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Research Article

Evaluation of Sun Protection Factor of *Zingiber officinale* Roscoe Extract by Ultraviolet Spectroscopy Method

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Abstract

The purpose of present study was to evaluate the sun protection factor (SPF) of aqueous and methanolic extract of rhizomes of *Zingiber officinale* Roscoe by ultraviolet (UV) spectroscopy method. Aqueous and Methanolic extract of rhizomes of *Zingiber officinale* having concentration of 200µg/ml and 400µg/ml was prepared respectively and the SPF values were evaluated by UV spectroscopy. In this study, it was found that aqueous extract of *Zingiber officinale* (200µg/ml) have SPF value about 1.44±0.034 and aqueous extract of *Zingiber officinale* (400µg/ml) have SPF value about 1.82±0.150. Methanolic extract of *Zingiber officinale* (200µg/ml) have SPF value about 1.48±0.094 and methanolic extract of *Zingiber officinale* (400µg/ml) have SPF value about 1.99±0.033. Marketed sunscreen lotion having concentration 200µg/ml shows SPF value about 0.66±0.006. It shows that the aqueous and methanolic extract of *Zingiber officinale* may absorb the UV radiation and possess good sun protection activity against ultraviolet radiation. These results show that active components responsible for ultraviolet absorption may be isolated from *Zingiber officinale* and used in sunscreens preparations for better protection against sun rays.

Keywords: Sun protection factor, *Zingiber officinale*, Ultraviolet spectroscopy, Sunscreens preparations

1.Introduction

Sun radiation produces 50% visible light (400-800 nm), 40% infrared radiation (1300-1700 nm) and 10% ultraviolet radiation (10-400 nm). Ultraviolet radiation is mainly divided into different types like UV-A region (320-400 nm), UV-B region (290-320 nm), UV-C region (100-290 nm) and vacuo UV (10-100 nm) region.[1] Exposure to UV radiation has pronounced effects on the skin.[2] The Ultraviolet radiation induces various skin responses such as inflammation, erythema, pigmentation, hyperplasia, immunosuppression, vitamin D synthesis, photo carcinogenesis and photo aging. UVB radiation has 30 to 40 folds greater energy than UVA and may produce immunologic functions defects and DNA anomalies and leads to cancer development.[3] UVB radiation is involved in about 65% of skin cancers. Sunscreens preparations are used to protect the skin from harmful aspects of ultraviolet radiation particularly UVB radiation. Sunscreen products are considered as any preparation which intended to be applied on skin to protect it from UV radiation through absorbing, scattering or reflecting radiation.[4] It includes formulations such as cream, ointments, oil, gel and spray. The ideal sunscreen product should provide good protection throughout the whole range UV spectrum, even after sunlight exposure. It should be non-toxic, non-irritating and not produce any type of allergy. Sunscreens are mainly of 2 types, physical blockers and chemical absorbers. Physical blockers such as titanium dioxide and zinc oxide scatter or reflect UV rays. Chemical absorbers such as avobenzone, padimate O, octyl methoxycinnamate, octisalate and octocrylene absorb high intensity UV rays.[5] *In vivo* SPF COLIPA testing method has been used for measuring SPF efficiency but it is time consuming and expensive so currently *in vitro* testing methods are used.[6] For screening or evaluating purpose and to minimize risks related to ultraviolet exposure to human subjects during a sunscreen product development various *in vitro* methods are used. One method involves measurement of absorption or the transmission of UV radiation through sunscreen product films placed in quartz plates and another method involves measurement of the absorption characteristics of the sunscreens product on the basis of spectrophotometric analysis.[7] Ginger (*Zingiber officinale* Roscoe belongs to Zingiberaceae family) is widely used as a spice in the world. Ginger is native to Asia and perennially cultivated in Australia, Brazil, China, India, Jamaica, West Africa and United States.[8] Ginger rhizome is used in Chinese and Ayurvedic medicine as an antiemetic, antipyretic and anti-inflammatory agent.[9] Ginger is herbaceous rhizomatous perennial plant up to 90 cm in height. Rhizomes are aromatic, lobed, pale yellowish colour, bearing simple alternate distichous narrow oblong lanceolate leaves. The ginger constituents are numerous and vary depending on the place of origin and whether the rhizomes are dry or fresh. The primary pungent agents (phenylalkylketones or vanillyl ketones) of ginger are gingerol, with other gingerol analogues such as the shogoals, paradol and zingerone found in high levels in rhizome extracts. *Z. officinale* is reported to possess essential oils, phenolic compounds, flavonoids, carbohydrates, proteins, alkaloids, glycosides, saponins, steroids, terpenoids and tannin as the major phytochemical groups. These phytochemicals plays an important role in the medicinal property of this plant.[10-12] Phenylalkylketones or vanillyl ketones of ginger include 6-gingerol 8-gingerol and 10-gingerol, 6-shogaol, 8-shogaol, 10-shogaol and zingerone. 6-paradol, 6- and 10- dehydrogingerdione and 6- and 10-gingerdione have also been identified.[13] Natural substances extracted from plants have potential sunscreen activity as it absorbs in the UV region due to presence of antioxidants.[15,16]Various plants are evaluated for sunscreen activity like Green tea, *Aloe barbadencis* extract, lichens aromatic compounds and aesculin glycosides.[13-16] It was reported that DNA damaging UV light induces the accumulation of UV light absorbing flavonoids and other phenolics in dermal tissue of the plant body and suggests beneficial role of plant constituents against UV rays.[15-20]

