidation is

psoriasis that affects about 2% of the population by showing symptoms like itching, thickening and scaling of skin. (Priya *et al.*, 2013). Synthetic drugs and cosmetic creams are extensively applied in the world to care of the skin and treatment of infections but most of the formulations are composed of chemical components that are health hazards. The European Union (EU) has set tough regulatory boundaries to keep consumers safe whereby they allow not more than 0.4% of a single paraben and 0.8% of mixtures of parabens and have completely banned a number of long-chain parabens, limited the application of hydroquinone to 0.02% in professional nail products, and corticosteroids in cosmetics are highly prohibited because of serious systemic effects (European Commission Regulation No. 1223/2009; Commission Regulation EU 2014/3 New restrictions on endocrine-disrupting chemicals like triclosan, triclocarban, kojic acid and derivatives of vitamin A, were further restricted under Commission Regulation (EU) 2024/996. Regardless of these safety requirements, there are still adverse effects as an extended and cumulative exposure, multiple and simultaneous product use, and individual genetic predisposition may result in a systemic absorption and toxicity even within the allowed levels. Research has found parabens in almost all human urine samples, exhibited cytotoxic and protumor genic actions in cell models, and identified differences in chemical burden among different groups of individuals, which has been the source of ongoing health concerns despite regulatory adherence (Mohamed Rafi *et al*., 2024; Tapia *et al*., 2023; Lee *et al*., 2025; Crinnion, 2010). They also contain comdogenic ingredient isopropyl myristate that increases the formation of blackheads (Razi *et al*., 2024).

Most of the creams for fairness that are sold in the market contain certain chemicals like steroids and hydroquinone, and long-term use of these creams leads to the lethal health issues like permanent pigmentation, skin cancer and skin burning. To prevent side effects of synthetic drugs plant-based products are the best option to tackle skin problems (Rahaman *et al*., 2023). Plants are the major source of natural antioxidants and thus are helpful in the treatment of the skin diseases that are caused due to the oxidative stress (Chanda and Baravalia, 2010). Natural antioxidants are used for the prevention of photo aging and contact dermatitis (Chanda and Baravalia, 2010). The extract of *Andrographis paniculata*, *Glycyrrhiza glabra*, *Ocimum sanctum*, *Azadirachta indica* possess the ability to treat and prevent acne (Tabassum and Hamdani, 2014; Pradhan *et al*., 2023). Acne can also be cured with other plants like *Calendula*, *Lavender*, *Citrus* etc. *Amaranthus* is used to treat various skin problems like acne, psoriasis and eczema (Bairagi *et al*., 2022). These plants contain the active compounds like saponins, flavonoids, phenolics, terpenoids, tannins, linalool, linaloyl acetate, polysaccharides, anthocyanins that contribute to the antioxidant effect and in the treatment of skin problems due to the oxidative stress (Kumar *et al*., 2005). The present study is planned to evaluate the natural antioxidants from the plants to cure skin diseases caused by oxidative stress and make the suitable combination of medicinally important plants in order to avoid the harmful aspects of synthetic chemicals. The present study aims to explore and compare the antioxidant potential of selected medicinal plants—rose, aloe vera, green tea, fig, and coconut to determine the optimal solvent extraction approach that maximizes bioactive yield for incorporation into efficacious medicated creams. Unlike previous studies that mainly focus on isolated plant extracts, the novelty of this research lies in the comparative analysis of multiple medicinal plants and solvent systems to identify the most suitable antioxidant-rich extracts for topical medicinal applications.

2. Materials and Methods

2.1. Plant Material Collection

Plant species *Aloe barbadensis* Mill., *Camellia sinensis* (L.) Kuntze, *Cocos nucifera* L., *Ficus carica* L., and *Rosa indica* L. were obtained from local herbalists (Akbari mandi of Lahore) and the Punjab Seed Corporation, Lahore.

2.2. Experimental Design

The study was conducted under a split-block arrangement in a Randomized Complete Block Design (RCBD) to evaluate the effect of different extraction solvents on antioxidant attributes. The concentrations were prepared using a volume-to-volume (v/v) ratio for each of the four solvents —Petroleum ether, Chloroform, Methanol, and Distilled water.

- Petroleum ether (30%, 50%, 70%, and 100%)
- Chloroform (30%, 50%, 70%, and 100%)
- Methanol (30%, 50%, 70%, and 100%)
- Distilled water (30%, 50%, 70%, and 100%)

2.3. Extraction & Phytochemical Analysis

2.3.1 Maceration method

The powdered *Aloe barbadensis* Mill., *Camellia sinensis* (L.) Kuntze, *Cocos nucifera* L., *Ficus carica* L., and *Rosa indica* L. was extracted using the maceration method (Tourabi *et al*., 2025).1 gram of powdered sample was mixed with 20 mL of each solvent (Petroleum ether, Chloroform, Methanol, Distilled water). The prepared mixtures were left to stand for 72 hours at room temperature in dark and shaken continuously. After 72 hours, each mixture was filtered using Whatman No. 1 filter paper. The filtrates were then evaporated using a rotary evaporator at 250–280 rpm, then used to evaluate their biological activity, and stored at 4˚C.

2.4. Antioxidant evaluation

For antioxidant evaluation of the plant extracts, DPPH assay and Total antioxidant assay, Total phenolic content determination assays were performed.

