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RESEARCH ARTICLE

Determination of Sun Protective Factor of Selected Medicinal Plants from Western Nepal

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Abstract

Plant extracts contain active ingredients that can absorb, reflect or scatter the sunlight, depending on their nature. The effectiveness of plant extracts as a skin protective agent can be determined by measuring the sun protection factor (SPF). The main aim of this study was to investigate the potential of selected medicinal plant extracts as a component in sunscreen production in modern cosmetics. The absolute methanol extract of six medicinal plants namely; *Asparagus racemosus*, *Bergenia pacumbis*, *Melia azedarach*, *Murraya koenigii*, *Pleurospermum benthamii*, and *Thymus linearis* were examined *in-vitro* for their sun protective ability by ultraviolet-visible spectrophotometry method with the application of Mansur equation. Our results revealed that most of the plant extracts possess prodigious SPF values as compared with commercial sunscreen. The greatest SPF value was found in *P. benthamii* (34.97±0.25), *T. linearis* (24.98±0.60), and *B. pacumbis* (24.02±0.15). These results show that these plant extracts can act as a very good antisolar agent.

Keywords: Medicinal plant extracts, sun protective factor, degradation

Introduction

Acute and chronic exposure of human skin to ultraviolet (UV) radiation can causes skin damages, oxidative stress, and photoaging depending on the exposure amount and form of the UV radiation [1-3]. Although the melanin acts as the skin natural sunscreen, excessive radiations of sunrays are vulnerable and leading to skin-related complications [4]. More than one million people worldwide are suffered from skin cancer and losses their life from malignant cancer every year [5,6]. Nowadays, various forms of sunscreen products are available commercially with synthetic agents for protection against UV exposure. However, synthetic agents have adverse effects on skin and human health due to its toxicity. Herbal based sun protective products have increasing demands owing to its less toxicity. Secondary metabolites produced by medicinal plants and herbs have great tendencies to absorb ultraviolet radiation hence protect skin from damage [7]. Sunscreens have been used for the prevention and treatment of sunburn but several studies have shown that they are not effective in preventing premature aging and skin-related complications [8,9]. Since reactive oxygen species (ROS) is the main causing factor for photoaging and skin cancers, an effective sunscreen should contain antioxidant agents in addition to sunblock agents to be effective in the prevention of photoaging and skin cancer [10,11].

The long-term exposure to solar radiation deteriorates the elastin fibers within the extracellular matrix which leads to a premature decrease in the skin flexibility and natural ability of the skin to repair itself [12]. These days, numerous products of creams for dermal protection such as moisturizers, sunscreens, and lotions are incorporated in the modern cosmeceutical which helps to reduce the chance of the harmful effects of UV radiation in the skin. Although sunscreen blocks UV-A and UV-B to a greater extent and is important for the prevention of negative effects of sun exposure

[13], the growing use of chemicals in it spreads detrimental consequences in peoples' health. So, plant-based sunscreen has been gaining attention in modern cosmetics to counter these problems [14-16]. In this study, our investigation finds out the potency of Nepalese herbal medicinal plants as a skin protective agent; *Asparagus racemosus* Willd., *Bergenia pacumbis* (Buch.-Jam.ex D. Don), *Melia azedarach* L., *Murraya koenigii* (L.) Spreng., *Pleurospermum benthamii* (DC.) C.B. Clarke, and *Thymus linearis* Benth. from Nepalese origin which are being used to treat skin-related complications from traditional medicine practice [17-22].

Materials and Methods

Plant collection, authorization and extract preparation

The respective plant species and plant parts were collected from Humla and Mugu District of Karnali Province and Banke district of Province 5 of Nepal and scientifically authorized in National Herbarium and Plant Laboratory (KATH) Godawori, Lalitpur, Nepal (Table 1).

***Table 1**: Details on plants collection*

Plant code	Plants (Family)	Vernacular name	Collection parts	Traditional uses
ST1	*Asparagus racemosus* Willd. (Asparagaceae)	Ban Kurilo	Rhizomes	reported to be used for treatment of skin diseases and stomach problems [20, 21]
ST2	*Bergenia pacumbis* (Buch. -Jam. ex D. Don) (Saxifragaceae)	Pakhanved	Rhizomes	used for the treatment of stomach problems, fever, cough, cold, and urinary problems [18]
ST3	*Melia azedarach* L. (Meliaceae)	Bakaina	Leaves	effective against treatment of skin disease, circulatory system disorder, fever, and dental problems [22]
ST4	*Murraya koenigii* (L.) Spreng. (Rutaceae)	Kadipatta	Leaves	traditionally used for Skin diseases, stomach problems, and urinary tract infection [17]
ST5	*Pleurospermum benthamii* (DC.) C.B. Clarke (Apiaceae)	Gandhaino	Rhizomes	used for stomach problems, cough, cold, and headache [21]
ST6	*Thymus linearis* Benth. (Lamiaceae)	Ghodamarcha	Leaves	effective for the treatment of stomach problems, cough, cold, and eye infection [19]

The plant materials were dried at room temperature and made powdered by grinding in electrical grinder. Five-gram powder of each samples were macerated with 50 mL of 100% methanol and kept overnight on rotary shaker (JEIO TECH, South Korea) at 150 rpm at 25 ºC. On the next day, entire mixture was filtrated and concentrated to dryness by evaporating on vacuum evaporator (hanil Modul 4080C, South Korea). The extracted crude samples were kept in air tight glass vial and stored at 4 ºC until use.