Studies have shown that in vitro pre-treatment with [6]-gingerol reduced UVB-induced intracellular reactive oxygen species levels. It also reduced UVB-induced expression and transactivation of COX-2. Examination by immune histochemistry showed topical application of [6]-gingerol (30 µM) prior to UVB irradiation (5 kJ/m^2) of hairless mice inhibited the induction of COX-2 mRNA and protein and NF-Kb translocation. Hence, it is a promising therapeutic agent against UVB induced skin disorders.[21] Ginger extract is used as one of the ingredient of sun-protection preparation Kama Ayurveda Sunscreen Lotion, Sunscreen lotion containing ginger, nutmeg and lime and

Herbal ChoiceMari Organic Hand & Body Lotion containing Peppermint and Ginger.[22-24] Flavonoids are widely available plant pigments and are water soluble and mainly found in vacuoles and membrane enclosed structure in cells.[25] In the present study, aqueous and methanolic extract of rhizomes of *Zingiber officinale* were evaluated for the SPF by ultraviolet spectroscopy method.

2. Materials and Methods

2.1. Plant material

Zingiber officinale rhizomes powder was obtained from Therin enterprise, Ahmedabad and authenticated by the Department of Pharmacognosy, Jamnagar. A voucher specimen (R-01) was deposited for the same for future reference. The rhizomes were cleaned, dried at 70°C and powdered and extracted with equal volumes of water and methanol with soxhlet apparatus (60-80°C) for 6 h and filtered through Whatman filter paper and concentrated by hot plate drying and air-drying at temperature of 40±2°C to obtain solid residues and stored in cool and dry place. All other reagents used were of analytical grade.

2.2. Sample preparation

100 mg of aqueous and methanolic extract were weighed accurately and dissolved in 100 ml of distilled water in volumetric flask, so the solution of 1mg/ml was produced. From this 2 ml and 4ml of solution was withdrawn and diluted to 10 ml with distilled water so the solution of 200µg/ml and 400µg/ml was produced. Then spectrophotometer readings (ELICO SL-210 Double Beam UV-VIS Spectrophotometer, Hyderabad, India) of these solutions were taken in wavelength ranging from 290 to 320 at 5nm interval and readings were noted down. SPF for aqueous and methanolic extract was calculated from the formula given by Mansur *et al.*,[7] by utilizing values given by Sayre *et al.*,[26] SPF was calculated three times and then mean value was taken in consideration. In vitro SPF can be calculated by following equation:

$$SPF = CF \times \sum_{290}^{320} EE \times I \times Abs$$

Where EE (I) - Erythemal effect spectrum, I (I)-solar intensity spectrum, Abs-Absorbance of sunscreen product, CF-correction factor (=10). The value of EE x I are constant and predetermined as shown in Table 1.

Table 1. Values of EE * I used in the calculation of SPF

Wavelength (λ nm)	EE * 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**

EE- Erythemal effect spectrum, I- solar intensity spectrum

3. Results and Discussion

The yield of aqueous and methanolic extract of *Zingiber officinale* rhizomes was found to be 4.5% (w/w) and 4.8% (w/w). Phytochemical examination revealed the presence of constituents such as carbohydrates, alkaloids, glycosides, saponins, tannins, flavonoids and terpenoids as shown in Table 2.