2.4.1. Radical Scavenging Activity by DPPH Assay

The DPPH assay of prepared plants extract was performed by following the methodology (Maqbool *et al*., 2025). with slight modifications. The preparation of extract solutions was done by dissolving 0.5mg/ml of each extract in the respective extraction solvent that is Dimethyl Sulphoxide (DMSO). 100µL of 0.2mg/ml DPPH in DMSO was mixed with the 100µL of test sample kept in dark for 30min and measured absorbance at 517 nm. The antioxidant activity was expressed as % age of scavenging activity (SC%) on DPPH radical as

SC% [1-(absorbance of sample) / (absorbance of control) x100.

The control contained all reagents except the plant extract. BHT (Butyl Hydroxytoluene) and Alpha Tocopherol used as standard.

2.4.2 Total Antioxidant Capacity Determination

The total antioxidant capacity of all the extracts was determined by following the methodolgy of (Saeed *et al*., 2025). 0.1ml of each solution (0.5mg/ml) was mixed with 1.9ml of reagent solution (0.6M sulphuric acid, 4Mm ammonium molybdate and 28Mm sodium phosphate). The incubation of reaction mixture was done at 95C for 60 minutes and then cooled it at room temperature. The antioxidant activity was expressed as the sample absorption at 695nm.

2.4.3. Total Phenolic Content Determination

The total phenolics of all the plant specimens were determined by following

the methodology of (Imb *et al*., 2024, Saleem *et al*., 2025). 0.1 ml of each of the plant extract (0.5mg/ml) was mixed with 2.8ml of 10% Na_2CO_3, and 0.1ml of 2N Folin-Ciocalteu reagent was also added to it. The absorbance of the reaction mixture was measured at 725nm by UV visible spectrophotometer. Total number of phenols were found out as micrograms of Gallic acid equivalents (GAE) per gram of the sample extract and a comparison was made with standard calibration curve that was prepared for different Gallic acid concentrations.

2.5. Statistical Analysis

For Statistical analysis Co-Stat software was used. It was evaluated by calculating Standard deviation (SD) was calculated. Mean separation was done by using least significance difference (LSD) with $p < 0.05$ level. The analysis was done using Duncan's Multiple Range Test (DMRT). (Bliss.,167).

3. Results

3.1. Radical scavenging activity by DPPH Assay

Across all five medicinal plants (*Aloe barbadensis, Camellia sinensis, Cocos nucifera, Ficus carica,* and *Rosa indica*), antioxidant responses varied significantly with solvent type and extract concentration (30–100% v/v), demonstrating strong solvent-polarity and concentration-dependent effects. The radical scavenging activity of the plant extracts was compared with standard antioxidants α-tocopherol.

In *Aloe barbadensis*, the highest scavenging activity was observed in the 100% v/v petroleum ether extract (98.6 ± 0.55^{d}%), which was statistically superior to most other treatments as shown in Fig 1. High scavenging values were also recorded for 70% v/v methanol (98.5 ± 0.97^{d}%), 30% v/v distilled water (98.5 ± 0.78^{b}%), and 100% v/v distilled water (98.3 ± 0.61^{a}%), all of which exceeded the standard α-tocopherol (78.3 ± 0.61^{a}%). In contrast, the 70% v/v chloroform extract showed the lowest activity (44.4 ± 1.21^{b}%), indicating poor radical scavenging efficiency of this solvent fraction.

In *Camellia sinensis*, the 100% v/v chloroform extract exhibited the maximum scavenging activity (98.3 ± 0.75^{a}%), followed closely by 50% v/v methanol (96.0 ± 0.62^{g}%) and 100% v/v distilled water (91.0 ± 1.20^{a}%). A sharp decline in activity was observed in the 100% v/v methanol extract (11.9 ± 0.89^{e}%), representing the lowest scavenging response among all green tea extracts. Overall, intermediate concentrations and non-polar solvents produced stronger antioxidant effects.

For *Cocos nucifera*, the 70% v/v methanol extract showed the highest scavenging activity (94.8 ± 1.20^{e}%), whereas the 100% v/v methanol extract exhibited the minimum activity (34.2 ± 0.71^{d}%). All remaining solvent–concentration combinations produced intermediate values, indicating that moderate polarity and concentration favored free radical scavenging in coconut extracts.

In *Ficus carica*, maximum scavenging was recorded in the 30% v/v petroleum ether extract (94.5 ± 0.95^{d}%), while the 50% and 100% v/v methanol extracts showed the lowest activity (48.3 ± 1.03^{c}% and 48.3 ± 1.05^{b}%, respectively). Distilled water extracts displayed moderate scavenging efficiency across concentrations.

In *Rosa indica*, the 30% v/v petroleum ether extract exhibited the highest scavenging activity (98.5 ± 1.00^{f}%), followed by 100% v/v petroleum ether (98.2 ± 0.68^{d}%) and 100% v/v distilled water (91.9 ± 0.88^{a}%). The 100% v/v chloroform extract showed the lowest activity (36.8 ± 0.95^{a}%). Overall,

petroleum ether extracts consistently demonstrated superior scavenging ability in this species.

3.2. Total Phenolic Content (TPC)

The total phenolic content (TPC) of all plant extracts showed statistically significant differences among solvents and concentrations (30–100% v/v), as indicated by different superscript letters (DMRT, $p < 0.05$).