Determination of in-vitro Sun protective factor (SPF)

The plant extracts were dissolved in methanol (HPLC grade) to prepare the concentration of 0.5 mg/mL and scanned from λ=290 to 320 nm in a UV-Visible spectrophotometer (UV-1800, SHIMADZU). The commercial sunscreens of SPF=30 was used as standard. The SPF was evaluated by an equation proposed by Mansur *et al*. [23].

$$SPF = \text{CF } X \sum_{290}^{320} EE(\lambda) X\, I(\lambda) X\, abs(\lambda)$$

In above equation, CF=10 (Correction factor), EE(λ)=Erythemogenic effect of radiation at wavelength λ, I (λ)=Intensity of solar light at wavelength λ, and abs (λ)=Absorbance of wavelength λ by a solution of the preparation.

***Table 2:** The normalized product function used in the calculation of SPF data*

Wavelength (λ nm)	EE x I (normalized)
290	0.0150
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0839
320	0.0180
Total	1

The values for the term "EE x I" are constants, which were determined by Sayre et al. [24], and are shown in Table 2. To study the effects of UV radiation in SPF values degradation, all absorbance values were measured in every seven days during twenty-one days.

Results and Discussion

Sun protective factor (SPF) value

UV-A (320 to 400 nm) of the UV region of the electromagnetic spectrum is the predominant source of harmful solar radiation then UV-B (290 to 320 nm) and UV-C (200 to 290 nm), which provokes the early aging of the skin by reaching to dermis and epidermis [25]. The SPF is extensively used term in expressing the efficacy of sunscreen, which is defined as the relation of UV energy required to produce a minimal erythema dose on protected skin to unprotected skin. Thus, the higher the SPF, the more effective is the product in preventing sunburn. The exposure to UV radiation affects the skin keratinocytes with inflammatory, metabolic, and proliferative responses which helps to attempt self-protection from and adaptation to UV-induced damage [26]. Effective and safe skin protection against damages induced by solar irradiation remains among the unsolved problems of modern dermatology and cosmetology [27].

Plants extracts are considered as valuable sources of anti-photo-aging and photo-protective agents for the development of cosmeceutical and topical pharmaceutical products these days [28-31]. Many studies support the synergic photo-protective effect among natural plant sources, able to exert synergic anti-photo-aging, anti-inflammatory, and antioxidant activities [32]. The determination of SPF values for all six samples was made through the UV-visible spectrophotometric method and the Mansur equation as described in material and methods. Among the analyzed samples, the methanol extract of *P. benthamii* has highest absorbance value and hence highest SPF value (34.97±0.25) followed by *T. linearis* (24.98±0.60), *B. pacumbis* (24.02±0.15), and *M. koenigii* (10.74±0.32). The SPF values of the plant extract were compared with commercial sunscreen (26.92±0.42). Two plant extracts; *A. racemosus* and *M. azedarach* does not shows potent SPF value (Table 3).

Table 3: *Sun protective factor (SPF)*

Plants	Sun protective factor (SPF)
A. racemosus (ST1)	1.97±0.07
B. pacumbis (ST2)	24.02±0.15
M. azedarach (ST3)	8.20±0.12
M. koenigii (ST4)	10.74±0.32
P. benthamii (ST5)	34.97±0.25
T. linearis (ST6)	24.98±0.60
Commercial Sunscreen (SRN)	26.92±0.42

Sun protective factor (SPF) value degradation

Natural substances are considered as a potential source of skin protection and sunscreen resources because of their absorption in the UV region [33] and their antioxidant activity [34]. Although the skin has the ability to deals against the UV induced oxidative stress, the chronic exposure to UV could generate unwarranted reactive oxygen species (ROS) that leads to oxidative damage causing diverse harmful effects in the skin [35]. The degradation of the substances itself is good for skin protection in the sense that they do not possess significant side effects on the skin they applied. The study was carried out under direct solar for 7, 14, and 21 days (3 weeks) which results in decreases in their SPF values in the exposition of samples to sunlight, revealing that sunscreen products are photosensitive in the range between λ=290 and 320 nm as expected. Our results revealed that the degradation of SPF value is directly correlated with sun exposure time (Figure 1). Our results also revealed that the *P. benthamii* extract has strong sun protection ability as compared with the standard sun screen.

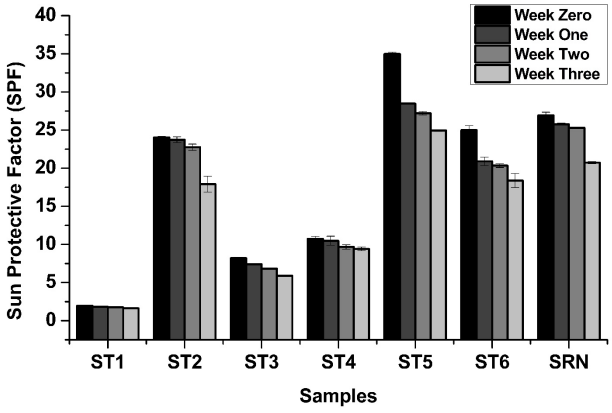

Figure 1*: Sun protective factor (SPF) degradation*

Conclusion

Our results revealed that examined plant extracts have greater tendencies to absorb UV radiation and hence proven to have UV protective effect. Among analyzed plant extracts, *P. benthamii*, *B. pacumbis*, and *T. linearis* have highest sun protective factor and are comparable with the commercially available sunscreen lotions. Hence, these plants can be used as a natural sun protecting agent in sunscreen cosmetic products. Further identification of natural products from these plant species might increase the sun protective effect. Our laboratory is focusing on the identification of natural sun protective agents from these plants extract. Our results open up the possibilities of these plant extract for the developments of cosmetics products.

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