Table 2. Phytochemical Investigations

Constituents	Aqueous extract of *Zingiber officinale*	Methanolic extract of *Zingiber officinale*
Carbohydrates	+	+
Alkaloids	-	+
Glycosides	+	+
Saponins	+	+
Tannins	+	+
Flavonoids	-	+
Terpenoids	-	+

SPF is a number given to sunscreen formulations to determine its effectiveness and it is also useful when applied about 2mg/cm^2. SPF numbers indicates the time period for the product up to which it protects the person while stay in the sun before burning. In order to protect the skin against ultraviolet radiation, the formulation should have good SPF number and also the formulation should have wide range of absorbance between 290 and 400nm range.[27] In the present research work, aqueous and methanolic extract of rhizomes of *Zingiber officinale* were subjected for SPF evaluation by ultraviolet spectroscopic method. SPF value for sunscreen above 2 isconsidered as having good sunscreen activity.[28] The calculated values of SPF of aqueous and methanolic extract of rhizomes of *Zingiber officinale* are presented in Table 3.

In present study, it was found that aqueous extract of *Zingiber officinale* (200µg/ml) have SPF value about 1.44±0.034 and aqueous extract of *Zingiber officinale* (400µg/ml) have SPF value about 1.82±0.15. Methanolic extract of *Zingiber officinale* (200µg/ml) have SPF value about 1.48±0.094 and methanolic extract of *Zingiber officinale* (400µg/ml) have SPF value about 1.99±0.033. Marketed sunscreen lotion having concentration 200µg/ml shows SPF value about I0.66±0.006. It indicates that aqueous and methanolic extract of rhizomes of *Zingiber officinale* was found near the range of good sunscreen activity. So, it shows that the aqueous and methanolic extract of rhizomes of *Zingiber officinale* may absorb the ultraviolet radiation and possesses good sun protection activity against ultraviolet radiation.

Table 3. Determination of SPF value of aqueous and methanolic extract of rhizomes of *Zingiber officinale*

Sl. No.	Wavelength (λ nm)	EE* I (Normalized)	Aqueous extract of *Zingiber officinale* (200µg/ml)	Aqueous extract of *Zingiber officinale* (400µg/ml)	Methanolic extract of *Zingiber officinale* (200µg/ml)	Methanolic extract of *Zingiber officinale* (400µg/ml)
1	290	0.0150	0.0208	0.0423	0.0198	0.0248
2	295	0.0817	0.108661	0.112201	0.109478	0.136711
3	300	0.2874	0.389906	0.461756	0.430142	0.722332
4	305	0.3278	0.486237	0.595503	0.499349	0.600967
5	310	0.1864	0.294512	0.446117	0.274008	0.352296
6	315	0.0839	0.113824	0.132003	0.124452	0.121935
7	320	0.0180	0.02658	0.03582	0.0264	0.03246
Sun Protecting Factor (SPF)			1.44±0.034	1.82±0.15	1.48±0.094	1.99±0.033

4. Conclusion

From the results obtained it was concluded that the aqueous and methanolic extract of rhizomes of *Zingiber officinale* possesses sun protection activity against ultraviolet radiation. These results shows that the active components responsible for ultraviolet absorption may be isolated from plant *Zingiber officinale* and used in sunscreens preparations for better protection against sun rays.