In *Aloe barbadensis*, petroleum ether extracts showed a significant concentration-dependent increase in phenolic content, with values of 210.4 ± 5.2^{a} µg GAE/g (30%), 356.8 ± 6.1^{b} µg GAE/g (50%), 482.3 ± 7.4^{c} µg GAE/g (70%), and reaching the maximum at 637.7 ± 6.3^{d} µg GAE/g (100%) as demonstrates in Fig 2. Methanolic extracts exhibited moderate phenolic content, increasing from 198.6 ± 4.9^{a} µg GAE/g (30%) to 412.5 ± 6.8^{c} µg GAE/g (100%). Distilled water extracts showed intermediate values (240.3 ± 5.6^{b} to 365.2 ± 6.4^{c} µg GAE/g), whereas chloroform extracts consistently recorded the lowest phenolic content, with a minimum of 22 ± 1^{a} µg GAE/g at 100% v/v.

In *Camellia sinensis*, petroleum ether extracts exhibited exceptionally high phenolic content across all concentrations, increasing significantly from 612.3 ± 5.7^{c} µg GAE/g (30%) to 843.3 ± 4.2^{e} µg GAE/g (100%), which was the highest value recorded among all plants. Methanolic extracts showed significantly lower phenolic levels, with 98.4 ± 6.1^{d} µg GAE/g (30%), 76.3 ± 5.4^{c} µg GAE/g (50%), reaching a minimum at 70% (43.0 ± 10.8^{e} µg GAE/g), followed by a slight increase at 100% (65.2 ± 4.9^{d} µg GAE/g). Distilled water extracts showed moderate phenolic content, while chloroform extracts remained consistently low.

For *Cocos nucifera*, methanolic extracts demonstrated a gradual increase in TPC from 178.6 ± 4.9^{b} µg GAE/g (30%) to 255.4 ± 5.8^{c} µg GAE/g (50%), peaking at 344.6 ± 6.3^{d} µg GAE/g (70%), followed by a decline at 100% v/v. Petroleum ether extracts showed minimal phenolic content across all concentrations (15–45 µg GAE/g), whereas distilled water extracts exhibited moderate values.

In *Ficus carica*, distilled water extracts recorded the highest phenolic content, increasing significantly from 245.6 ± 6.8^{a} µg GAE/g (30%) to 436.3 ± 12.7^{a} µg GAE/g (100%). Methanolic extracts showed moderate phenolic levels, while chloroform extracts consistently recorded the lowest TPC, with 25 ± 1^{b} µg GAE/g at 70% v/v.

In *Rosa indica*, the maximum phenolic content was observed in the 30% v/v chloroform extract (578.0 ± 6.3^{d} µg GAE/g), followed by a significant decrease at 50% (432.5 ± 5.4^{c} µg GAE/g), 70% (298.4 ± 4.8^{b} µg GAE/g), and 100% (255.2 ± 4.6^{a} µg GAE/g). Methanolic extracts showed a concentration-dependent increase, while distilled water extracts recorded the lowest phenolic content.

3.3 Total Antioxidant Activity

Total antioxidant activity measured by the phosphomolybdenum assay also varied significantly among solvents and concentrations, with distinct statistical groupings ($p < 0.05$) as represented in Table 1.

In *Aloe barbadensis*, petroleum ether extracts showed a progressive increase in antioxidant activity from 0.126 ± 0.002^{e} (30%) to 0.220 ± 0.001^{g} (50%), 0.222 ± 0.001^{f} (70%), and reaching the highest value at 0.240 ± 0.0005^{h} (100%). Methanolic extracts exhibited moderate antioxidant activity ranging from 0.036 ± 0.002^{e} to 0.166 ± 0.001^{h}, whereas chloroform and distilled water extracts recorded comparatively lower values.

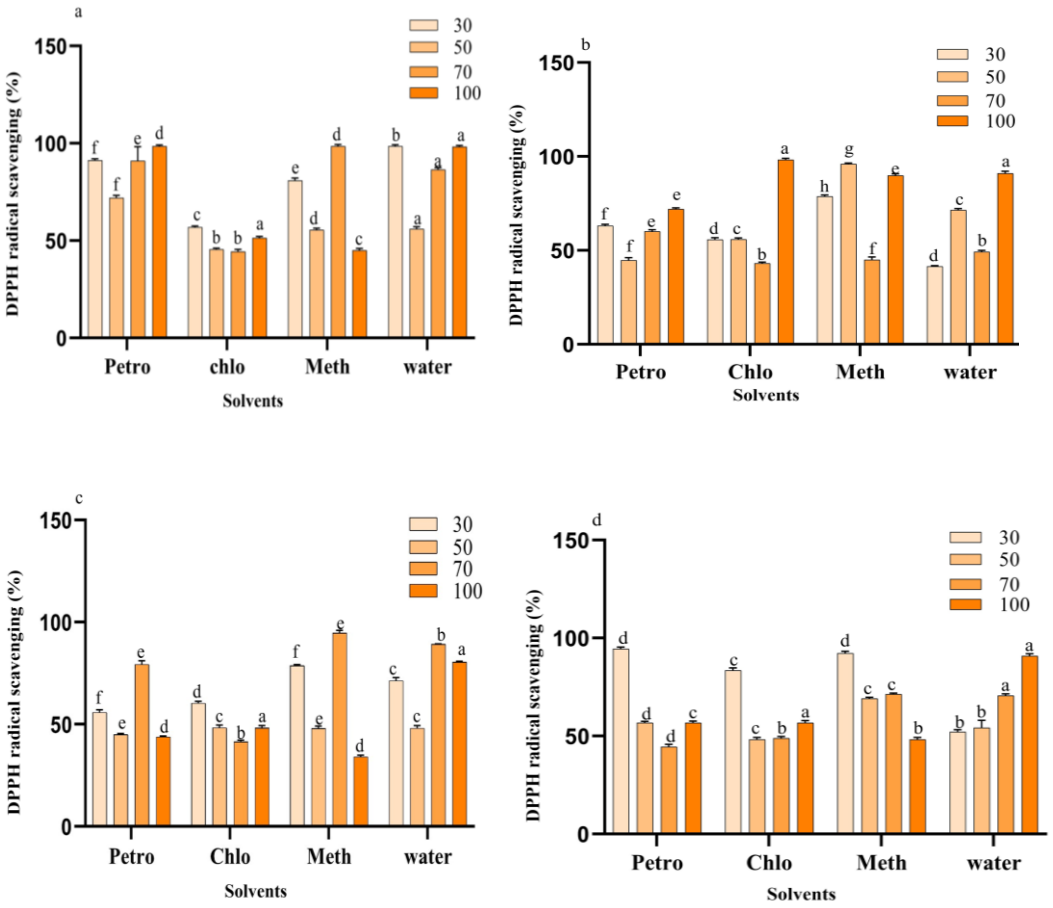
In *Camellia sinensis*, petroleum ether extracts exhibited the highest antioxidant activity among all plants, with 0.801 ± 0.001^{g} (30%), 0.740 ± 0.010^{g} (50%),

0.628 ± 0.002[f] (70%), followed by a marked reduction at 100% (0.070 ± 0.002[e]). Methanolic extracts showed high activity at 30% (0.729 ± 0.002[f]) and 50% (0.796 ± 0.002[g]) but declined sharply at higher concentrations.

In *Cocos nucifera*, petroleum ether extracts exhibited moderate antioxidant activity, peaking at 70% v/v (0.211 ± 0.002[e]), while chloroform extracts showed consistently low activity (0.030–0.147).

In *Ficus carica*, methanolic extracts showed a significant concentration-dependent increase in antioxidant activity, from 0.230 ± 0.010[g] (30%) to 0.465 ± 0.002[g] (50%), 0.304 ± 0.002[f] (70%), and reaching the maximum at 100% (0.520 ± 0.010[e]). Distilled water extracts recorded the lowest antioxidant values.

In *Rosa indica*, methanolic extracts exhibited a strong increase in antioxidant activity from 0.018 ± 0.010[g] (30%) to 0.493 ± 0.002[e] (100%), whereas petroleum ether extracts showed moderate values across concentrations.



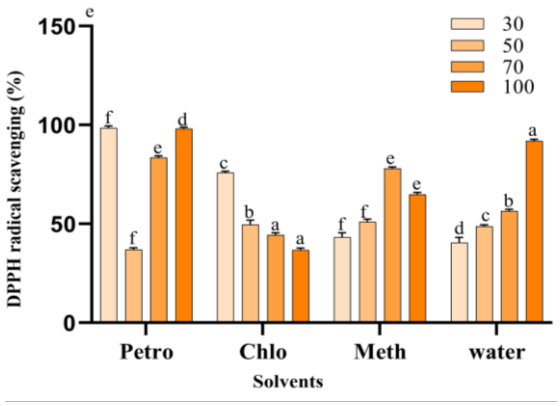
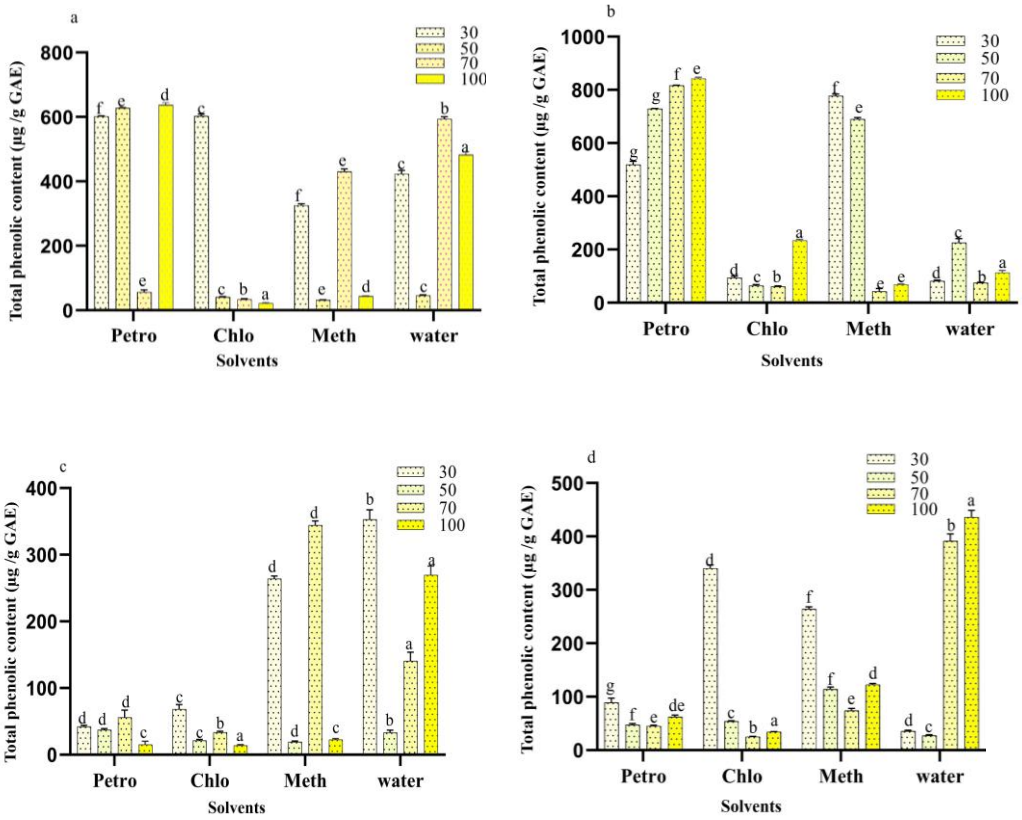