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References

1. Mensah AY, Sampson J, Houghton PJ, Hylands PJ, Westbrook J, Dunn M. Effects of Buddleja globosa leaf and its constituents relevant to wound healing. J Ethnopharmacol 2001; 77:221-226.
2. Francis PG, Mark M, Frankash J. A review of sunscreen safety and efficacy. Photochem and Photobiology 1998; 68:243-256.
3. Narayanan DL, Rao NS, Joshua LF. Ultraviolet radiation and skin cancer. Intern J Dermatol. 2010; 49:978-986.
4. Steinhauer AF. Laboratory and human exposure evaluation of unique sunscreen formulation. J Society Cosmetic Chemists 1974; 24:541-50.
5. Gasparro FP, Mitchnick M, Nash JF. A review of sunscreen safety and efficacy. Photochem Photobiol 1998; 68:243-256.
6. Bendova H, Akrman J, Krejci A, Kubac L, Jirova D, Kejlova K et al. In-vitro approaches to evaluation of sun protection factor. Toxicol in Vitro 2007; 21:1268-1275.
7. Mansur JS, Breder MN, Mansur MC, Azulay RD. Determinacao do fator de protecao solar por espectrofotometria. An Bras Dermatol 1986; 61:121-124.
8. Langner E, Greifenberg S, Gruenwald J. Ginger: history and use. Advance Thera. 1998;15;25-44.
9. Leung AY. Chinese Herbal Remedies. New York: Universe Books, 124.
10. Otunola GA, Oloyede OB, Oladiji AT, Afolayan AJ. Comparative analysis of the chemical composition of three spices Allium sativum L. *Zingiber officinale* Rosc. and Capsicum frutescens L. commonly consumed in Nigeria. African Journal of Biotechnology 2010; 9:6927-6931.
11. Sasidharan I, Menon AN. Comparative chemical composition and antimicrobial activity fresh & dry ginger oils (Zingiber officinale Roscoe). Int J Curr Pharm Res 2010; 2:40-43.
12. Adel PRS, Prakash J. Chemical composition and antioxidant properties of ginger root (Zingiber officinale). Journal of Medicinal Plants Research 2010; 4:2674-2679.
13. Chrubasik JE, Roufogalis BD, Chrubasik D. Evidence of effectiveness of herbal anti inflammatory drugs in the treatment of painful osteoarthritis and chronic low back pain. Phytother Res 2007; 21:675-683.
14. Liu MC, Lin CT, Shau MD, Chen ZS, Chen MT. Studies on natural ultraviolet absorbers. J. Food Drug Anal 1996; 4:243-248.
15. Bonina F, Lanza M, Montenegro L, Puglisi C, Tomaino A, Trombetta D. Flavonoids as potential protective agents against photo-oxidative skin damage. Int J Pharm 1996; 145:87-91.
16. Urbach F. The historical aspects of sunscreens. J Photochem Photobiol 2001; 64:99-104.
17. Elmets CA, Young C. Sunscreens and photo carcinogenesis: An objective assessment Photochem Photobiol 1996; 63:435-440.
18. Wang ZY, Agarwal R, Bickers DR, Mukhtar H. Protection against ultraviolet B radiation induced photo carcinogenesis in hairless mice by green tea polyphenols. Carcinogenesis 1991; 12:1527-1530.
19. Rancan F, Rosand S, Boehm K, Fernandez E, Hidalgo ME, Quihot W. Protection against UVB irradiation by natural filters extracted from lichens. J Photochem Photobiol 2002; 68:133-139.
20. Strack D. Phenolic Metabolism. Plant Biochemistry. London: Academic Press, 1997.
21. Kim JK, Kim Y, Na KM, Surh YJ, Kim TY. [6]-Gingerol prevents UVB-induced ROS production and COX-2 expression in vitro and in vivo. Free Rad Res 2007; 41:603-614.
22. Availableat:http://www.kamaayurveda.eu/dev/index.php/shop/skincare/sunscreen-lotion.html. Accessed on 20 February 2014.
23. Available at:http://www.sheerskinz.com/sunscreen-lotion-nutmeg-ginger-lime-spf-30-100-ml. Accessed on 20 February 2014.
24. Available at: http://www.herbalchoicemari.com/hcm/peppermint-lotion.html. Accessed on 20 February 2014.
25. Bohm BA. Introduction to flavonoids. Department of botany. University of British Columbia, Vancouver: Harwood Academic Publishers, 5-7.
26. Sayre RM, Agin PP, Levee GJ, Marlowe E. Comparison of *in vivo* and *in vitro* testing of sun screening formulas. Photochem Photobiol 1979; 29:559-566.
27. Elizangela AD, Daniella AGO, Erika RM, Kedor-Hackmann, Maria Ines RM. Determination of sun protection factor (SPF) of sunscreens by ultraviolet Spectrophotometry. Brazilian J Pharma Sciences 2004; 40:381-86.
28. Kale S, Sonawane A, Ansari A, Ghoge P, Waje A. Formulation and In vitro determination of sun protection factor of *Ocimum basilicum* linn. leaf oils sunscreen cream. Int J Pharm Pharm Sci 2010; 2:147-149.