Figure 1: Antioxidant Evaluation of Various Extracts through DPPH Assay (a) *Aloe barbadensis (b) Camellia sinensis*, (c) *Cocos nucifera*, (d) *Ficus carica*, (e) *Rosa indica*. Key: Petro = petroleum ether, Chlo = chloroform, Meth = Methanol.



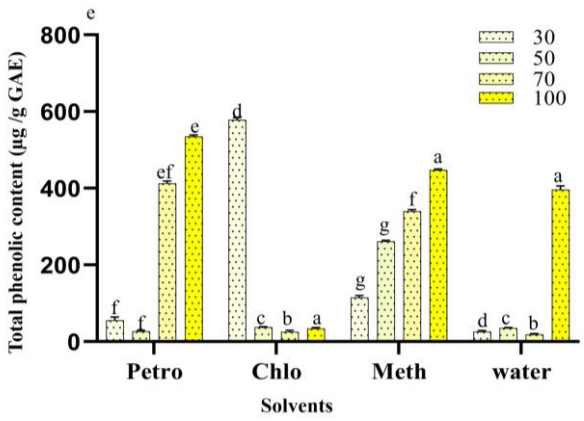


Figure. 2: Total phenolic content of Various Extracts through DPPH Assay (a) *Aloe barbadensis (b) Camellia sinensis*, (c) *Cocos nucifera*, (d) *Ficus carica*, (e) *Rosa indica*. Key: Petro = petroleum ether, Chlo = chloroform, Meth = Methanol.

Table 1: Total antioxidant assay of Various Extracts of *Aloe barbadensis, Camellia sinensis, Cocos nucifera, Ficus carica, Rosa indica*.

Solvent	*Aloe barbadensis*	*Camellia sinensis*	*Cocos nucifera*	*Ficus carica*	*Rosa indica*
Petroleum ether					
30%	0.126±0.002 e	0.801±0.001 g	0.05±0.0015 f	0.116±0.002 f	0.201±0.001 5^{h}
50%	0.22±0.001^{g}	0.74±0.01^{g}	0.046±0.001 5^{f}	0.044±0.001 e	0.031±0.001 5^{g}
70%	0.222±0.001 f	0.628±0.002 f	0.211±0.002 e	0.037±0.001 5^{d}	0.264±0.001 f
100%	0.24±0.0005 h	0.07±0.002^{e}	0.057±0.001 d	0.041±0.001 5^{d}	0.092±0.001 e
chloroform					
30%	0.092±0.002 d	0.042±0.002 d	0.147±0.002 cd	0.103±0.002 d	0.072±0.001 d
50%	0.012±0.001 c	0.058±0.001 c	0.052±0.001 5^{c}	0.048±0.001 c	0.054±0.001 5^{c}
70%	0.033±0.001 b	0.046±0.001 b	0.03±0.0015 b	0.042±0.002 b	0.062±0.001 5^{b}
100%	0.024±0.001 5^{a}	0.082±0.002 a	0.031±0.001 5^{a}	0.029±0.001 a	0.048±0.001 a
Methanol					
30%	0.166±0.001 h	0.729±0.001 g	0.141±0.002 h	0.23±0.01^{g}	0.018±0.01^{g}
50%	0.012±0.002 g	0.796±0.002 f	0.043±0.001 g	0.465±0.002 g	0.234±0.000 8^{g}
70%	0.112±0.001 f	0.045±0.001 5^{e}	0.091±0.002 f	0.304±0.002 f	0.332±0.001 5^{f}
100%	0.036±0.002 e	0.053±0.002 e	0.052±0.002 a	0.52±0.01^{e}	0.493±0.002 e
water					
30%	0.044±0.001 d	0.03±0.001^{d}	0.062±0.002 d	0.035±0.001 d	0.042±0.001 5^{d}

50%	0.028±0.0015[c]	0.155±0.02[c]	0.031±0.0015[c]	0.027±0.001[c]	0.04±0.0015[c]
70%	0.078±0.001[b]	0.055±0.0005[b]	0.108±0.002[b]	0.053±0.003[b]	0.052±0.001[b]
100%	0.059±0.0015[a]	0.24±0.0015[a]	0.134±0.002[a]	0.082±0.0015[a]	0.152±0.001[a]

Superscript letters indicate statistically significant differences only within the same plant species and assay

4. Discussion

Antioxidants are helpful as they protect living organisms from the damage caused by reactive oxygen species. Many skin, inflammatory and chronic diseases also arise due to the oxidative stress. Antioxidants are also helpful in increasing the shelf life of many food and cosmetic products (Petcu *et al*., 2023). Antioxidants also play an essential role in the process of aging (Tariq and Reyaz, 2013; Devi *et al*., 2021). This need of antioxidants can be fulfilled by the artificial synthetic antioxidants such as butylated hydroxytoulene (BHT), butylated hydroxyanisole (BHA) and tertiary butylhydroquinone (TBHQ) (Hu *et al.*, 2003). But these synthetic chemicals used by different industries contain toxic compounds and are carcinogenic. Thus, natural antioxidants are preferred in food and cosmetic industry as they do not have any side effect and are not toxic.

The DPPH Assay along with Ferric Thio Cyanate (FTC) and linoleic acid system method was performed on the ethanol extracts of *Aloe barbadensis* (Hu *et al*., 2003; Saeed *et al*., 2022). The current research work demonstrated that certain plant extracts exhibit exceptionally high antioxidant activities. In the present study the antioxidant activity of *A. barbadensis* in different solvents having range of polarity is evaluated and also compared with the standard antioxidants. 100% v/v petroleum ether, 70% v/v methanol, 30% and 100% v/v distilled water showed the highest scavenging (%) 98.6±0.55[d], 98.5±0.971[d], 98.5±0.77[b] and 98.3±0.608[a] respectively far exceeding the α-tocopherol standard (~78%). *Camellia sinensis* (green tea) extracts showed very high activity (up to ~98% DPPH inhibition). Green tea is rich in catechins (flavonoid phenolics) that confer strong antioxidant power. Indarti *et al*. (2019) reported that catechins in Camellia sinensis responsible for antioxidant properties of green tea. Hu *et al*., 2003 observed that *A. barbadensis* extracts exhibited highest or equivalent antioxidant activity as compared to BHT and α-tocopherol. Thus *A. barbadensis* can be used as natural antioxidant in food, medicine and cosmetics. The antioxidant capacity of methanolic and aqueous extracts of *Camellia sinensis* by DPPH, FRAP, FIC and Total Phenolic Assay was evaluated (Chan *et al*., 2007). Methanolic extracts showed highest antioxidant activity. The results include only polar fraction of the solvent. Examination of the scavenging ability of distilled water and 70% ethanol extracts with chloroform, ethylacetate and n-butanol of *Camellia sinensis* was evaluated by DPPH Assay (Yang *et al*., 2007). Ethanol extracts have showed higher contents of phenols. The results were more genuine as solvents having range of polarity are used to investigate the antioxidant potential In the current study range of solvents i.e. petroleum ether, chloroform, methanol and distilled water at various concentrations are used to evaluate the antioxidant capacity of *Camellia sinensis* by DPPH, TPC and Total Antioxidant Assay. 100% v/v Chloroform, 50% v/v Methanol and 100% Distilled water extracts showed the higher radical scavenging values i.e. 98.3±0.754a, 96.0±0.624[g] and 91.0±1.201[a] respectively. Maximum phenolic contents lie in the 100% Petroleum ether extract having the value of 843.3±4.2[e]. Free radical scavenging activities of aqueous extracts of *Cocos*

nucifera were evaluated by the in vitro experiments using the DPPH Assay along with HPLC technique (Alviano *et al*., 2004) This technique is beneficial to identify different phytochemicals. In the present study 70% v/v Methanol extract showed the highest antioxidant capacity (%) 94.8 ±1.201[e] among polar and non-polar extracts of *C. nucifera* by DPPH Assay. This radical scavenging value of *C. nucifera* is very near to the BHT and α-tocopherol, taken as standard. Leliana *et al*. (2022) reported that coconut fruits contain catechins and phenolic acids that can scavenge free radicals. In the present study various solvents having the wide range of polarity are used for extraction to explore the range of bio-constituents that are accountable for the antioxidant activity. Among all the extracts of *F. carica* in different solvents, 30% v/v Petroleum ether extract has the highest radical scavenging activity having the value of 94.5±0.950[d]. Ahmad *et al*. (2013) evaluated the antioxidant potential of methanolic extracts of *Ficus carica* by DPPH assay. Comparison of antioxidant potential of 30% v/v Petroleum ether extract with the standard antioxidants BHT and α-tocopherol shows that this extract can replace synthetic artificial antioxidants. *F. carica* can be used in the cosmetics, food and medicine as the natural antioxidant and is helpful in the protection from the skin and inflammatory diseases. Evaluation of the antioxidant activity of 80% ethanol extracts of *Azadirachta indica* has been done through DPPH and Total antioxidant Assay (Kiranmai *et al*., 2011). Root bark extract of *A. indica* possess strong antioxidant potential. The results were further affirmed by the Phospho-molybdenum Assay. In the current study ambit polarity solvents are used to investigate the bioavailability, responsible for the antioxidant capacity of *Rosa indica*. Overall, the total antioxidant capacity (TAC) results mirrored the DPPH trends: e.g. *C. sinensis* petroleum ether extract had the highest TAC (0.801), and *F. carica* methanol showed strong TAC (0.520). The total phenolic content (TPC) assay revealed that some extracts were particularly rich in phenolic compounds. Notably, 100% petroleum ether extracts of *C. sinensis* and *A. barbadensis* had the highest TPC (843 and 638 µg GAE/g, respectively), and *R. indica* 30% chloroform had 578 µg GAE/g. Zahid *et al*. (2018) demonstrated that Rosa indica is rich in phenolic compounds responsible for its highest radical scavenging activity upto 95%. Leliana *et al*. (2022) supports our finding reported that there is positive correlation r≈0.87 between TPC and DPPH activity. Current research work generally reflects this: extracts with very high phenolics (like *C. sinensis* and *R. indica* chloroform) showed highest antioxidant capacity. Crucially, these findings have implications for formulating antioxidant-rich medicated creams. Natural phenolic extracts from plants are widely used in dermatological products to combat oxidative skin damage and aging (Muthukumarasamy *et al*., 2016).

Conclusion

Present study revealed that highest DPPH radical-scavenging activity (~98%) was observed in petroleum ether extracts of *Camellia sinensis*, *Aloe barbadensis*, and *Rosa indica*, surpassing the standard α-tocopherol. The maximum total antioxidant capacity was observed in *C. sinensis* petroleum ether extract (TAC = 0.801), while the highest total phenolic content was exhibited in *C. sinensis* petroleum ether extract (843 µg GAE/g), followed by *A. barbadensis* (638 µg GAE/g). These findings highlight *C. sinensis*, *A. barbadensis*, and *R. indica* as particularly promising natural antioxidant with strong potential for incorporation into antioxidant-rich medicated or cosmetic cream formulations.

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Conceptualization, FU.; methodology, FU.; software, AS.; validation, AS. formal analysis, AS.; investigation, SI.;

data curation, SI and JR.; writing—original draft preparation, FU.; writing—review and editing, AS and SI.; visualization, JR.; All authors have read and agreed to the published version of the manuscript

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References

Ahmad, J., Khan, I., Khan, S., & Iqbal, D. (2013). Evaluation of antioxidant and antimicrobial activity of *Ficus carica* leaves: An in vitro approach. *Plant Pathology and Microbiology*, **4**(1), 1-5.

Alviano, D. S., Rodrigues, K. F., Leitão, S. G., Rodrigues, M. L., Matheus, M. E., Fernandes, P. D., & Alviano, C. S. (2004). Antinociceptive and free radical scavenging activities of *Cocos nucifera* L.(Palmae) husk fiber aqueous extract. *Journal of Ethnopharmacology*, **92**(2-3), 269-273.

Bairagi, S., Katare, V., Delouri, M. A., & Jain, M. P. K. (2022). Formulation and Evaluation of Anti-Acne Gel of *Calendula officinalis* (Leaves) for the Effective Treatment of Acne. *International Journal of Pharmaceutics and Drug Research*, **11**(2), 46-58.

Barankin, B., & DeKoven, J. (2002). Psychosomatic dermatology: Is there a role for dermatologist-delivered counseling? *Journal of Cutaneous Medicine and Surgery*, **6**(1), 27-31.

Bickers, D. R., & Athar, M. (2006). Oxidative stress in the pathogenesis of skin disease. *Journal of Investigative Dermatology*, **126**(12), 2565-2575.

Bliss, C. I. (1967). *Statistics in biology: Statistical methods for research in the natural sciences*. New York: McGraw-Hill.

Chan, E. W. C., Lim, Y. Y., & Chew, Y. L. (2007). Antioxidant activity of *Camellia sinensis* leaves and tea from a lowland plantation in Malaysia. *Food Chemistry*, **102**(4), 1214-1222.

Chanda, S., & Baravalia, Y. (2010). Screening of some plant extracts against skin diseases caused by oxidative stress and microorganisms. *African Journal of Biotechnology*, **9**(21), 3210-3217.

Crinnion, W. J. (2010). Toxic effects of the easily avoidable phthalates and parabens. *Alternative Medicine Review*, **15**(3), 190-196.

Devi, A., Dwibedi, V., & Khan, Z. A. (2021). Natural antioxidants in new age-related diseases. *Revista Brasileira de Farmacognosia*, **31**(4), 387-407.

European Commission. (2009). Regulation (EC) No 1223/2009 of the European Parliament and of the Council on cosmetic products. *Official Journal of the European Union*, **L342**, 59-209.

Faraz, K., Seely, M., & Marano, A. L. (2024). The role of the environment in allergic skin disease. *Current Allergy and Asthma Reports*, **24**(6), 323-330.

Hu, Y., Xu, J., & Hu, Q. (2003). Evaluation of antioxidant potential of *Aloe vera* (*Aloe barbadensis* Miller) extracts. *Journal of Agricultural and Food Chemistry*, **51**(26), 7788-7791.

Imb, M., Véghelyi, Z., Maurer, M., & Kühnel, H. (2024). Exploring senolytic and senomorphic properties of medicinal plants for anti-aging therapies. *International Journal of Molecular Sciences*, **25**(19), 10419.

Indarti, K., Apriani, E. F., Wibowo, A. E., & Simanjuntak, P. (2019). Antioxidant activity of ethanolic extract and various fractions from green tea (*Camellia sinensis* L.) leaves. *Pharmacognosy Journal*, **11**(4), 771-776.

Joel, J. J., Jose, N., & SSSC. (2013). Patterns of skin disease and prescribing trends in rural India. *Scholars Academic Journal of Pharmacy*, **2**(4), 304-309.

Kimothi, S. (2025). Skin health and anti-aging benefits of dry fruits: Hydration and collagen boosting. *Dry Fruits Wellness*, **1**(1), 12-18.

Kiranmai, M., Cb, M. K., & Ibrahim, M. (2011). Free radical scavenging activity of neem (*Azadirachta indica* A. Juss) root bark extract. *Asian Journal of Pharmaceutical and Clinical Research*, **4**(4), 134-136.

Kumar, S. M., Chandrasekar, M., Nanjan, M., & Suresh, B. (2005). Herbal remedies for acne. *Natural Product Radiance*, **4**(4), 328-334.

Lee, S. Y., Silva, P., & Segovia Mendoza, M. (2025). Toxic effects of parabens and their by products on human skin and endothelial cells. *Environmental Toxicology and Pharmacology*, **1**(1), 100011.

Leliana, L., Setyaningsih, W., Palma, M., Supriyadi, & Santoso, U. (2022). Antioxidant activity of aqueous and ethanolic extracts of coconut (*Cocos nucifera*) fruit by-products. *Agronomy*, **12**(5), 1102.

Maqbool, Z., Aftab, A., Rizwana, H., Yousaf, Z., & Rehman, S. (2025). Tomato disease combat and yield optimization using selenium nanoparticles: A sustainable nano-agriculture approach. *Food Science and Nutrition*, **13**(7), e70386.

Mohamed Rafi, S., et al. (2024). Understanding parabens: A literature review. *CosmoDerma*, **4**(33), 1-10.

Muthukumarasamy, R., Ilyana, A., Fithriyaani, N. A., Najihah, N. A., Asyiqin, N., & Sekar, M. (2016). Formulation and evaluation of natural antioxidant cream comprising methanolic peel extract of *Dimocarpus longan*. *International Journal of Pharmaceutical and Clinical Research*, **8**(9), 1305-1309.

Pai, S. B., & Anchan, V. N. (2024). Phototoxicity and photoallergy: Pathogenesis, recent advances, and clinical approach. *Indian Journal of Skin Allergy*, **3**(1), 28-35.

Pai, V. V., Kikkeri, N. M., & Shukla, P. (2024). Quality of life in patients with pigmentary disorders: A comprehensive review. *Journal of Cosmetic Dermatology*, **23**(1), 1-12.

Petcu, C. D., Tăpăloagă, D., Mihai, O. D., Gheorghe-Irimia, R. A., Negoiță, C., Georgescu, I. M., et al. (2023). Harnessing natural antioxidants for enhancing food shelf life. *Foods*, **12**(17), 3176.

Pradhan, P., Naquvi, K. J., & Kumar, N. (2025). Phytochemical analysis and antimicrobial antioxidant activities of polyherbal planterosomal gel. *Cuestiones de Fisioterapia*, **54**(2), 4765-4776.

Pradhan, S., Dash, S., & Patnaik, S. (2023). A review on the use of herbal medicinal plants for the treatment of acne vulgaris. *International Journal of Research and Review*, **10**(1), 450-462.

Priya, R., Kumar, U., Saran, A., Kumari, R., & Kishore, C. (2013). Oxidative stress in psoriasis. *Biomedical Research*, **25**(1), 132-134.

Priya, M. G. J., & Ravichandran, R. (2013). Prevalence of skin diseases in a rural population of South India. *Journal of Clinical and Diagnostic Research*, **7**(12), 2826.

Rahaman, M. M., Hossain, R., Herrera-Bravo, J., Islam, M. T., Atolani, O.,

Adeyemi, O. S., ... & Sharifi-Rad, J. (2023). Natural antioxidants from some fruits, seeds, foods, natural products, and associated health benefits: An update. *Food Science & Nutrition*, **11**(4), 1657-1670.

Rahaman, S., Islam, M. T., Atolani, O., Adeyemi, O. S., Herrera-Bravo, J., & others. (2023). Plant-based natural products: A leading source for skin disease treatment. *Phytomedicine Plus*, **3**(1), 100411.

Razi, S., Tan, I. J., Pathak, G. N., & Rao, B. (2024). Unraveling the mirage of fairness cream commercials in South Asia. *Journal of Cosmetic Dermatology*, **23**(5), 1713-1717.

Saeed, M. K., Zahra, N., Abidi, S. H. I., & Syed, Q. U. A. (2022). Phytochemical screening and DPPH free radical scavenging activity of *Aloe vera* powder. *International Journal of Food Science and Agriculture*, **6**(3), 341-346.

Saeed, R., Aftab, A., Maqbool, Z., Yousaf, Z., Khalid, A., & Aftab, Z. E. H. (2025). Impact of leaf growth stages on essential oil composition and bioactivity in lemongrass (*Cymbopogon citratus*). *Journal of Applied Botany and Food Quality*, **98**(1), 53-65.

Saleem, A., Aftab, A., Yousaf, Z., Maqbool, Z., & Ijaz, S. (2025). Pasteurization optimization and nano-enabled preservation of carrot juice: Quality and shelf-life assessment. *Applied Food Research*, **5**(1), 101642.

Tabassum, N., & Hamdani, M. (2014). Plants used to treat skin diseases. *Pharmacognosy Reviews*, **8**(15), 52-60.

Tapia, J. L., Bister, A., Cáceres, S., Valdés, M., & Rojas, E. (2023). Parabens promote protumorigenic effects in luminal breast cancer cell lines. *Journal of the Endocrine Society*, **7**(8), bvad080.